Spokane Valley Rathdrum Prairie Aquifer
3-6 grade Curriculum Unit

Made possible by the Spokane Aquifer Joint Board and the West Valley Outdoor Learning Center for more information contact 509-340-1029 or jami.ostby@wvsd.com

The Spokane Aquifer Joint Board would like to thank all who have made possible this Spokane Rathdrum Prairie Aquifer Curriculum Unit. The Spokane Aquifer Joint Board (SAJB) is comprised of twenty-two water purveyors throughout the Spokane area dedicated to providing safe, clean drinking water to your homes, offices and industries every day. Collectively it operates 122 wells, supplying drinking water to more than 300,000 people in the Spokane area. All purveyors draw water from the same source - the SPOKANE VALLEY - RATHDRUM PRAIRIE AQUIFER and the collective priority of SAJB is to protect the public water supply. The Spokane Aquifer Joint Board would like to express their gratitude to the many talented professionals who have contributed to the development, writing, review, editing, and field testing of the "Spokane Rathdrum Prairie Aquifer Curriculum Unit". We hope the "Spokane Rathdrum Prairie Aquifer Curriculum Unit" will be found as a valuable curriculum which is tied into Washington State Academic standards and Idaho State standards. We would like to especially thank the West Valley School District for their support of this process.
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Dear Educator:
Franklin D. Roosevelt *said "We think of our land and water and human resources not as static and sterile possessions but as life-giving assets to be directed by wise provisions for future days."* The SAJB sponsored the creation of this curriculum in the hopes that it will teach the children who live over and near the aquifer to be good stewards of their most precious resource, clean drinking water.

The themes of this curriculum are:

- Formation of the Aquifer: geology, hydrology, Ice age floods, River/Aquifer Interaction (similarities and differences)
- Quantity: conservation, water budget (inputs, outputs, wildlife, and human use
- Social Issues: Human history, water rights, problems/solutions, the future, sharing a regional resource and occupation opportunities.
- Water Systems: Distribution, storm water (drywells, run-off, and sewer) Waster water (disease) Hydropower (dams).
- Water Quality: Pollution and treatment/testing

Spokane Valley Rathdrum Prairie Aquifer

The Spokane Valley Rathdrum Prairie Aquifer is a high quality underground water body that is the sole source of water for most of the people in Spokane County, Washington and Kootenai County, Idaho. Discovered in 1895, this Aquifer has become one of the most important resources in the region, supplying drinking water to about 500,000 people. The formation of this aquifer began thousands of years ago. The Spokane Valley and Rathdrum Prairie are ancient geologic features that have, for millions of years, been slowly formed by water flowing towards the Pacific Ocean. During the last Glacial Age, between 12,000 and 1.6 million years ago, a series of catastrophic floods covered this area as a result of the rapid draining of ancient Lake Missoula in Montana when ice dams broke. These floods deposited thick layers of coarse sediments (gravels, cobbles, and boulders) in this area. The saturated portion of these

sediments, where void spaces are filled with water, comprises the Aquifer. Waters from adjacent lakes, mountain streams, the Spokane River and precipitation flow through the flood sediments replenishing the Aquifer. The Aquifer begins in Idaho between Spirit Lake and the south end of Lake Pend Oreille. The Aquifer water flows south until it reaches the middle of the Rathdrum Prairie, then it turns west and flows into Washington under the Spokane Valley. When the Aquifer water reaches downtown Spokane, most of it turns north, flows under the city and discharges into the Little Spokane River.

In the 1970s area residents became concerned about aquifer water quality. The highly permeable aquifer boulders, gravel and sands, together with permeable overlying soils, make the Aquifer highly susceptible to contamination from the surface. One of the first important steps to protect the Aquifer was taken by the Environmental Protection Agency, when it designated the Spokane Valley-Rathdrum Prairie a "Sole Source Aquifer" in 1978. The Aquifer was the second aquifer in the nation to receive this special designation. This step further increased public awareness for aquifer protection and supported the development of special management practices by local agencies. Newspaper articles from the 1890s and 1910s relate that area residents believed the Aquifer was an "inexhaustible supply of pure water." The belief that the Aquifer was unlimited continued until the early 1980s when the U. S. Geological Survey presented the results of a flow model for the Aquifer. We now know that while the aquifer is large and plentiful, it is not inexhaustible.

Aquifer Facts

- The Aquifer has one of the fastest flow rates in the nation, flowing as much as 50 feet per day in some areas. In comparison, a typical aquifer has a flow rate between a quarter inch and five feet per day.
- The Aquifer deposits range from about 150 feet to more than 600 feet deep.
- The Aquifer covers 321 square miles.
- The total flow of the Aquifer is estimated at 390 cubic feet per second at the Idaho-Washington state line.
- The volume of the entire Aquifer is about 10 trillion gallons, making it one of the largest aquifers in the United States.
- Even though contamination has reached the Aquifer, the Aquifer water quality remains very good.

We welcome any comments on the lessons in this curriculum. Please let us know what works well or what we could do to make it better. Please feel free to contact Jami at 509-340-1028.

Water and the Spokane Rathdrum Prairie Aquifer System

Activities and Lessons

Formation

Ice Age Floods
Properties of Earth Materials
How Much Will it Hold?
Permeability of Three Earth Materials
Get the Ground Water Picture.
Making an Aquifer System Model
The Edible Aquifer

Water Cycle

The Life of a Water Droplet
The Incredible Journey
Branching Out

Water Systems

Water Town USA
Adventures in the Aquifer/Waterworks
Spokane's Wet-Work Shuffle (adapted from Project WET)
Amazing Water
Pinwheel Power
Hydropower Plant
What Happens When I flush the Toilet?
Where Does My Drinking Water Come From?

Social Issues & History

Spokane Falls Water Works
Investigation: Occupations
Water Rights
Aqua Duck's New Sidekick
The History of Our Aquifer

Quantity

Conserving Water in Your Life
We can all Help Save Our Aquifer!

Water Quality

Keeping Our Aquifer Clean
How Do the Pollutants get Down There?
Our Future Drinking Water

Formation of the Aquifer

Title: Ice Age Floods

Grade Level: 4-6

Overview: Students learn about the Ice Age Floods and the impact they had on our local geology and geography.

Objective: Learn about the Ice Age floods, their cause, their history, and their impact on the Pacific Northwest.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2. Structures: Understand how components, structures, organizations, and interconnections describe systems.
1.2.4 Understand that Earth's system includes a mostly solid interior, landforms, bodies of water, and an atmosphere.
1.3. Changes: Understand how interactions within and among systems cause changes in matter and energy.
2.1.4 Understand how to use simple models to represent objects, events, systems, and processes.
2.1.5 Understand how to report investigations and explanations of objects, events, systems, and processes.

Idaho State Content Standards:
Science:

Goal 1.2.2 Replicate and/or use models.
Goal 1.3.1 Analyze changes that occur in and among systems.
Goal 4.1.1 Describe the interactions among the solid earth, oceans and atmosphere (erosion, climate, tectonics and continental drift).

Materials:

- Paper or Poster Board for each student*
- Markers/Crayons*
- Ice Age Floods Video
- Copies of Glossary (1 for each student)

* Items to be provided by teachers

Time: Pre-Activity: 20 minutes
Video: 25 minutes
Post-Video Activity: 1 hour or more

Background: The glossary activity and Ice Age Floods video provide background information for the remainder of the aquifer unit.

Pre-Video Activity:

To help students prepare for the geology vocabulary words that are included in the video "Ice Age Flood," assign each student one of the words in the glossary. Ask them to SHOW and TELL what their geology word means by creating a large poster explaining in words and also showing in a drawing or sketch what their term means. Have the students share these posters with the class. When the vocabulary terms come up during the video, you might wish to stop the video to refer students to the appropriate poster to remind them of the definition, and invite the student who prepared the poster to personally help explain his or her word.

Glossary

archeologist: scientist who studies the material remains (as fossil relics, artifacts, and monuments) of past human life and activities
bar: mound of gravel and sand deposited by flowing water
bottleneck: a narrow route
cataract: waterfall with a single, sheer drop
channel: the deepest part of a river
cliff: a very steep, vertical, or overhanging face of rock
climate: the average condition of the weather at a place over a period of years
cobble: a rock fragment between 64 and 256 millimeters in diameter, especially one that has been naturally rounded
current: the swiftest part of a stream
dam: a barrier preventing the flow of water
erratic: a large rock that was moved to its present location by glacial ice
flood: peak flow of water that tops the banks of a stream channel
geologist: a scientist who studies the history of the Earth and its life, especially as recorded in rocks
glacier: a mass of ice, formed by the recrystallization of snow, that flows forward, or has flowed at some time in the past
gravel: round rock fragments larger than the sand
Jokulhlaups: a flood created when a body of water held by a glacial dam breaks through the confining walls
loess: wind-blown silt that originated from glacial sediment
margin: outside limit or edge
payload: a load carried
pothole: a circular hole formed in the rocky bed of a river by the grinding action of stones or gravel whirled round by the water
raft: to transport
reservoir: an artificial lake where water is collected and kept in quantity for use

ripple marks: deposits of sediment that have been left by fast-moving water in the shape of parallel, long rows
scabland: an irregular surface of land shaped by floodwaters with exposed lava rocks and a thin layer of soil and sparse vegetation
sediment: matter that settles to the bottom of a liquid
silt: loose sedimentary material with rock particles usually 1/20 millimeter or less in diameter
soil: the upper layer of earth that may be dug or plowed and in which plants grow
topography: the configuration of a surface including its relief and the position of its natural and human-made features
topsoil: surface soil usually including the organic layer in which plants have most of their roots and which the farmer turns over in plowing

Procedure:

1. Watch the Ice Age Floods Video as a class, when each of the glossary words appear in the video, stop the video and have the student share their poster and definition with the class.
2. After the activity, these posters can be hung around the room to remind students of definitions throughout the unit.

Post-Video Activity:

To help make the Glacial Lake Missoula flood "come alive" for students, ask them to paint a mural, sketch out a large poster map, or make a 3-D relief model of the geographic area affected by the Glacial Lake Missoula flood. Locate and label the following geographic locations that are mentioned in the video program:

- Missoula, Montana
- Lake Missoula
- Clark Fork River
- Camas Prairie
- Dry Falls
- Frenchman Cataract
- Wilson Creek
- Walla Walla Valley
- Snake River and main tributaries
- Columbia River and main tributaries
- Phillipi Canyon
- John Day River
- Willamette Valley
- East Portland
- Alameda Ridge
- West Portland and Beaverton
- Rocky Butte

- McMinnville
- Pacific Ocean
- Present states of Washington, Oregon, Idaho, and Montana

Then, review the video and label on the map the Ice Age geologic evidence found at each of these geographic locations (for example, ripple marks, scablands, silt, boulders, gravel, etc.) In groups, ask students to use their geographic/geologic map to visually, and as dramatically as possible, tell the cataclysmic story of the Ice Age floods.

Assessment: Teachers will check student vocabulary definition posters and the floods mural for validity. Students will also be graded on participation during all activities.

Vocabulary: See pre-video activity

Resources:
http://www.opb.org/education/iceageflood/index.html

Title: Properties of Earth Materials

Grade Level: 3-6

Overview: In this investigation, students will focus on observing and recording the properties of three different *Earth material*s; soil, sand and gravel. These materials will be used in further investigations to model a part of the system that we call the Spokane Valley-Rathdrum Prairie Aquifer.

Objective: Students will be able to observe and record properties of three different earth materials.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.1.1 Understand how to use properties to sort natural and manufactured materials and objects.
1.1.5 Understand physical properties of Earth materials including rocks, soil, water, and air.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials:

- Potting soil*
- Sand*
- Gravel*
- Magnifying glass
- Properties of Earth Materials lab sheet.

* Items to be provided by teachers

Time: 30-45 minutes

Background: Three major components of the Spokane Aquifer are soil, sand and gravel. Soil consists of both biotic and abiotic materials. Earth materials are abiotic, non-living portions of the environment. Sand and gravel are examples of earth materials. Each of these materials has different observable properties such as size, shape, color, texture, or smell. Students will observe three earth materials with the aid of magnifying glasses and record their properties on the lab sheet provided. They should also sketch the earth material using their magnifying lens. The properties of each material will interact with another earth material, water in different ways. This lesson is the lesson that the remaining three lessons in this sequence are based upon.

Procedure: Students should work cooperatively in groups of 3 or 4. Each team needs a small container of each of the earth materials, at least one *magnifying glass* and one lab sheet for each member of the team.

1. Each student is responsible for filling in their lab sheet as completely as possible. Vocabulary used to describe each material will vary depending on grade level.
2. After the class has had 5 or 10 minutes to begin to examine the materials, ask for their attention and have several students share a word they have used to describe a property of one of the materials. Help students focus on finding words that mean roughly the same thing to everyone. (Example: Property of Size. Tiny has many different meanings. The size of the tip of a pencil might communicate a common meaning to the class.)
3. Reconvene the investigation. Students should be encouraged to share their observations with other member of their team after they fill in Part One.
4. After all students have had the opportunity to examine each material and record their observations you should either convene the class to share their findings, using the overhead, a piece of chart paper or document camera to record the properties of each Earth material. Collect the lab sheets and fill out a master chart listing the properties of each earth material using student vocabulary. Post the completed summary for the next lab session.

Assessment: This is an investigation designed to provide background knowledge about what earth materials are and provide practice on how we use properties, observable characteristics, to identify and describe those materials. You may want to review the lab sheets to see what kind of language students are using to describe the properties of the various materials.

Extensions: Students can practice drawing what they see using a magnifying glass. They should sketch the object larger that its actual size. This is a skill that needs practice and is foundational to developing observational skills important to examining natural systems.

Vocabulary:

- **Abiotic:** non-living components of a natural system. Light, air, water, and soil (non organic mineral portion) are examples of abiotic components of a natural system.
- **Biotic:** living. The organic portion of soil is biotic.
- **Earth material**: a substance that makes up or comes from the earth.
- **Property**: a characteristic of a *material* or an *object*, something that you can *observe* such as *color*, smell and *texture*.

Resources: Science: K-10 Grade Level Expectations, A New Level of Specificity 2004, FOSS Water, 2000

Student_____
Date_____

Properties of Earth Materials

Directions: Carefully examine each of these earth materials; soil, sand, and gravel. You should use all of your senses except taste. Record your observations in the space below.

	Color	Shape	Size	Texture	Sketch*
Soil					
Sand					
Gravel					

* Be sure to use your magnifying glass to look at each material up close.

Make your sketch bigger than life size and draw all the details that you see.

Title: Permeability of Three Earth Materials

Grade Level: 3-6

Overview: This investigation looks at the permeability of three Earth materials; soil, sand, and gravel. The Spokane Valley-Rathdrum Aquifer exits because of the permeability of the materials of which it is made. The permeability of a material is related to its porosity. This lab explores and demonstrates this property of the three Earth materials that the student has previously worked with. *Gravity* is the *force* that moves the water down through the materials.

Objectives: Students will make a prediction, conduct an experiment and relate the results of the experiment to their prediction. They will be able to follow an established procedure and record data accurately. Students in grades 3 and 4 will be given the changed and measured variables (FORM A). Students in grades 5 and 6 will identify the changed variable and the measured variable (FORM B).

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.1.5 Understand physical properties of Earth materials including rocks, soil, water, and air.
2.1.1 Understand how to ask a question about objects, organisms, and events in the environment.
2.1.2 Understand how to plan and conduct simple investigations following all safety rules.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 1.6: Understand Scientific Inquiry and Develop Critical Thinking Skills
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials: (NOTE) Put the three Earth materials in larger open containers to dry out over night.

Class Materials

- 2 liter water containers with lids*
- Containers of soil, sand and gravel*

Team Materials (Teams of 3 are ideal due to the nature of the materials)

- Soil, sand, gravel, water*
- 9oz SOLO cup with drain holes (3)
- 7oz SOLO cup (3)
- Coffee filter (1)
- 50 mL graduated cylinder
- .5 liter container
- Water

- Permeability/Porosity lab sheet (1 per team member) Form A 3rd or 4th Grade , Form B 5th or 6th Grade
- Scissors (1)*

* Items to be provided by teachers

Time: 45-60 minutes. You may want to save the team report out and the class discussion for a follow up session depending on how the lab progresses.

Background: One of the key features of the Spokane Aquifer is how fast water can flow through it. This is a result of the size of the materials that make up the Aquifer. This experiment will allow students to observe how quickly water flows through the three earth materials. Two factors determine this: permeability and porosity. This lab explores and demonstrates these properties of the three Earth materials that the student has previously worked with.

Procedure:

1. Hand back How Much Will it Hold? lab sheet with their predictions.
2. Tell the class that today they will be testing each material's ability to allow water to pass through it. The property of an Earth material that allows water to pass through is call permeability. It is a result of the porosity of a material. Porosity is determined by how big and/or frequent the spaces are between pieces the material. For today's lab you will measure the permeability/porosity of each Earth materials by how much a given amount of water passes through a sample of each material. The more water that passes through, the greater the materials permeability.
3. Have a student get three 9 oz cups with drain holes, three 7 oz cups and one coffee filter.
    a. Fold the coffee filter in half, then in half again.
    b. Set bottom of one 9 oz cup on the folded coffee filter and trace around the bottom of the cup.
    c. While still folded, cut out the circle on the coffee filter. They will now have 4 filter papers for the bottom of the drain cups. (1 extra)
4. Place a filter paper in the bottom of each drain cup, covering the drain holes.
5. Fill each cup with one of the Earth materials. Cups should be filled to the line below the top of the cup as in previous investigation.
6. Have another team member get enough Permeability of Earth Materials lab sheets for each member of their team.
7. Read and discuss Part 1. Have students review their predictions from the previous lab sheet and fill out their prediction in Part 2 of today's lab. (The focus of the lab is on making a prediction, collecting and using data to check if the prediction was accurate.) Only a prediction is required at 3rd Grade. Lab Sheet Form A. The other elements of the process are at 5th Grade in the GLEs. Lab sheet Form B is provided for upper grades.
8. Students fill each drain cup to the same level with one of the three earth materials and set each filled drain cup into the top of a 7 oz cup.

9. Have a student from each team use the 2 liter pitchers to fill a .5 liter container with water.
10. Fill graduated cylinder with 50 Ml of water. Carefully pore over first earth material (soil). Observe the lower cup. Refill and repeat until you have pored 150 mL of water into the cup containing the soil. Observe after each 50 mL of water.
11. Repeat this process for the sand and then the gravel.
12. Allow all containers to stand until water is no longer dripping from the top cup. Complete Part 5 including the two statements.
13. Have each team report on the results of their experiments. Collect all lab sheets and check for complete accurate thinking.

Assessment: This lab can be used to collect formative data on the class and individual students. Lab sheets should be checked for completeness and reasonableness of thinking. Use information gathered to clarify misunderstandings.

Extensions: Ask students to develop a procedure to remove the sediments or debris from the water in the lower cup with out affecting the amount of water present. Use Form B sheet to place more responsibility on the students for demonstrating their understanding of scientific inquiry.

Vocabulary:

- **Changed Variable:** Only one variable is changed in an experiment. The changed material in this experiment is the earth material. All other variable must remain constant.
- **Measured Variable:** Water is the measured variable in this experiment. The amount of water that passes through the material as a result of its permeability is what will be measured.
- **Gravity:** The force that causes all materials to move towards the center of the earth.
- **Permeability**: The ability of rock or sediment to permit water to pass through it. It is dependent on the number and size of the pores and openings in the material and their interconnectedness.
- **Porosity**: In rock or soil, it is the ratio of the volume of openings in the material to the total volume of the material. For the purpose of our investigation, the measure of porosity is the amount of the 150mL of water that flowed trough the material into the lower cup.

Resources: Science: K-10 Grade Level Expectations, A New Level of Specificity 2004, FOSS Water, 2000, The Spokane Valley-Rathdrum Prairie Aquifer Atlas, 2004 Update.

Form A

Student_____ Date_____

Part 1- Permeability of Earth Materials

Today you are going to conduct an experiment to see which of the three Earth materials will let the most water move through it. The more water that moves through, the more **permeable** the material is said to be. **Permeability** happens when spaces occur between pieces of a material or materials. These spaces may allow water and other materials to pass through. A material with more **porosity** (spaces) will allow water to pass through more quickly. **Gravity** is the force that moves the water down through the materials.

Part 2- Look at your predictions from How Much Will it Hold? to help you complete this part.

Question: Which earth material will allow the most water to move through?

Prediction: I predict that _____ will allow the most water to move through because

_____

_____.

The only ***changed variable*** will be the Earth material.

The ***measured variable*** will be the amount of water that moves into the lower cup.

Part 3- Carefully measure and add 50 ml of water to each material. After the first 50 ml are added to each material, record what do you ***observe*** using the table below. Repeat

	After first 50 mL I observed	**After second 50 mL I observed**	**After third 50 mL I observed**	**mL of water in lower cup***
Soil				
Sand				
Gravel				

Part 4 - *Measure the total water in each lower cup using the graduated cylinder and enter the amounts in the last column. Circle the Earth material that was the most permeable.

Did your prediction turn out to be true? _____ Why or why not?

_____

_____

_____

_____.

_____ is the most permeable of the three Earth materials tested

because_____

_____.

Form B

Student_____ Date_____

Part 1- Permeability of Earth Materials

Today you are going to conduct an experiment to see which of the three Earth materials will let the most water move through it. The more water that moves through, the more **permeable** the material is said to be. **Permeability** happens when spaces occur between pieces of a material or materials. These spaces may allow water and other materials to pass through. A material with more **porosity** (spaces) will allow water to pass through more quickly.

Part 2- Look at your predictions from How Much Will it Hold? to help you complete this part.

Question: Which earth material will allow the most water to move through?

Prediction: I predict that _____ will allow the most water to move through

because_____

_____.

The ***changed variable*** will be _____.

The ***measured variable*** will be the_____.

Part 3- Carefully measure and add 50 mL of water to each material. After the first 50 mL are added to each material, record what do you ***observe*** using the table below. Repeat

	After first 50 mL I observed	**After second 50 mL I observed**	**After third 50 mL I observed**	**mL of water in lower cup***
Soil				
Sand				
Gravel				

Part 4 - *Measure the total water in each lower cup using the graduated cylinder and enter the amounts in the last column. Circle the Earth material that was the most permeable.

Did your prediction turn out to be true? _____ Why or why not?

_____

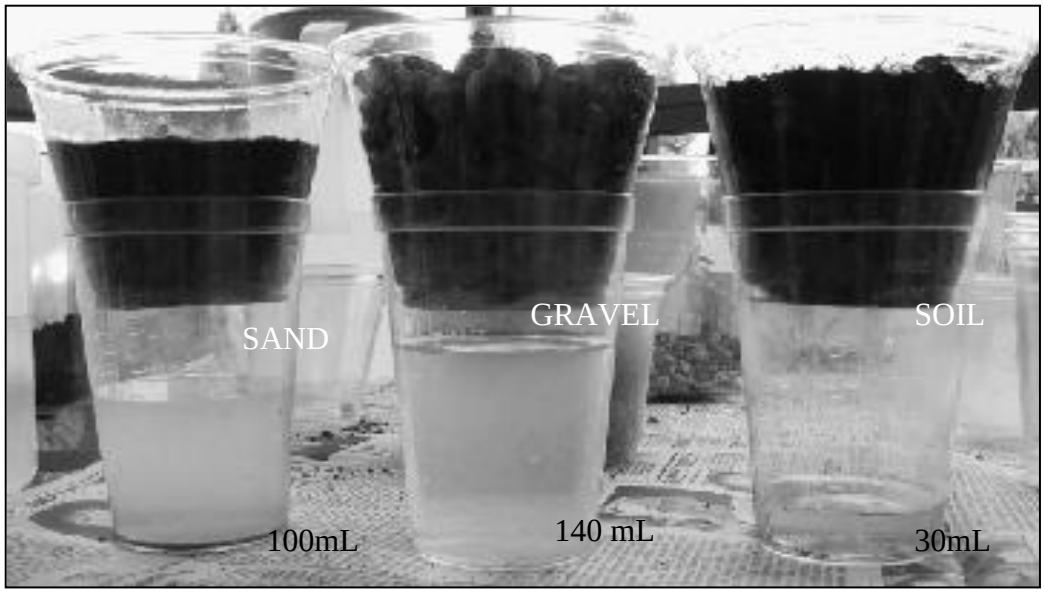
_____

_____.

_____ is the most permeable of the three Earth materials tested

because_____

_____. Preliminary graphic and comments for this investigation.



All materials began at the same level below the rim of the cup. The sand and soil settled during the experiment. I'll need to redo and clean up the graphic before final publication, as well as show them in the correct order. The bottom container is really neat because it has a standard and metric measurement scale built in. I do not recall where I got them. The 50 ml Plastic Graduated Cylinder is available from Delta Education Lab Supplies for 1.95. Item # WW070-2085. I had to go to 150mL of water because of the soil. It was not dry, but not very moist either.

Title: How Much Will it Hold?

Grade Level: 3-6

Overview: In this activity the student adds the Earth material *water* to the soil, sand and gravel to create a *mixture*. A mixture occurs when two or more materials are combined. Mixtures can be separated back in to their original materials. Students conduct this investigation to find out how much water a given volume of each Earth material will hold.

Objective: Students will predict what the outcome of their experiment might be. They will conduct an experiment to test their predictions. Students will be able to measure and record the amount of water that a given earth material can hold and record observations based on the evidence in their data table.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.1.5 Understand physical properties of Earth materials including rocks, soil, water, and air.
2.1.1 Understand how to ask a question about objects, organisms, and events in the environment.
2.1.3 Understand how to construct a reasonable explanation using evidence.

Idaho State Content Standards:
Science:

Goal 1.6: Understand Scientific Inquiry and Develop Critical Thinking Skills
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials: (NOTE) Put the three Earth materials in larger open containers to dry out over night.
For the class:

- Large pitchers of water*
- Containers of soil, sand, and gravel*

For each team:

- Lab Sheet: How Much Will it Hold? (1 per team member)
- 9oz cups (3)
- Plastic spoon (1)
- 50mL graduated cylinder (1)
- .5 liter container of water

* Items to be provided by teachers

Time: 30-45 minutes

Background: New properties emerge when two earth materials interact. The properties of a given earth material will affect the amount of water that can be held by that material.

The soil, which has a large organic component, will hold the most water. As the size of the material increases, more water will flow through. The amount of water held is related to the amount of organic materials and the size of the spaces between the different sized materials. These spaces are another property of the material. For this lesson, make sure that each cup contains the same volume of material, not the same mass.

Procedure:

1. Have student from each group get copies of How Much Will it Hold? lab sheet. Read through the directions and answer and questions the class might have.
2. Show the class the set of materials they will need to conduct the experiment. You may decide it is appropriate to demonstrate the process of adding water, observing and recording on the data sheet.
3. Have each student make a prediction on which will hold the most. They should write their choice on the lab sheet before they begin.
4. Have a team member collect the materials they will need to conduct the experiment. They should fill each cup so that it is even with the line below the rim of the cup using the process listed on the lab sheet. Use a plastic spoon to add additional material if necessary.
5. Students conduct the experiments. Move around the room monitoring the progress of each team.
6. Discuss with class finding of the groups of students.

Assessment: This is a formative activity designed to introduce or review the concept of how different materials interact with water, another *Earth material*. Students are given the opportunity to review *inquiry* by recognizing that all *inquiry* begins with a *question* and a testable *prediction* based on that question. The term *hypothesis* does not occur until the 10^{th} Grade Science Vocabulary List. The focus in elementary school is on making a prediction that can be tested. Student work should be reviewed for comprehension.

Extensions: Depending on the age of the students, you might consider using a sponge and water as an analogy to get students thinking about where the water might go when added to the materials. Pores in the sponge are like the spaces between individual pieces of a material. The water fills those spaces. When all the spaces are filled, the sponge cannot hold any more water. How do you know when a sponge will not hold any more water? What do you see?

Vocabulary:

- **Soil:** a mixture of organic (biotic) and inorganic (abiotic) materials.
- **mL:** milliliter, 1/1000 of a liter.

Resources: Science: K-10 Grade Level Expectations, A New Level of Specificity 2004, FOSS Water, 2000

Student _____Date _____

How Much Will it Hold? Adding water to create mixtures.

The objective of today's lab is to find out how much water, another earth material, can be added to the three Earth materials before the material becomes saturated. We will know this when water appears at the surface of the materials. The amount of water added to each material will be recorded on the data table below.

Question: Which Earth material holds the largest amount of water?

Make a *prediction*. I *predict* that _____ will hold the most water.

Directions:

1. Place one of the Earth materials in each of three 9 oz cups.
2. Gently tap each cup on the desk several times during filling to settle the material.
3. All cups should be filled to the line below the rim of the cup.
4. Fill your graduated cylinder with exactly 50 mL of water. Slowly pour the water evenly across the surface of the Earth material soil.
5. Stop, record water added in mL Water Added column of the table, and observe the cup of soil.
6. Repeat Steps 4 and 5 until you first observe water on the surface of the soil. Stop and record how much water you added to the soil
7. Repeat Steps 4-6 for the sand and the gravel.
8. Total amounts in mL Water Added and record the total in Total mL Water to reach Saturation column.

Earth Materials	mL Water Added*	Total mL Water used to reach Saturation
SOIL + Water		
SAND +Water		
GRAVEL + Water		

*Remember:
50mL **subtract** the amount remaining in the graduated cylinder **equals** the amount used of that 50mL.

Was your prediction correct? Yes / No. Circle one.

The Earth material that held the greatest amount of water was _____.

Why?_____

_____

_____.

What new properties did you discovered?

_____

_____.

What do you predict would happen if you poked a hole in the bottom of each container?

_____

_____

Title: Ground Water

Grade Level: 3-5

Overview: Students will 'get the ground water picture' and learn about basic ground water principles as they become gravel, sand, clay, and water.

Objectives: Students will be able to describe what ground water is and observe ground water moving through a system.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.3.6 Understand weather indicators and understand how water cycles through the atmosphere.
2.1.4 Analyze how models are used to investigate objects, events, systems, and processes.

Idaho State Content Standards:
Science

Goal 1.2: Understand Concepts and Processes of Evidence, Models, and Explanations
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials:

- Clear, plastic cups with holes punched in the bottom for drainage
- Gravel*
- Sand*
- Clay*
- Hand-held magnifying lens

* Items to be provided by teachers

Time: 30 minutes

Background: Students should understand that ground water refers to the water found in spaces between soil particles underground, such as the aquifer.

Procedure:

Tell students they are about to learn how they can 'get the ground water picture'. Explain that hydro geologists study wells to learn the types of rock material located below ground. Ask students what they think it might look like underground and what happens to water after it seeps into the ground.

Part I

Ground Water Demonstration

1. Have students conduct the following activity to learn how water moves through rock materials such as gravel, sand, and clay.

2. Place gravel, sand and clay in separate clear containers. Have students look closely at teach container. A hand-held magnifying glass works well. To demonstrate that ground water moves through underground rock foundations, pour water into each container; observe and discuss the results. Which container emptied the fastest? The slowest? How would the different materials influence water movement in natural systems?

Part II

Ground Water Movement Activity

Conduct the following activity to show how different sizes and kinds of rock material affect water movement. Select three or four students to become molecules of water. The rest of the students will be rock materials.

a. Water Movement Through Gravel

Students become gravel by raising arms outstretched. Students should be able to rotate and not touch other students. The goals of the students representing water molecules is to move (flow) through students representing gravel to the other side of the room.

b. Water Movements Through Sand

Students become sand by extending arms, bending them at the elbows, and toughing waists with fingertips. Students should stand so their elbows are almost touching. The water molecules will experience some difficulty this time, but should still reach the other side of the room.

c. Water Movements Through Clay

Students become clay particles by keeping arms at their sides and huddling together. They should be very close together. They should be very close together, making it a formidable task for water molecules to move through the clay. Without being rough, the water molecules should slowly push their way through the clay. The water molecules may be unable to move through the clay at all.

d. Contaminate Movements Through Earth Materials

Students should be standing in groups representing gravel, sand, and clay in layers. Have some of the water molecules lightly attached colored balloons to themselves with tape. Have other water molecules rub a little flour on the sides of their arms. Cut small pieces of paper and on each write one of the following: bacteria, nitrate, arsenic, and lead. Secretly distribute these pieces of paper to about half of the water molecules and tell students to hide them in their pockets. Have the water molecules move through the students representing gravel, sand,

and clay. The balloons and flour should be 'cleaned' off the water molecules as they move through the earth material (filtered).
After they have all passed through, ask students (except for the 'contaminated' water molecules, "Do you believe that the water that just filtered through the rock particles is clean: that is, would you be willing to drink it?" Students will likely answer yes. Have the contaminated water molecules remove the contaminants from their pockets. Remind students that even though water may appear 'clean', it may still carry contaminants that are only detected through testing.

Assessment: Have students draw, label, and explain how the movement of surface water through earth materials filters out some contaminants.

Title: Making an Aquifer System Model

Grade Level: 3-6

Overview: In this investigation students will create a model of an aquifer using water, soil and gravel in a 2 liter bottle lying on its side with portion of the upper side removed to allow access. The container represents the confining geology and geography of the aquifer, the recharge area. Water from a spray bottle represents precipitation from the water cycle that lands directly on the surrounding geography and the surface of the aquifer. This part of the water cycle is how the aquifer recharges. Students will make predictions about the interactions of different components of the system and test their predictions using the model they construct. (For younger students, it will be necessary to provide each team with the 2 liter bottle already prepared.)

Objectives: Students will be able to create a model of a system, sketch they system and accurately label all the key components. They will be able to state two ways that parts of the system are dependent on each other.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
1.2.4 Understand that Earth's system includes a mostly solid interior, landforms, bodies of water, and an atmosphere.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials:

- Soil, gravel and water*
- 2 liter soda bottles (one per team)*
- Scissors for older students if they are to prepare the bottle*.
- Spray bottles (one per team)
- Lab sheet Aquifer in a Bottle

* Items to be provided by teachers

Time: Two sessions: The first session of 30-45 to construct the model. A second session of 45-60 to investigate the system should follow.

Background: The aquifer is an example of a system. This system has many parts. We have examined the role that different earth materials play in the movement of water. The system also has boundaries, the surrounding geographical and geological area. Geology

and geography confine the aquifer and what provides it with water. The bottle represents these boundaries. The sides of the bottle and the surface of the land above the aquifer comprise the recharge area. The slope of the bottle allows gravity to move water through the system laterally, not just vertically. The aquifer requires continuous recharge for water to flow through it. Anything that can be dissolved by water or has similar properties to water can flow into and through the aquifer. Use maps of the aquifer to determine what geography and geology border the aquifer. These also are active parts of the recharge area.

Procedure:

1. Show the class the materials and demonstrate how to construct the model.
2. Distribute the lab sheet Aquifer in a Bottle. Teams should follow the directions on the lab sheet and answer all prompts.

Assessment: Students should be able to create their aquifer with the gravel on the bottom and the soil on the top. The first sketch should correctly use the terms listed. They should also be spelled correctly. The paragraph should identify two ways in which the aquifer and the water cycle are connected.

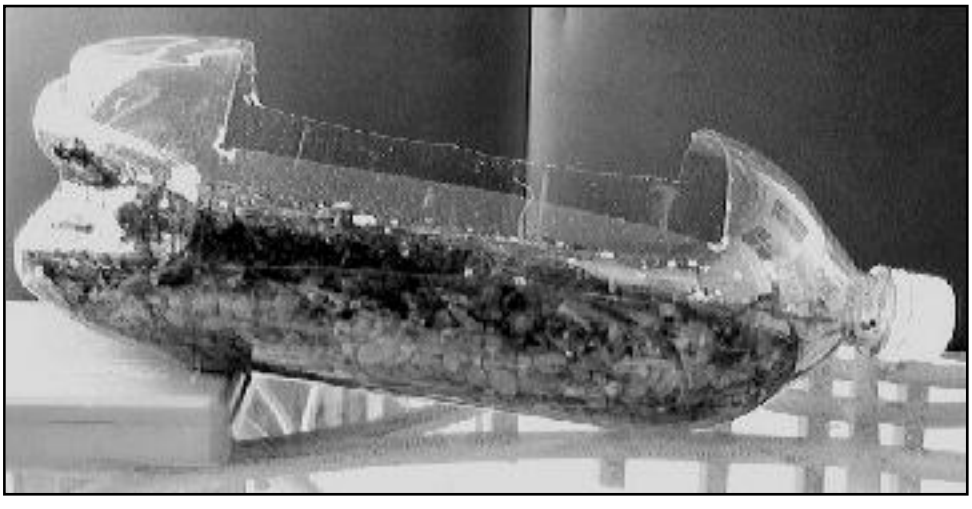
Extensions:

- Students could also create aquifers made out of different combination of the materials they studied and evaluate the different materials interaction as a system.

Vocabulary:

- **Aquifer:** An underground permeable layer of rock or sediment that holds water and allows water to easily pass through.
- **Precipitation:** Any form of water that falls to the ground from the atmosphere.
- **Recharge area:** An area in which an aquifer receives water by the force of gravity moving water down from the surface.
- **Recharge, groundwater:** The addition of water to the zone of saturation. Precipitation and its movement to the water table is an example
- **System:** a system is made up of different parts that work together. An aquifer is a system made up of several parts.

Resources: Science: K-10 Grade Level Expectations, A New Level of Specificity 2004, The Spokane Valley-Rathdrum Prairie Aquifer Atlas, 2004 Update.



Student _____Date_____

Aquifer in a Bottle

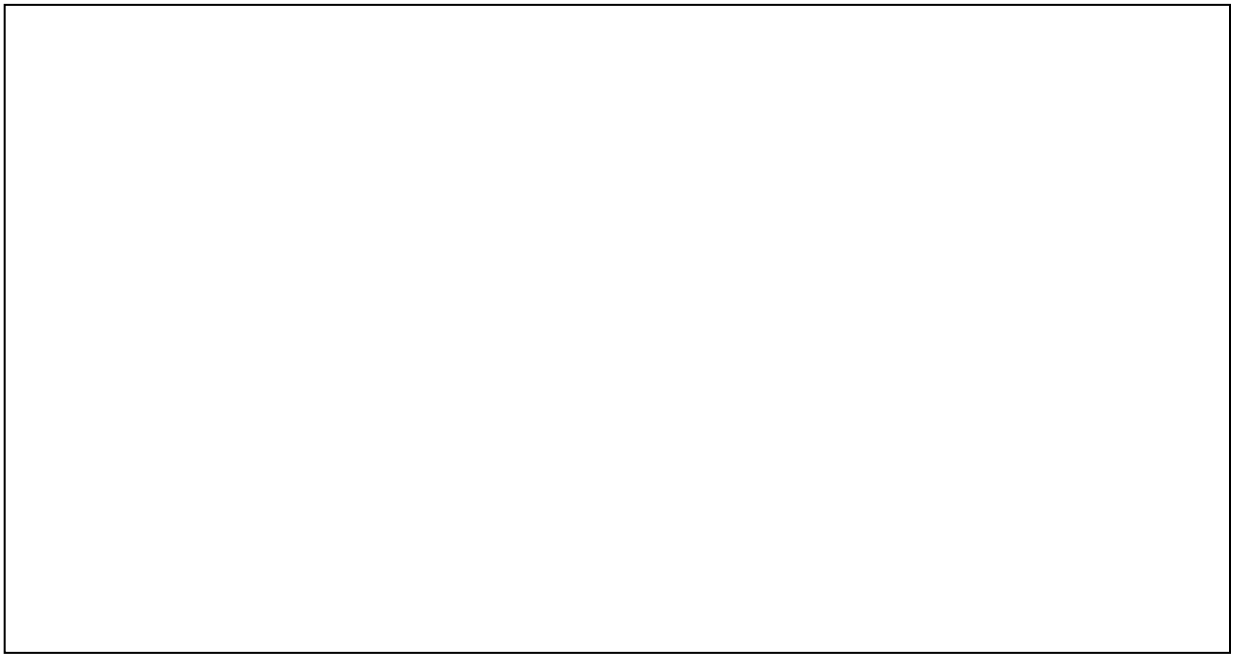
During this investigation, you will use the earth materials that you have been investigating to construct a model of an aquifer. The pop bottle takes the place of the cups from earlier investigations. It will represent the mountains that border the aquifer and the valley floor beneath the aquifer. The soil will represent the surface of the valley. The gravel will represent the aquifer. Water as precipitation will come from the spray bottle. Later in the investigation, you will tilt the bottle so that the cap end is lower. This will allow the force of gravity to move water through the system.

Directions:

1. Set the bottle on its side with the open side on the top.
2. Fill the bottom with gravel up to the level of the cap.
3. Use a spoon to put a thin layer of soil over the entire surface of the gravel.
4. Draw a sketch of your aquifer in the space below. Label the different parts of the aquifer model; Surrounding mountains, valley bottom, top soil, aquifer.

5. What do you predict will happen when you spray water directly onto soil?____ _____.
   What do you predict will happen when you spray water onto the inside of the bottle wall and into the "base" of the bottle? _____ _____.
6. Begin to spray water onto the soil and the sides of the bottle. Stop often to observe the soil, grave and sides of the bottle.
7. After the aquifer has filled to the level of the bottle cap, place a book under the opposite end of the bottle so the bottle cap is "down hill". What happens to the water in the gravel? The water in the gravel _____ _____.

8. What do you predict will happen when you remove the cap from the bottle? _____.
9. Place a container under the cap end of the bottle and carefully remove the cap.
10. What do you need to do the keep the water from the gravel flowing out of the bottle? How can you **recharge** your aquifer? _____ _____ _____.
11. Try your idea and see if it works?
12. Sketch your aquifer model again showing both how water gets into the aquifer and where it flows out.



13. Write a short paragraph describing two ways the parts of this system depend on each other. Be sure to use the vocabulary you have learned in your paragraph.

_____

_____

_____

_____

_____

_____

_____

_____

Title: The Edible Aquifer

Grade Level: 3-4

Overview:
Students will learn of the geologic formations in an aquifer, how pollution can get into the groundwater and how pumping can cause a decline in the water table.

Objectives:
Students will be able to identify all parts/layers of an aquifer and what happens when pollution is introduced to the aquifer.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2. Structures: Understand how components, structures, organizations, and interconnections describe systems.
1.3.6 Understand weather indicators and understand how water cycles through the atmosphere.
3.1 Designing Solutions: Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.

Idaho State Content Standards
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Background: Students should have an understanding of the aquifer. An aquifer is an underground bed of saturated soil or rock that yields significant water.

Materials:

- Blue/red food coloring
- 1 quart vanilla ice cream*
- 2-2 liter bottles of lemon-lime soda*
- Small gummy bears, chocolate chips, crushed cookies, cereal, crushed ice or other material to represent sand and gravel*
- Variety of colored cake decoration sprinkles & sugars*
- Drinking straws*
- Clear plastic cups*
- Ice cream scoop*
- Spoons*

* Items to be provided by teachers

Duration:
20-30 minutes

Procedures:

1. Review "What is groundwater?" and aquifer vocabulary terms.
2. Begin to construct your edible aquifer by filling a clear plastic cup 1/3 full with gummy bears, chocolate chips, crushed cookies, or crushed ice to represent gravels and soils.
3. Pour a little soda into each cup (there should be no standing water on top of sand) to let students see how the water is absorbed in the 'sand', but remains around the 'sand particles' as it is stored in the ground and ultimately forms part of the aquifer.
4. Add a layer of ice cream to serve as a 'confining layer' over the soda-filled aquifer. With a spoon, have the students press the ice cream to one side of the container to seal off that side. This 'confining layer' keeps water from passing through it. Pour a small amount of soda onto the ice cream. Let the students see how the soda remains on tope of the ice cream, only flowing into the sand below in areas not covered by the confining layer.
5. Next have students add chocolate chips and sprinkles to cover the entire container as rocks and topsoil. To one side of your cup, have students slope the rocks, forming a high hill and a valley. Explain to students these represent some of the many layers contained in the earth's surface.
6. Now pour the soda into your aquifer until the soda in the valley is even with your hill. Students will see the soda stored around the rocks. Explain these rocks are porous, allowing storage of water within the pours and openings between them. They will also notice a 'surface' supply of water (a small lake) has formed. This will give them a view of both the ground and surface water supplies that can be used for drinking water purposes.
7. Now add the food coloring to the top of the hill. The food coloring represents contamination like oil, lawn fertilizers, trash, and farm chemicals. Watch what happens when it is poured on the top of the 'aquifer'. Point out that the same thing happens when contaminants are spilled on the earth's surface.
8. Using a drinking straw, drill a well into the center of your aquifer. Slowly begin to pump the well by sucking on the straw. Watch the decline in the water table. Notice when the aquifer is lowered, the lake also loses water. Notice how the contaminants can get sucked into the well area and end up in the groundwater by leaking through the confining layer.
9. Now recharge your aquifer by adding more soda which represents a rain shower. Review what your have learned as you enjoy eating your edible aquifer.

Assessment:

Follow up with a discussion of other activities that can pollute our aquifer. Assign students the task of locating activities around the school or their own homes that could pollute their drinking water sources if not properly maintained. Students should discuss with parents what steps they can take as a household to prevent water pollution.

Adapted from EPA, Aquifer in a Cup and
Edible Earth Parfaits, wwww.groundwater.org

Water Cycle

Title: Water Droplet Day

Grade Level: 3-5

Summary: This lesson allows students to apply what they have learned about the water cycle into a creative writing assignment.

Objective: The student will demonstrate knowledge of the water cycle, as well as apply knowledge of the water cycle, by writing a story about a water droplet in all phases of its cycle (precipitation, collection, run off, evaporation/transpiration, condensation).

Standards/GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.

1.2.4 Understand that Earth's system includes a mostly solid interior, landforms, bodies of water, and an atmosphere.

Writing:

1. The student understands and uses a writing process.
2. The student writes in a variety of forms for different audiences and purposes.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization

Language arts:

Goal 4.1: Acquire Expressive (Narrative/Creative) Writing Skills

Goal 4.1.1 Write short narratives with a logical sequence of events that include a beginning, middle, and end.

Duration: Up to one school week (depending on editing and re-writing)

Materials:

- Writing materials*
- Pencils/Pens*
- Paper*
- Computers*

* Items to be provided by teachers

Procedure:

1. Teach water cycle prior to this lesson.
2. Read example "Drop story" to students, or copy and hand out copies to each.
3. Instruct students that they will also be creating a story about a water droplet moving through the water cycle.
4. Give time in class to brainstorm and begin writing process.
5. Revise, edit, rewrite…..at teacher's digression.

Assessment:

Rubric

Phases of the water cycle were clear
1 2 3 4 5 6 7 8 9 10
Story was related to water cycle
1 2 3 4 5 6 7 8 9 10
Story was well-written with few errors
1 2 3 4 5 6 7 8 9 10
Story was enjoyable to read
1 2 3 4 5 6 7 8 9 10
Conventions of writing (spelling, sentence structure, punctuation, etc…)
1 2 3 4 5 6 7 8 9 10

Total _____/50 total points

Extensions:

Peer editing
Story share (students pass stories around the room)
Read-aloud of stories
Illustrations required in story

Suggested Resources for teaching the water cycle :
http://ga.water.usgs.gov/edu/watercyclesummary.html
http://www.kidzone.ws/water/
http://www.epa.gov/safewater/kids/flash/flash_watercycle.html

Example "Drop Story":

If you want to travel the world, help people everywhere you go, and see the Earth top to bottom you should consider a career as a water drop. You can't name a country I haven't seen. I've been a river in Thailand, swam the arctic oceans, made wine in France, grown pineapples in Hawaii, and provided drinking water in Africa.

Just this past year, I made a fascinating journey through the Rathdrum Prairie Spokane Valley Aquifer. It all started last October when I was swimming though the Puget Sound. It was really warm that day and as I made my way to the surface the warmth gave me so much energy that I felt I could l just jump into the sky. So I did and I flew past the space needle in Seattle and over the Cascade mountains.

Then I traveled over the deserts in the middle of Washington, past Spokane and into the Rocky Mountains of Northern Idaho. Well I don't have to tell you that Northern Idaho in October is COLD. I got so cold that I begin to lose all my energy and suddenly I couldn't move at all. I started falling to the ground as a solid piece of ice. It was quite the fall. Luckily I landed in a big snow drift where I was able to see my cousins and my best friend from the 1st grade. His name was aqua and he had recently been staying in Brazil as a waterfall. Anyway it was a great Holiday season but as spring came we began to warm up again and I felt very loose and free. My friends and I began shooting down the mountains towards Hayden Lake. I got to swim for about three days before I suddenly found myself flowing in the aquifer. I swam through boulders and around rocks. It was fun but very dark since it is underground and all.

So I was down under ground when suddenly I heard a loud roar and was suddenly sucked to the surface, pushed through a long pipe until I ended up here in the drinking fountain at your school. As you can see I have quite the career. If it's something you might be interested in you should apply today!

Title: Roll of the Die

Grade Level: 3-6

Overview:
This lesson provides students with first hand experience of what it is like to be water in the water cycle. With the roll of a die, students simulate the movement of water within the water cycle.

Objective:
Students will be able to describe the movement of water within the water cycle. Students will be able to identify the states of water as it moves through the water cycle.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2 know that matter can undergo changes of state such as evaporation, condensation, freezing and thawing
1.3 recognize that water is continually cycled
2.1 model processes by representing them physically

Idaho State Content Standards:
Science:

Goal 2.1: Understand the Structure and Function of Matter and Molecules and Their Interactions
Goal 1.1: Understand Systems, Order, and Organization

Materials:

- 9 large pieces of paper*
- Copies of Water Cycle Table (optional)
- Marking pens*
- 9 boxes, about 6 inches (15 cm) on a side

  Boxes are used to make dice for the game. Gift boxes used for coffee mugs are a good size or inquire at your local mailing outlet. There will be one die [or box] per station of the water cycle. [To increase the pace of the game, use more boxes at each station, especially at the clouds and ocean stations.] The labels for the sides of the die are located in the Water Cycle Table. These labels represent the options for pathways that water can follow. Explanations for the labels are provided. For younger students, use pictures.
- A bell, whistle, buzzer, or some sound maker

* Items to be provided by teachers

Time: 2- 50 minute Sessions

Background:
While water does circulate from one point or state to another in the water cycle, the paths it can take are variable. Heat energy directly influences the rate of motion of water molecules (refer to the activity "Molecules in Motion"). When the motion of the molecule increases because of an increase in heat energy, water will change from solid to liquid to gas. With each change in state, physical movement from one location to another usually follows. Glaciers melt to pools which overflow to streams, where water may evaporate into the atmosphere. Gravity further influences the ability of water to travel over, under, and above Earth's surface. Water as a solid, liquid, or gas has mass and is subject to gravitational force. Snow on mountaintops melts and descends through watersheds to the oceans of the world. One of the most visible states in which water moves is the liquid form. Water is seen flowing in streams and rivers and tumbling in ocean waves. Water travels slowly underground, seeping and filtering through particles of soil and pores within rocks. Although unseen, water's most dramatic movements take place during its gaseous phase. Water is constantly evaporating, changing from a liquid to a gas. As a vapor, it can travel through the atmosphere over Earth's surface. In fact, water vapor surrounds us all the time. Where it condenses and returns to Earth depends upon loss of heat energy, gravity, and the structure of Earth's surface.
Water condensation can be seen as dew on plants or water droplets on the outside of a glass of cold water. In clouds, water molecules collect on tiny dust particles. Eventually, the water droplets become too heavy and gravity pulls the water to Earth. Living organisms also help move water. Humans and other animals carry water within their bodies, transporting it from one location to another. Water is either directly consumed by animals or is removed from foods during digestion. Water is excreted as a liquid or leaves as a gas, usually through respiration. When water is present on the skin of an animal (for example, as perspiration), evaporation may occur. The greatest movers of water among living organisms are plants. The roots of plants absorb water. Some of this water is used within the body of the plant, but most of it travels up through the plant to the leaf surface. When water reaches the leaves, it is exposed to the air and the sun's energy and is easily evaporated. This process is called transpiration. All these processes work together to move water around, through, and over Earth.

Procedure:
Warm Up:
Ask students to identify the different places water can go as it moves through and around Earth. Write their responses on the board.

Activity:
1. Tell students that they are going to become water molecules moving through the water cycle.
2. Categorize the places water can move through into nine stations: Clouds, Plants, Animals, Rivers, Oceans, Lakes, Ground Water, Soil, and Glaciers. Write these names on large pieces of paper and put them in locations around the room or yard. (Students may illustrate station labels.)
3. Assign an even number of students to each station. (The cloud station can have an uneven number.) Have students identify the different places water can go from their

station in the water cycle. Discuss the conditions that cause the water to move. Explain that water movement depends on energy from the sun, electromagnetic energy, and gravity. Sometimes water will not go anywhere. After students have come up with lists, have each group share their work. The die for each station can be handed to that group and they can check to see if they covered all the places water can go. The *Water Cycle Table* provides an explanation of water movements from each station.

4. Students should discuss the form in which water moves from one location to another. Most of the movement from one station to another will take place when water is in its liquid form. However, any time water moves to the clouds, it is in the form of water vapor, with molecules moving rapidly and apart from each other.
5. Tell students they will be demonstrating water's movement from one location to another. When they move as liquid water, they will move in pairs, representing many water molecules together in a water drop. When they move to the clouds (evaporate), they will separate from their partners and move alone as individual water molecules. When water rains from the clouds (condenses), the students will grab a partner and move to the next location.
6. In this game, a roll of the die determines where water will go. Students line up behind the die at their station. (At the cloud station they will line up in single file; at the rest of the stations they should line up in pairs.) Students roll the die and go to the location indicated by the label facing up. If they roll stay, they move to the back of the line. When students arrive at the next station, they get in line. When they reach the front of the line, they roll the die and move to the next station (or proceed to the back of the line if they roll *stay*). In the clouds, students roll the die individually, but if they leave the clouds they grab a partner (the person immediately behind them) and move to the next station; the partner does not roll the die.
7. Students should keep track of their movements. This can be done by having them keep a journal or notepad to record each move they make, including stays. Students may record their journeys by leaving behind personalized stickers at each station. Another approach has half the class plays the game while the other half watches. Onlookers can be assigned to track the movements of their classmates. In the next round the onlookers will play the game, and the other half of the class can record their movements.
8. Tell students the game will begin and end with the sound of a bell (or buzzer or whistle). Begin the game!

Wrap Up:

Have students use their travel records to write stories about the places water has been. They should include a description of what conditions were necessary for water to move to each location and the state water was in as it moved. Discuss any *cycling* that took place (that is, if any students returned to the same station).

Assessment:

Students will be assessed on their ability to correctly cycle through the activity in the correct manner. They will also be assessed on their travel records and stories that they write about their travels.

Extensions:

Have students compare the movement of water during different seasons and at different locations around the globe. They can adapt the game (change the faces of the die, add alternative stations, etc.) to represent these different conditions or locations.

Have students investigate how water becomes polluted and is cleaned as it moves through the water cycle. For instance, it might pick up contaminants as it travels through the soil, which are then left behind as water evaporates at the surface. Challenge students to adapt "The Incredible Journey" to include these processes. For example, rolled-up pieces of masking tape can represent pollutants and be stuck to students as they travel to the soil station. Some materials will be filtered out as the water moves to the lake. Show this by having students rub their arms to slough off some tape. If they roll *clouds*, they remove all the tape; when water evaporates it leaves pollutants behind.

Resources:

Alexander, Gretchen. 1989. *Water Cycle Teacher's Guide.* Hudson, N.H.: Delta Education, Inc.

Mayes, Susan. 1989. *What Makes It Rain?* London, England: Usborne Publications.

Schmid, Eleonore. 1990. *The Water's Journey.* New York, N.Y.: North-South Books.

WATER CYCLE TABLE

Station	Die Side	Label Explanation
SOIL	One Side *Plant*	Water is absorbed by plant roots.
	One Side *River*	The soil is saturated, so water runs off into river.
	One Side *Ground Water*	Water is pulled by gravity; it filters into the soil.
	Two Sides *Clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	One Side *Stay*	Water remains on the surface (perhaps in a puddle, or adhering to a soil particle).
PLANT	Four Sides *Clouds*	Water leaves the plants through the process of transpiration.
	Two Sides *Stay*	Water is used by the plants and stays in the cells.
RIVER	One Side *Lake*	Water flows into a lake.
	One Side *Ground Water*	Water is pulled by gravity; it filters into the soil.
	One Side *Ocean*	Water flows into the ocean.
	One Side *Animal*	An animal drinks water.
	One Side *Clouds*	Heat is added to the water, so the water evaporates and goes to the clouds.
	One Side *Stay*	Water remains in the current of the river.
CLOUDS	One Side *Soil*	Water condenses and falls on soil.
	One Side *Glacier*	Water condenses and falls as snow onto a glacier.
	One Side *Lake*	Water condenses and falls into a lake.
	Two Sides *Ocean*	Water condenses and falls into the ocean.
	One Side *Stay*	Water remains as a water droplet clinging to a dust particle.

Station	**Die Side**	**Label Explanation**
OCEAN	Two Sides *Clouds*	Heat energy is added to the water, so the water evaporates and goes to the clouds.
	Four Sides *Stay*	Water Remains in the ocean.
LAKE	One Side *Ground Water*	Water is pulled by gravity; it filters into the soil.
	One Side *Animal*	An animal drinks water.
	One Side *River*	Water flows into the river.
	One Side *Clouds*	Heat energy is added to the water, so the water evaporates and goes into the clouds.
	Two Sides *Stay*	Water remains within the lake or estuary.
ANIMAL	Two Sides *Soil*	Water is excreted through feces and urine.
	Three Sides *Clouds*	Water is respired or evaporated from the body.
	One Side *Stay*	Water is incorporated into the body.
GROUND WATER	One Side *River*	Water filters into the river.
	Two Sides *Lake*	Water filters into the lake
	Three Sides *Stay*	Water stays underground
GLACIER	One Side *Ground Water*	Ice melts and water filters into the ground.
	One Side *Clouds*	Ice evaporates and water goes to the clouds (sublimation).
	One Side *River*	Ice melts and water flows into the river.
	Three Sides *Stay*	Ice stays frozen in the glacier.

Title: Water Limbs

Grade Level: 3-6

Overview: Student build a model landscape to investigate how water flows through and connects watersheds.

Objectives: Students will be able to draw, label, and explain how water filters down to a closed /open aquifer.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system interconnect and influence each other.
2.1.1 Understand how to generate a question that can be answered through scientific investigation.
2.1.2 Understand how to plan and conduct scientific investigations
2.1.3 Apply understanding of how to construct a scientific explanation using evidence and inferential logic.
2.1.4 Analyze how models are used to investigate objects, events, systems, and processes.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Materials:

- Copy of "Branching Patterns"
- Blue colored water
- Spray bottle
- Drawing paper and pencil*
- Blue pens
- Tracing paper
- Copies of local map showing rivers*
- White scrap paper, newsprint or butcher paper*
- 5-10 rocks, ranging from 2-6 inches in height*
- Square or rectangular aluminum tray, large enough to hold rocks
- Heavy plastic wrap

* Items to be provided by teachers

Time: 50 minutes

Background: Students should have an understanding of open and closed watershed systems. In closed systems, such as Crater Lake in southwest Oregon, water collects at a low point that lacks an outlet. The only way water naturally leaves the system in through

evaporating or seeping into the ground. Most watersheds are open; water that collect in smaller drainage basins overflow into Outlet Rivers and eventually empties into the sea.

Procedure:

1. Show students the copy of Branching Patterns (the outlines of a watershed's drainage pattern, a tree in winter, the human nervous system, and a road map). Ask them what all the pictures have in common.
2. Instruct student wrap rocks with scrap white paper and lay them in a rectangular or square aluminum tray. Place larger rocks near one end of the tray. Cover the rocks snugly with plastic wrap.
3. Have student's sketch a bird's-eye view of the model. They should mark points of higher elevation with "H" and low spots with "L". To identify possible ridgelines, connect the Hs. On a few of the low spots use a stick pin to punch holes to represent the water movement into groundwater.
4. Tell students that the model will soon experience a rainstorm. Where do they think water will flow and collect in the model? Have them sketch predictions on their drawings. Show them crevices in the model and possible locations of watersheds.
5. Spray blue-colored water over the model and note where it flows. Water may need to be sprayed for several minutes to cause a continual flow. Assist students in identifying branching patterns as water from smaller channels merges into larger streams.
6. Have student use blue pencil to mark on their drawings the actual branching patterns of water. Some imagination and logic may be required. Ask them to confirm the locations of watersheds by noting where water has collected in the model.
7. Have students determine if smaller watersheds overflow into larger ones. Does all the water in the model eventually drain into one collection site? Does the model contain several closed watershed systems (collection sites that lack an outlet)?

Assessment: Have students write a story about the drainage patterns in their watershed.

Extensions: Have students compare their drawings/stories to *Where the River Begins,* a story by Thomas Locker. In the book, two boys and their grandfather follow a river to its source.

Vocabulary:

- Watershed: The land area from which surface runoff drains into a stream channel, lake, reservoir, or other body of water; also called a drainage basin.
- Aquifer: An underground bed of saturated soil or rock that yields significant quantities of water.
- Tributary: A stream that contributes its water to another stream or body of water.
- Runoff: Precipitation that flows overland to surface streams, rivers, and lakes

Water Systems

Title: Water Planning Role Play

Overview: Students will learn about economics and environmental planning as they calculate the cost of building a water development projects.

Objectives:

Students will calculate the costs involved in supplying clean water to consumers and removing wastewater.

Students will recognize that cost and environmental considerations influence the planning and construction of water projects.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

3.1.2 Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.

Idaho State Content Standards:
Science:

Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Goal 5.2: Understand the Relationship between Science and Technology

Materials:

- Utility Bill (optional)*
- Sim City Computer game (optional)*
  This game allows students to experience what a city planner does.
- A set of Water Town City maps for each group
- (you may want to enlarge to 11 by 17)
- A set of Water Town City Voters Needs for each group
- Class set of the Mayor's Letter
- A set of Water Town City Calculation Check for each group
- A group set of Water Town City Rubric
- A piece of blank paper to sketch*
- Rulers*
- Calculators*
- One copy Components of Municipal Water and Wastewater Treatment

* Items to be provided by teachers

Time: 15 min prep time, 45 minute lesson

Procedure:

- Show or describe a water bill to the students.
- Ask students what do they think is involved in establishing the cost of the water?
- Have students sketch a diagram of how they think water gets from water resources to their homes and back to the water source.
- Use the *Components of Municipal Water and Wastewater Treatment* sheet for a reference.
- What do students think of the costs reflected in a water bill now?

1. Explain that the mayor has just asked our class to help redesign their municipal water and wastewater treatment system. Show students the letter from the mayor.(This letter will explain what the city needs and what your job will be)
2. Divide the class into small groups. Pass out the Water Town City Voters Needs and the Water Town City maps. Each group will have to collaborate to determine how they will stay within the city budget and meet the voters' needs. You may want to assign different roles, such as county auditor, a water inspector, a city planner, and a spokesman for the city council.
3. Have the students share their community plans with The Water Town City council (the class) they will need to make sure that the City Council President assess the project with the Water Town City Rubric. You will need to pick a student to be the city council president or be it yourself.

Assessments:

Through informal observation during student work time, students can be assessed on working well with one another. You will also have the Water Town City Rubric.

Extensions:

Have students write a play or act out different situations as bankers, and project designers. The project designers can ask for loans.

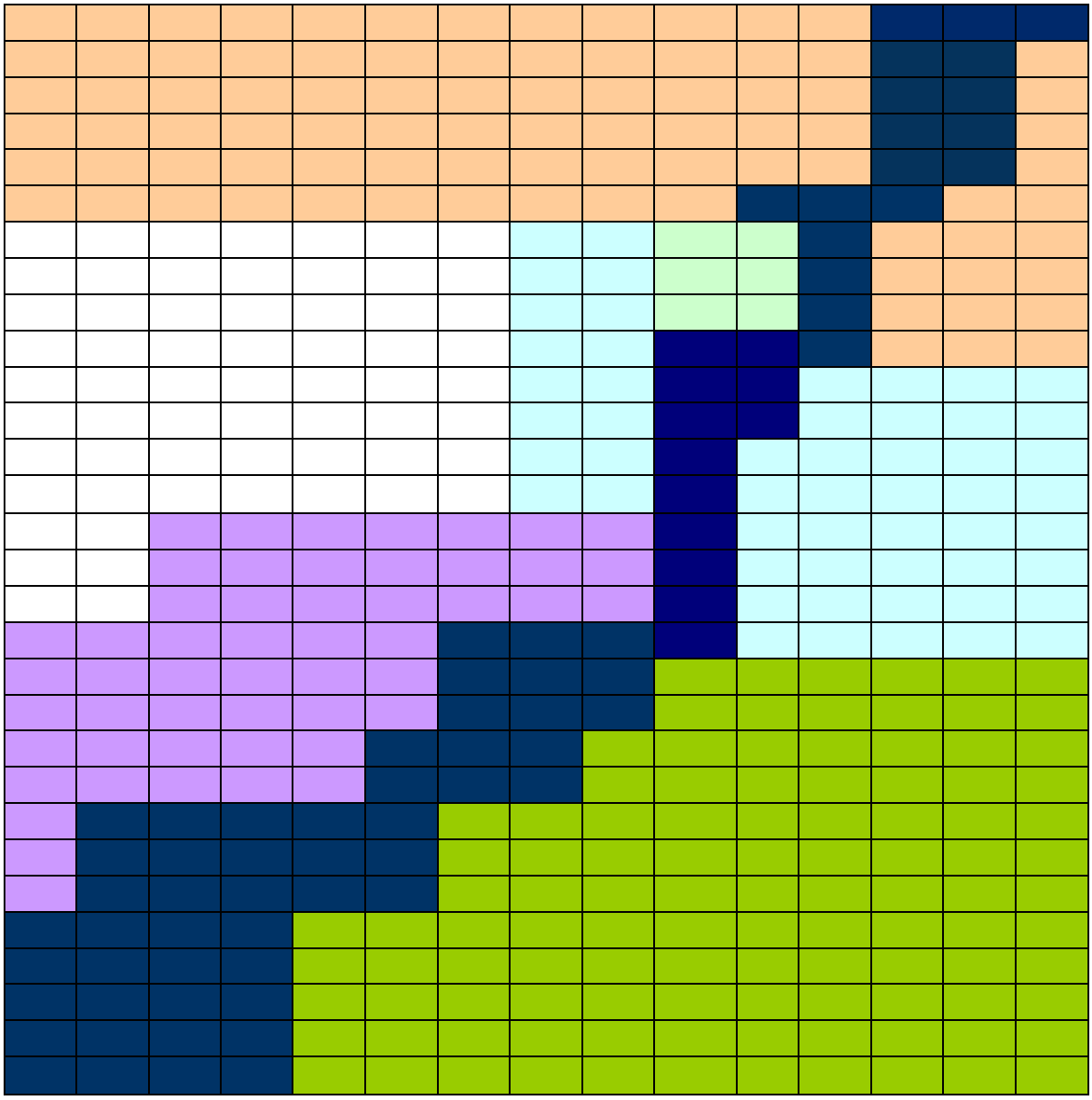
Resources:

Books:

- Barnes, 1981, Water and Wastewater Engineering Systems
- Cheremisnoff, Paul,1993, Water Management and Supply

Map

East



West

Label a River

Locate

_____a Park Neighborhood

_____South Hill area **_____ West Central City**

_____ North town **_____ The City Valley**

Components of Municipal Water and Wastewater Treatment Systems

HOUSEHOLD:

1. a 200 foot deep well, $2,400
2. bathroom faucet, $65
3. dishwater, $410
4. Swimming pool, $16,000
5. hot tub, $ 6,000
6. septic tank, $5,000

CITY

1. 6 million gallon water storage tank, $5 million
2. wastewater treatment plant, $45 million
3. water treatment plant $ 8 million
4. a sprinkler system for a golf course, $450,000
5. a man hole, $2,000

Dear Conscious Citizens,

This is a special letter to your class. As the mayor we are looking for input from all of our citizens. As the mayor, I am asking you and a group of your class mates to help design a new water system for our city. Over time, some of our water lines and pipes have needed to be replaced. We are also experiencing growth in many neighborhoods. I am attaching a letter the Mayor's office received a list of needs of our citizens. I hope you can help me to help accommodate them. After you are finished designing a water system, I would like to personally invite you to present your ideas for the City Council in 3 days. Our city planners would like you to know that we do have to follow some very strict rules and regulations. I would encourage you to do your best to follow these. I look forward to seeing you at the council meeting.

Yours truly,

The Mayor

Simulated City Voters Wants and Needs

The Simulated City has designated a total of $75 million.

City Costs

$6 million - A well to store water which supports 25,000 people.

$45 million- Waste Water Treatment facility

$5,000 – for every mile of water pipes

$2,400 – 200 foot deep well

$10 million –new water park like Silverwood, or Splash Down

Rules and Regulations

_____ Every neighborhood needs 3 houses. Each house represents 5,000 people. The houses will need to take up 6 squares (zoning regulations) on your map. Every house must be connected to water.

_____ You should have a well for storage water so everyone in the city has drinking water. Each well will take up 10 squares.

_____ You will need to have at least one Waster Water Treatment Facility.
A Waste Water Treatment facility will take up 24 squares.
This facility must have all water pipes connected to it.
It must also be able to discharge water into a river.

_____ Each water pipe will take up one box.

If you have extra money, you may want to put in a water park for your citizens. A water park will take up 25 squares.

Simulated City Calculation Sheet

How many houses did you build?_____

How many wells did you build? _____

What was the total cost of all of your wells? _____

How many waste treatment plants did you build? ____

What was the total cost of all of your plants? _____

How many miles (or boxes) did you use for water pipe?

What was the total cost of all of your pipe? _____

How many water parks did you build? _____

What was the total cost of your water pipe? _____

What was your total spending amount? _____

Did you have money left over? _____

Did you spend too much money? _____

Simulated City Rubric

Did every neighborhood have 3 houses? _____

Was every house connected to a water pipe? _____

Was there a well to support every resident? _____

Was there a waste water treatment plant? _____

Was it connected to a river? _____

Did this project stay within the budget? _____

To the best of your knowledge did this project follow all of the city rules and regulations?

_____

Title: Adventures in the Aquifer/Waterworks

Grade level: 3-5

Background: Students will have an understanding of how water is delivered to our homes, and the components of the water system. (wells, pumps, water storage, purification, etc.)

Objective: Students will be able to describe the components of the water system, from the aquifer to a home, within a storybook setting.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.1.1 Understand how to use properties to sort natural and manufactured materials and objects.
1.1.5 Understand physical properties of Earth materials including rocks, soil, water, and air.
1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
2.1.3 Understand how to construct a reasonable explanation using evidence.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Overview: Students will write and illustrate a story, modeled after the Magic School Bus series, about a class adventure through the aquifer.

Materials:

- Book: *The Magic School Bus at the Waterworks*
- Art supplies*
- Map of aquifer
- Web Site: http://www.spokaneaquifer.org/index.htm

* Items to be provided by teachers

Time: Two 50-minute sessions

Procedure:

1. Begin by reviewing the components of the water system. Ask students to predict what they believe would happen if Ms Frizzle and her students went on an adventure with the Spokane / North Idaho water purveyors.* Document predictions. Tell them that they will see what happens when Ms Frizzle and her

class take a trip to the waterworks. * (Water Purveyor-an organization that provides water to its customers.)

2. Read them the story, *The Magic School Bus at the Waterworks.* Ask if any of their predictions had come true? Were there any similarities between the waterworks that Ms. Frizzle's class visited and the Spokane / North Idaho Water Purveyor? (Please read the Notes from the Author, Joanna Cole, on pg. 39. It explains that the actual process of how we get our water may be different than the story. If you will go to the web site http://www.spokaneaquifer.org/index.htm , click on Aquifer, click on "What is an Aquifer"?)
3. Explain that the class will be writing a story, similar to the Magic School Bus, which will show the class. (each and every student) moving through the components of the Spokane/ North Idaho water system and ending at the drinking fountain/classroom sink/etc. of the school.
4. As a class, brainstorm some adventures that the class could have, as well as what components of the system need to be addressed. Once that is completed, break the students into groups of 3-4 and assign them a "part" to write and illustrate. (Make sure that each group has a specific component of the system.) Groups should write and illustrate two pages of the story.
5. After the writing is done (before binding) read the story together as a class, making sure to check for all the components of the system, as well as each student's name within the stories.

Extensions:

- Using the computer lab, students could research prominent Spokane landmarks, which they could insert into their stories.

Title: Spokane Shuffle

Grade Level: 3-7

Overview: Students will learn about different water resource occupations and place them in order from water resources to its delivery into home, to its resources.

Objectives:

Students will:

- sequence water relate occupations involved in transporting water to and the home
- describe various water resource careers
- identify important features and structures related to the Spokane Valley and Rathdrum Prairie

Standards and GLEs:

Washington State Grade Level Expectations:

Science:

3.2.3 Understand how knowledge and skills of science, mathematics, and technology are use in common occupations.
Identify occupations using science, mathematical and technological knowledge and skills.

Idaho State Content Standards:

Science:

Goal 1.7: Understand That Interpersonal Relationships Are Important in Scientific Endeavors

Goal 5.2: Understand the Relationship between Science and Technology

Materials:

- A set of water career cares for each group of students
- A map of the Spokane Valley/Rathdrum Aquifer for each student (Found on spokaneaquifer.org)
- Marking Pens*
- Butcher Paper*
- Movie provided on CD titled Aquifer :Water Careers

* Items to be provided by teachers

Time: 20 min movie, 30 min prep, 50 minute activity

Background: To build background knowledge in water careers watch the 20 min movie first. This movie features the life of a chemist, hazardous material technician, environmental engineer, meteorologist, and waste water management operator.

Procedure:

Present the following situation to your students:

One morning you wake up. You go to turn on the faucet to wash your face or get a drink of water and nothing comes out. NOT A DROP!

(Write these 3 questions on your butcher paper)

1. What if the entire city of Spokane and the Spokane Valley didn't have water, what would you do?
2. Who should you and your parents call to find out what happened to your water?
3. What are the different jobs or professions of the people who get water to your homes?

As students answer these questions write down their answers, right now you are trying to assess their background knowledge of water related careers.

After you have discussed these 3 questions and have student answer them, have students look at the map of the aquifer; see if you can locate the following on the map:

- The origin and span of the aquifer
- Lake Pend Oreille, Lake Couer D Alene, Hayden Lake
- The Post Falls dam, the Upriver Dam, the dam in River Front park, and Nine Mile Dam
- The Spokane River
- The Water Treatment Plant, or Waste Water Treatment Plant
- 3-4 wells
- Your own house, your school

After you have located these land marks, tell the students that you have a set of water career cards, but some how they have been scrambled. The students' job will be to put them back in order. The challenge will be to put the cards back in the proper order.

1. Divide students up into groups of 2-4 students. Ask each group to arrange the cards in the best order of who would help them out first.
2. Ask each group to explain the water career pathways and the relationships they have devised. Have students compare the arrangements, discussing whether or not the town of Spokane will still get its water. Have students draw a picture of the aquifer using a map and label where the correct career placements would be.
3. Present students with the order given on the original water career cards sheet. Ask students to evaluate their own sequencing and make adjustments. Have students use a different pen to record their adjustments.
4. Remind students of the variety of careers related to water other than water supply.
    a. These include fisheries specialist, meteorologist, marine biologist navigator and educator.

Assessment:

Look at the students drawings. Did they show a complete understanding of water resource jobs and where these water professionals are located within the aquifer or water system?

Could they locate the different landmarks are on the map?

You can create a rubric to show points of understanding with the class as a follow up session or add on to this lesson.

Extensions:

- Watch DVD/Video on careers of a chemist, marine biologist, and waste water treatment surveyor.
- Invite water related professionals to explain their roles in water management and discuss the nature of their jobs. (See Attached sheet)
- Visit Mobius Children's Museum
  808 W Main St (River Park Square Mall)
  509-624-5437

  Call for prices and field trip accommodations.
  The Mobius children's museum has a permanent Geo Topia exhibit which shows how the aquifer works in our area, there is also a water table to illustrate the flow of water, and a sand/gravel table where students can construct dams and rivers.

Vocabulary: You may need to introduce the names of water related careers.

Resources:

Books-

Isaac Asimov and Elizabeth Kaplan, 1993, What Happens When I Flush the Toilet?
Richard Nelson Bolles, 1993, What Color is Your Parachute? A Practical Manual to Job-Hunters and Career Changers
Joanna Cole, 1986, The Magic School Bus at the Waterworks
Louis Pasteur: and the founding of microbiology by Jane Ackerman
Microbiology: 49 Science Fair Projects by H. Steven Dashefsky
Chemistry: Connections to our Changing World, By H. Eugene Le May

Videos-

Careers in Water Quality
16 min
Order from New Dimension Media, (800) 288-4456
Or Water Pollution Control federation (800) 666-0206

Contacts

American Water Works Association, (303) 347-6202

Local Contacts

Have a Meteorlogist visit your room

KREM Channel 2 krem.com
KXLY Channel 4 www.kxly.com/weather/kris.php
Work with Kris Crocker to provide weather information
KHQ Chanel 6 (509) 448-6000

Water Conservation and Enviroscapes, Brooke Beeler, bbee461@ecy.wa.org
Brooke will be able to talk about the importance of education

Pasadena Park Irrigation Park, Kathy Small, pasadenapk17@comcast.net
Students can see a well and learn about the many wells and well operators.

Water Quality Laboratory and Drinking Water Testing, Kris Graf, kgraf@spokanecity.org
Kris can talk about how to test for water in the river, and aquifer. She can also talk about working in a lab, and how she came about this as a career.

Waste Water Treatment Plant, (509) 625-4600

Water Career Cards

This is a limited list of careers involved in transporting water from a source to homes and back to the sources. Many more people are actually involved in the process. The arrangement of the careers is based on seven main categories. The sequence of careers in each category many vary somewhat, because the responsibilities of some careers coincide or overlap.

Category 1 Career involved in removing water from the source (river, lake, ground water supply) and transferring it to a water treatment plant.

HYDROLOGIST **A scientist who measures the properties and movement of water, often assessing its availability.**	**FISHERIES BIOLOGIST** **A scientist who studies the population and behavior of fish species in relation to available habitats and quality of the water resources.**
HYDRAULIC ENGINEER **An engineer with knowledge of the mechanical properties of water who would be involved in designing or maintaining a dam or water retraction devices.**	**HYDROGEOLOGIST** **A scientist who studies the properties and movement of ground water and aquifers.**
MICROBIOLOGIST **A scientist who determines the quality of the water and the health of the water source by studying microorganisms.**	**WATER MASTER** **A person who monitors with drawl of water by water users in watersheds where supplies may be limited.**

Category 2: Careers involved in removing impurities from water at a water treatment plant.

CHEMIST **A scientist who tests the water to ensure its suitability or public consumption.**	**TREATMENT PLANT TECHNICIAN** **A person who operates and maintains the water treatment plant.**

Category 3 Career responsible or transporting the treated water to a storage tank.

WATER WORKS ENGINEER
A person who designs systems for transport of water, often in municipal settings; can also be the person who controls the discharge of water from places of storage.

Category 4 Careers involved in planning, constructing, and maintaining distribution systems that carry water underground to homes.

WATER POLICY PLANNER	MUNICIPAL PLANNER
A person who studies water related problems and issues and prepares plans for consideration by agency decision makers and the public	**A person who works with engineers and local officials to determine the municipal Needs, including the optimal water supply system or a city. This person is knowledgeable about the relevant laws.**
SPECIAL INTEREST GROUPS **Groups that have special interests in protection of use of water. They are involved as lobbyists when laws are made and have a voice at public meetings involving water.**	

Category 5 Careers involved in monitoring quantities of water used in hoes and maintaining service lines to homes.

METER READER	PLUMBER
A person who reads the water meter at your house to determine how much water is used monthly.	**A person who designs a system and fits pipes for the transportation of water (both sewage and drinking) in facilities and buildings.**

Category 6 Careers responsible for transporting wastewater to the waste water treatment plant and monitoring sanitary conditions.

WATER LINE TECHNICIAN **A person who plans and installs main lines and service lines through out the town.**	**SANITARIAN** **A person who enforces public health, especially in relation to garbage and sewage disposal.**

Category 7: Careers involved in operating wastewater treatment plants and ensuring water quality prior to its return to the source.

WASTEWATER TREATMENT PLANT OPERATOR **A person who controls and maintains equipment at a sewage treatment plant.**	**CHEMIST** **A scientist who tests water after it has been treated, to ensure its suitability for reintroduction into a stream.**

Title: Down the Drain

Grade Level: 3-5

Overview: Students play a interactive game demonstrating what happens to water when it goes down the drain.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other
2.1.4 Understand how to use simple models to represent objects, events, and systems.
3.2.3 Understand how knowledge and skills of science, mathematics, and technology are used in common occupations.
3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affects humans' ability to survive.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 1.2: Understand Concepts and Processes of Evidence, Models, and Explanations
Goal 1.7: Understand That Interpersonal Relationships Are Important in Scientific Endeavors
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Objectives: Students will describe urban forms of pollution. Students will provide reasons why people should monitor what they put on their lawns or in their streets. Students will identify ways to treat urban runoff.

Materials:
For Option 1:

- Can or bottle labeled “chemicals” or “oil”*
- Chalk
- Pieces of self-sticking paper, flour, or other materials to represent pollutants found in urban runoff.

* Items to be provided by teachers

Time:

Preparation Time: 15 minutes
Activity Time: Option 1: 30 minutes

Background: Prior understanding of how water flows through a watershed supports this activity

Procedure:

Warm Up:

Show students a can or bottle labeled "chemicals" or "oil". Tell students you need to dispose of the chemicals and plan to dump them in the street in front of the school. Ask students if they think that this is a good idea. Have students describe what they think will happen to the waste material.

Activity:

1. Discuss how water is used to clean things, such as the surface of a table after a spill. Relate how rainwater washes the outdoors. Explain that as it flows over plants, soil, and sidewalks, it picks up and carries away soil and other materials. Inform students that cities use water to clean the waste from the city streets and sidewalks. Often the water goes down storm drains, collects in pipes, and flows to a river or a treatment plant. In other places the water goes down storm drains into drywells (buried concrete barrels) where it then soaks through the soil down to our aquifer.
2. Draw a simple but large maze on the school blacktop, or arrange the chairs of the classroom to form the maze. The maze represents underground pipes that collect and transport surface water that flowed down storm drains. Have students run the maze. Inform them they are water flowing through the drainage pipes to the river or treatment plant. Draw a smaller maze off to one side that is connected to the larger maze. The second maze represents water running to drywells. Students in this maze go a short distance to several circles. When they reach the circles they disappear, become invisible for the moment. (It might be fun to have some kind of tube that the students move through to the river.)
3. Discuss sources of water that run into the storm sewer system (streets, lawns, parking lots, etc.). What might this water carry? (Oil from cars, fertilizers, litter, etc.)
4. To simulate water transporting pollutants into drainage pipes and drywells, have several students position themselves along edges of the maze. They represent storm drains and the contaminated water flowing through them. They should hold pieces of self-sticking paper or bowls of flour to symbolize the pollutants. When other students run through the maze, the students representing storm drains stick pieces of paper or sprinkle flour onto the clothing of the maze runners to represent contaminated water mixing with water (that may or may not be clean) flowing through the system. Allow students to take turns playing different roles.
5. After several trips through the maze, discuss what happens to this dirty water. What if it flows into the river? Can treatment plants process all the waste? Have students summarize why they should not litter.
6. To represent a treatment system, have two students stand at the maze exit. Similar to the game "London Bridge", the two treatment students "trap" each passing water student and remove as many pollutants as possible

before he or she goes into the river. What are students' attitudes about the quality of this water passing into the river? To represent treatment before water runs into a drywell, have two students represent a grassy swale that "traps" each passing water student to remove pollutants before passing into the aquifer. Not all drywells have grassy swales, so the "grassy swales" could be in place at some of the "drywells" or part of the time.

7. Discuss the problems associated with untreated urban runoff entering rivers or other bodies of water or the aquifer. Have students identify or research ways contaminated water affects life and drinking water supplies. Polluted runoff entering the aquifer is the most likely way of contaminating drinking water in our area. Discuss the fact that during low flow conditions in the Spokane River, the aquifer sends water into the river. When the river runs high in the spring, it sends water into the aquifer. Refer to the maze where the water students who went to drywells disappeared – they can reappear in the river joining with the other water students who went there.
8. Introduce students to the many actions people can take to limit contaminants entering urban runoff. These include properly disposing of pet waste and litter, and discarding chemicals and oils according to manufacturer's directions. Inform students that many cities have developed systems to treat runoff.
9. Have students contact their local wastewater treatment plant to determine whether their street runoff enters the treatment plant or if it flows directly into the river or filters into groundwater systems.

Assessment:

Have students:

- Identify urban sources of pollution
- Design mazes to simulate storm water drainage systems
- Explain why certain materials should not be dumped into the street or used carelessly
- Design a brochure describing steps individuals and communities can take to prevent surface water contamination

Extensions:

- Students can research alternatives to house and lawn chemicals and cleaning agents.
- Contact the local recycling center, the waste treatment facility, or a local environmental group for details.
- Invite a representative from the local water treatment plant to enrich the activity.
- Visit a local gas station and have the manager explain what happens to oil after cars are serviced.

Vocabulary:

- **Dry Wells:** Buried concrete barrels that hold runoff until is seeps into the ground and then into the aquifer.

- **Pollution:** An alteration in the character or quality of the environment, or any of its components, that renders it less suited for certain uses. The alteration of the physical, chemical or biological properties of water by the introduction of any substance that makes the water harmful to use.
- **Grassy Swales:** A depression with vegetation and a drywell in the middle. It holds runoff until it can seep through the vegetation and soil which remove some of the pollution.
- **Urban runoff:** Precipitation or water that flows over land from urban areas into surface streams, rivers and lakes.
- **Water treatment plant:** Facilities that treat water to remove contaminants so that it can be safely used.
- **Wastewater:** Water that contains unwanted materials from homes, businesses, and industries; a mixture of water and dissolved or suspended substances.
- **Wastewater treatment:** Any of the mechanical or chemical processes used to modify the quality of wastewater in order to make it more compatible or acceptable to humans and the environment.

Resources:

Cole, Joanna. 1986. *The Magic School Bus at the Waterworks*. New York, N.Y.: Scholastic, Inc.

Environmental Concern Inc., The Watercourse, and Project WET. 1995. Activities "Treatment Plants" and "Water Purifiers." Published through a partnership between Environmental Concern, Inc., St. Michaels, Md., and The Watercourse, Bozeman, Mont.

The Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814. (916) 448-7699.

For information on storm drain monitoring and stenciling programs contact:

Step Coordinator, Oregon Department of Fish and Wildlife, P.O. Box 59, 2501 S.W. First Avenue, Portland, OR 97207.

Earthwater stencils, 4425 140th SW, Dept. WT, Rochester, WA 98579.

Center for Marine Conservation, 306A Buckroe Avenue, Hampton, VA 23664.

Title: Pinwheel Power

Grade Level: 5-7

Overview: Student have seen water in streams, rivers and dams, but they don't always make the connection of the moving water and how that helps turn on and off lights or move heavy objects. Designing simple machines and equipment will help the student see how energy in water works for us.

Objective: Students will understand the effect of Hydropower and how it produces energy.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.3 Understand how interactions within and among systems cause changes in matter and energy.

Idaho State Content Standards:
Science

Goal 641.03a: Identify alternative sources of energy.
Goal 650.05b: Classify energy as potential and/or kinetic and as energy contained in a field.
Goal 650.05a: Explain that energy can be transformed but cannot be created nor destroyed.

Materials:

- Coffee can (with straight punched holes)*
- Can with holes punched bent*

* Items to be provided by teachers

Time: 1 period for intro and 1-2 periods for project

Background: For thousands of year people have used water for natural energy. Moving water can be used to do work because its potential energy changes to kinetic energy

Procedure:

1. To get the students to understand the idea that water can create energy the teacher will begin with a demonstration using cans, and water. Show the student a coffee can with straight punched holes in it and fill the can with water. Ask the students if they think there is any energy in the can. Discuss what forces might be present that could produce energy. Talk about gravitational pull and explain that it causes water to have potential energy. Define potential energy and relate that energy to the water in the can.

2. Hold the can by the handles above sink or outdoors. Remove whatever is covering the straight holes so the water does not escape. The water will drain from the can in a straight stream, but the can should remain motionless.

3. Ask the students to explain what happened to the potential energy. Explain that it was converted to kinetic energy when the water was allowed to flow. Define work and ask if the students think any work was done. The force of gravity caused the water to move, but did the can do any work? Since it did not move, no work was done.

4. Repeat the procedure with the other can. The steams of water draining the can will be directed sideways by the bent holes, and the can will spin in the opposite direction. Explain how you can make the flowing water do work be altering or directing its flow as it drains from the can. This is similar to what is done to harness energy with hydro power.

Assessment: Students are going to create their own design of a hydro electric dam. They may do this by themselves or with partners. Their task is to develop a dam that demonstrates or illustrates how energy is generated by water-- lifts, moves, pulls, twists or in some way changes the placement of an object (water) and changes it into energy.

Extension:

- Do a timeline of water use through history.
- Visit the area dams.
- Create other machine or object that also demonstrate energy generated by water.

Vocabulary:

- **Work:** the ability of a force to create movement
- **Energy:** ability to do work
- **Kinetic energy:** energy you have when you do motion
- **Potential energy:** the energy a part has because of its position or the arrangement of its parts

Resources:

Dictionary: The Merriam-Webster dictionary copyright 1999
6th grade- Scott Forsman science book
7th grade- Scott Forsman science book

Title: Hydropower Plant

Grade Level: 3-6

Overview: Students will design and/or draw a dam/hydropower plant.

Objective: Students will be able to learn the components of a hydropower plant and be able to draw a power plant and label its parts with 100% accuracy.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.3 Understand how interactions within and among systems cause changes in matter and energy.

Idaho State Content Standards:
Science:

Goal 641.03a: Identify alternative sources of energy.
Goal 650.05b: Classify energy as potential and/or kinetic and as energy contained in a field.
Goal 650.05a: Explain that energy can be transformed but cannot be created nor destroyed.

Materials:

- Pencils*
- Paper*
- Pinwheel* (directions included to make one)
- Computers*

* Items to be provided by teachers

Time: 1-2 days

Background:

Students should be made aware of how water is used in hydropower plants. Flowing water creates energy that can be captured and turned into electricity. This is called hydroelectric power. The most common type of hydro electric power uses a dam on a river to store water in a reservoir .Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity. But hydroelectric power doesn't necessarily require a large dam. Some hydroelectric power plants just use a small canal to channel the river water through a turbine.

Another type of hydroelectric power plant called a pumped storage plant-can even store water. The power is sent from a power grid into the electric generators. The generators the spin the turbines backwards, which cause the turbines to pump water from the river or lower reservoir to an upper reservoir back down into the river. This spins the turbines forward, activating the generators to produce electricity.

Procedure:

1. First do a K-W-L chart with the class. What they Know, What they want to know, and what they learned about hydropower and Dams.
2. Discuss hydropower and dams. Where are they located in our area? (Post Falls and Spokane.)
3. Go to web site with partner www.fwee.org/walk.html and with a partner draw and color all the components of the hydropower plant.
4. On the second day use a pinwheel to illustrate that falling water contains energy.
5. Have students hold a pinwheel under running water. What happens? (The pinwheel spins.)
6. What happens when the water pressure is increased? (The pinwheel spins faster.) Decrease? (It spins slower.)
7. What conclusions can the students reach about water pressure and energy production? How does this relate to the power plant

Assessment: Student will be given a blank drawing of hydropower plant and will label the parts of the plant. Go to website to get the picture of the hydropower plant

Extension:

- Visit the Post Falls Dam for a field trip.
- Make a booklet with all the part of the power plant described on each page. The pages should be colored, parts labeled and drawn correctly

Vocabulary:

- **Power house:** a building in which electric power is generated
- **Generator:** a machine by which mechanical energy is changed into electric energy.
- **Turbine:** an engine whose central drive-shaft is fitted with curved vanes spun by the pressure of water
- **Reservoir:** a place where something is kept in store. An artificial lake where water is collected as a water supply

Resources:

USGS-science for a changing world
http://ga.water.usgs.gov/edu/hyhowworks.html
Dictionary: The Merriam-Webster dictionary copyright 1999

Title: What Happens When I Flush the Toilet?

Grade Level: 3- 5

Overview: This is an introductory lesson on Wastewater Management for students in grades 3-5. A great extension is to schedule a trip to your local wastewater treatment plant in conjunction with any other field trips you may schedule pertaining to the aquifer.

Standards/GLEs:
Washington State Grade Level Expectations:
Science:

3.1.1 Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.
3.2.2 Understand that people have invented tools for everyday life and for scientific investigations.
3.2.1 Understand that science and technology have been practiced by all peoples throughout history.
3.2.3 Understand how knowledge and skills of science, mathematics, and technology are used in common occupations.

Idaho State Content Standards:
Science:

Goal 1.7: Understand That Interpersonal Relationships Are Important in Scientific Endeavors
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced
Goal 5.2: Understand the Relationship between Science and Technology

Objectives:
Students will:

- Understand the basic concept and necessity of wastewater management.
- Understand that without treatment wastewater can contaminate drinking water.

Materials:

- One copy of diagrams on pages 344 and 350 from Project Wet for each student and teacher.
- One crayon for each student.
- One copy of the quiz for each student.

Time: 20 minutes

Background: To prevent health risks and contamination of drinking water, cities must provide some form of treatment and disposal of sewage. This lesson provides a general overview of the process.

Procedure:

1. Introduce the topic by saying that no one really likes to think about or discuss what happens when they flush the toilet. Inform students that long ago raw sewage ran into rivers, lakes, and eventually the ocean. Inform students that this waste contaminated the drinking water and that some people got sick from drinking the water. People realized that something had to be done. People used science to create a system to carry the sewage from homes to a place where they could treat the waste without contaminating the drinking water.
2. Distribute copies of both diagrams to the students and refer to the diagram as you explain the process of wastewater treatment. Inform students that when a toilet is flushed the water and human waste flow into sewage pipes which carry waste from home sewer lines to larger community sewer line, unless people have a septic system. (Explain that these systems hold the waste in large tanks which are emptied periodically and the waste is then taken to a treatment plant.) Community sewer lines take the waste to a wastewater treatment plant. Upon reaching the plant the waste goes through stages of treatment. The first stage is primary treatment. Waste goes through filters and a settling process to remove solids. The primary stage removes half of the pollutants. Remember to refer to the diagram have student mark or trace the journey on their diagram. Next, wastewater receives secondary treatment. Another separation process is used and chlorine is used to kill germs. Finally water is filtered again before returning to rivers or streams.
3. Inform students the remaining solids known as sludge can be used to fertilize crops as is the case in Spokane. In some places the sludge is burned.
4. Discuss, brainstorm, list possible jobs in this field and education skills that these jobs may require.
5. Inform students if you will be going on a field trip to your local wastewater treatment plant.
6. Take quiz

Assessment: Quiz

Extensions: Lessons from Project Wet Sparkling Water pages 348-351 and Superbowl Surge pages 353- 359.

Vocabulary: Sludge, fertilize, sewage , primary, secondary

Resources: Spokane Wastewater Management 509- 625-7900 or contact your local utility.

Answers to quiz: 1. True 2. False 3. False 4. True 5. True

Name _____ Date _____

What Happens When I Flush the Toilet Quiz?

1. Wastewater treatment helps keep our drinking water safe. _____

2. Water mains carry sewage to treatment plants. _____

3. It is safe to put raw sewage into rivers, lakes and streams._____

4. Sludge can be used to fertilize crops. _____

5. Chlorine is used to kill germs in waste. _____

Title: Where Does My Drinking Water Come From?

Grade Level: 3-5

Overview: This lesson is a basic introduction to how a water purveyor system works for grades 3-5. This lesson is best taught prior to a field trip to Upriver Dam, or Pasadena Park Irrigation District. Contact phone numbers to arrange the field trip are listed at the end of this lesson in the extensions section.

Objective:

Students will:

- Locate and identify various water purveyors in Spokane County
- Understand each purveyor has a system consisting of wells, pumps, treatment plants, water mains, water towers, and pipes to distribute water to consumers in homes, businesses, schools, fire hydrants etc.

Standards and GLEs:

Washington State Grade Level Expectations:

Science:

3.1.1 Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.

3.2.1 Understand that science and technology have been practiced by all peoples throughout history

3.2.2 Understand that people have invented tools for everyday life and for scientific investigations.

3.2.3 Understand how knowledge and skills of science, mathematics, and technology are used in common occupations.

3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affect humans' ability to survive.

Idaho State Content Standards:

Science:

Goal 1.7: Understand That Interpersonal Relationships Are Important in Scientific Endeavors

Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System

Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Goal 5.2: Understand the Relationship between Science and Technology

Goal 5.3: Understand the Importance of Natural Resources and the Need to Manage and Conserve Them

Materials:

- 1 copy of the Spokane County Coordinated Water System Plan Map for each student and teacher, or 1 copy of Idaho Water Systems Map
- 1 copy of the Spokane Valley Rathdrum Prairie Aquifer Map for each student and teacher.
- 1 copy of water system for each student and teacher
- A blue crayon for each student*
- 1 blue felt marker for teacher
- 1 copy of the quiz for each student and teacher.

* Items to be provided by teachers

Time: 20-30 minutes

Background: Most cities have a method of providing drinking water to homes and businesses. In our area water is pumped from the aquifer by different water purveyors and sent to homes and businesses via water mains and pipes. Read the How Stuff Works article for additional information.

Procedure:

1. Display the copy of the Spokane Valley Rathdrum Prairie Aquifer Map on the board or display using a data projector.
2. Explain that this is our sole source of drinking water.
3. Locate and label with a marker Spokane County (the area from Long Lake to Liberty Lake), or your county in Idaho on the teacher map and have students do the same on their map.
4. Describe the basic procedure of how water is removed from the aquifer and sent through the system. As you describe the process use the attached water system diagram on your data projector and have students trace the journey on their own copy with a blue crayon. Wells are dug and water is pumped from the aquifer. Water is then treated in most but not all water districts by adding chlorine to keep water safe for drinking on its journey. Inform students that water is tested regularly to insure safe drinking water. Water is sent throughout the system through large underground pipes called water mains. In some places water is stored in large water tanks. (Ask students to name places they have seen water tanks). Water goes from mains into smaller pipes which carries the water to homes, businesses, schools etc…. ask students to name places in their homes they have seen pipes that carry drinking water to their sinks, tubs, hoses , sprinklers etc…..
5. Inform students that this is an example of how people use science and machinery in real life. Discuss/ brainstorm and list possible jobs in this field.
6. Explain to students that in different parts of our county people get water bills and their water from many different water purveyors. Distribute copies of the Water systems maps to students Have students locate their water purveyor on the map and label with a blue crayon. Invite students to share and discuss their

observations about the # of water purveyors and varying sizes of the water districts.

7. Inform students of forthcoming field trip if applicable. You may want to consider any other possible field trips pertaining to the aquifer and try to schedule these all on the same day.

Assessment: Take Quiz (see attached)

Extensions: Schedule a field trip to Upriver Dam. Contact City of Spokane Water at 509-625-7800. Schedule a field trip to Pasadena Park Irrigation District. Contact Kathleen Small at 509-926-5535

Vocabulary: Water main, water purveyor

Resources: How Stuff Works Article

Answers to quiz 1. true 2. true 3. false 4. true 5. true 6. true 7. true 8. false 9. true 10. false

Name: _____ Date:_____

Where Does My Drinking Water Come From Quiz

True or False

1. The aquifer is our sole (only) source of drinking water. _____

2. Wells are dug to remove water from the aquifer. _____

3. There is only 1 water purveyor for the whole aquifer. _____

4. Many purveyors treat water with chlorine. _____

5. Water mains are used to carry water to homes and businesses. _____

6. Pumps are used to help remove water from aquifer. _____

7. People pay a bill for their water. _____

8. Water towers are pretty but serve no real purpose. _____

9. Water is tested to make sure it is safe to drink. _____

10. Water arrives at our house magically. _____

Social Issues & History

Title: Spokane Falls Water Works

Grade Level: 3-6

Overview: Students create a 'water web' to illustrate the interdependence among water users and producers in the early 1800s in Spokane Falls.

Objective: Students will learn to distinguish between direct and indirect uses of water, about the interconnectedness of water users in a community, and will better understand the complexity of resolving water shortages among interdependent community water users.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2 Understand how components, structures, organizations, and interconnections describe systems.
3.2 Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 5.2: Understand the Relationship between Science and Technology

Materials:

- Copy of Descriptions of Water Users
- String
- Ball of yarn
- 2 plastic milk jugs* (Label one jug "surface water" and the other "ground water") (Fill jugs with water and cap jugs. Tie the two handles together with string.)

* Items to be provided by teachers

Time: 50 minutes

Background:
Students will begin with the knowledge of their 'direct' use of water and should discover the many 'indirect' uses they access throughout their day.

Procedures:

1. Have students list the ways they use water. If students do not include indirect uses of water, ask them if they think they use water when they ride in a car or read a newspaper. Explain that producing both cars and paper requires water. Have students suggest other ways they indirectly use water.
2. Ask student to guess how much water is required to make each of the following items. Do not tell them if their guesses are accurate.

A pair of cotton jeans	1,800 gallons
A 2 -pound loaf of bread	1,000 gallons
A pound of hamburger	4,000 gallons
A 12-ounce can of soda	16.5 gallons
The ton of finished steel for a car	32,000 gallons
40 sheets of paper	100 gallons

3. Hand out a water user slip of paper to each student from the Description of Water Users. Have each student read silently the description of his or her water user. Ask 'water users' to consider how they depend on products and services supplied by other users. For instance, the wheat farmer uses water to grow grain and the blacksmith uses water to make horse shoes and farm equipment.
4. Clear an area in the room. Place the two milk jugs tied together with string at the handles on a chair in the middle of the cleared area. Tie the loose end of the ball of yard to the string holding the two jugs together. Explain that the jugs represent sources of water the ball of yarn symbolizes the water user's need for water.
5. Ask students to stand in a circle around the jugs of water. Select a student to describe the goods or services his or her water user provides and how this product or service uses water. Run the ball of yarn to the student (who remains holding the yarn) and back to the jugs (around the string holding the two jugs together). This indicates that this water user consumed water. This can be repeated for each student.
6. Choose one water user and hand him or her ball of yarn. Ask other students to raise their hands if they use the goods or services offered by that student.
7. Tell the student (Student 1) to pass the ball of yarn to one of the students (Student 2) who raised his or her hand. Ask Student 2 to describe how he or she uses the products or services of Student 1.
8. Ask if other students use the products manufactured by Student 2. Have Student 2 pass the ball to another student (Student3). Have all students repeat the process until connections are made among all or most class members.
9. To emphasize the interdependencies among water users, have one student tug gently on the yarn. Ask those who felt the pull to raise their hands. The tug symbolizes reliance on both water and that student's product.
10. At some time during the activity, the water jugs may shift or be lifted from the chair. Explain that this indicates the supply is being overextended. Ask students if they think one water user should leave the circle. What will happen if one student lets go? What if one user wants to dam up the river to irrigate more property?

11. Inform student of the quantities of water used to produce the materials listed in Step 2. Do any water users in the activity supply these materials? Do students use any of these materials? If community water supplies are overextended how the community would decide which manufacturer should reduce water consumption? Students may find it difficult to single out one manufacturer. They may determine that causing all water users to conserve water is fairer.

Assessment: Have students describe their direct and indirect uses of water. Have students draw a diagram showing how water users rely on the goods and services provided by other water users.

Extensions: Tell students a bottle of food coloring represents a source of pollution. Place a drop in the jug. Have students explain how water quality affects the quantity of water available to water users.

Vocabulary:

- **Direct water uses:** uses of water that are apparent (e.g. washing, bathing, cooking)
- **Indirect water uses:** Uses of water that are not immediately apparent to the consumer. For example, a person indirectly uses water when driving a car because water was used in the production process of steel and other parts of the vehicle.
- **Ground water:** Water found in spaces between soil particles underground (located in the zone of saturation).
- **Surface water:** Water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff.
- **Irrigation:** The controlled application of water to cropland, hay fields, and/or pastures to supplement that supplied by nature.
- Hydroelectricity: Electric energy produced by water-powered turbine generators.
- **Interdependent:** Mutually dependent; depending on each other
- **Overextended:** To expand or disperse beyond a safe or reasonable limit

Description of Water Users in Spokane Falls

Agriculture: Water is used to produce food and fiber for processing and consumption and to transport crops to market.

Cattle rancher: Uses water to grow food and provide drinking water for cattle, and to clean their areas for living and feeding.

Corn grower: Uses water to irrigate crops and transport crops to market.

Wheat farmer: Uses water to irrigate crops and transport crops to market.

Dairy farmer: Uses water to grow food and provide drinking water for cows, to sanitize milking equipment and stalls, and transporting milk to market.

Goat and pig farmer: Uses water to grow food and provide drinking water for animals, and to clean their areas for living and feeding.

Mining: Water is used in the extraction process of raw materials (coal, iron, gold, copper, sand, and gravel).

Miner: Uses water to carry and wash rock material during the mineral removal processes.

Logging: Water is used to grow, harvest, and transport trees.

Forest manager: Uses water to support tree growth and control fires.

Logger: Uses water to support tree growth, transport trees to market, and control fires.

Logging company owner: Uses water to float rafts of logs on the rivers to markets and to control fires.

Transporting/Shipping: Water is used to transport raw materials and finished products to other ports.

Ferry Boat Owner: Uses water to haul ore, grains, animals, and logs to market and finished products to other cities on the rivers.

Business/Industry: Water is used in the processing and manufacturing of goods.

Flour Mill Owner: Uses water to generate power to grind grain and to clean the mill and equipment.

Blacksmith: Uses water to forge horse shoes and farm equipment, to feed horses, and to clean the building and stalls.

Restaurant Owner: Uses water to cook meals, clean the kitchen and dishes, wash tables and chairs, and serve customers.

Boarding Home Owner: Uses water to cook meals, for bathing, cleaning the house and yard, and to serve boarders.

General Store Owner: Uses water to clean building and walkway, and for drinking.

Milliner: Uses water to clean building, wash fabrics and clothes, and for drinking.

Saloon Owner: Uses water for making beverages, to clean the kitchen and dishes, wash tables and floors, and for drinking.

Spokane Indians: Water is used for domestic, maintenance, recreational, and religious purposes.

Spokane Indian: Uses water for fishing, cooking, cleaning, and religious ceremonies.

Recreation: People recreate in and around water for exercise and enjoyment.

Fishing and swimming: People catch fish and swim and play in rivers and lakes.

Winter sports: Snow and ice provide fun for skaters, skiers, ice fishers, and sledders.

Wildlife: Water provides habitat for countless plant and animal species.

Mammals: Beavers, muskrats, and otters live in and near waterways.

Fish: Salmon, trout, and carp live in water and eat organisms that live in water.

Insects: Aquatic insects are a food source for many other organisms.

Vegetation: Trees and other plants use water in photosynthesis and to transport nutrients.

Community: Water is used by community members for domestic, maintenance, and recreational purposes.

Spokane citizens: Water is used in many ways in and around the home.

Fire department: Uses water to extinguish fires, water animals, and clean.

Park department: Uses water in fountains and reflecting ponds and for landscaping needs.

Title: Occupations Investigation

Grade Level: 3-5

Overview: This lesson is great to do after the students have had many aquifer lessons. They need to understand the aquifer, the rolls of: transfer station, Dept. of Ecology, Health Department, and Spokane Joint Aquifer Board.

Objectives: Students will be able to see what different jobs are offered in the water related areas. This lesson mainly for exposure of occupations you don't normally know about. Students will be able to use persuasive writing to advertise different occupations.

Standards/GLEs:
Washington State Grade Level Expectations:
Science:

3.1.1 Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.
3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affects humans' ability to survive.

Language Arts:

3.2.1 Understand information gained from reading to perform a specific task.

Idaho State Content Standards:
Science:

Goal 1.6: Understand Scientific Inquiry and Develop Critical Thinking Skills
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Language Arts:

Goal 2.1: Acquire Strategies and Skills for Comprehending Text

Materials:

- Computer lab*
- Paper*
- Pencil/pen*

* Items to be provided by teachers

Time: 60 minutes

need to understand the aquifer, the rolls of: transfer station, Dept. of Ecology, Health Department, and Spokane Joint Aquifer Board.

Procedure:

1. At a computer lab, have kids partnered up or individual go to the following website: **http://www.spokaneaquifer.org/ed.htm.**

2. Once they get to that page, they need to scroll down and find "Water Related Careers." Under that title you will see different categories – In general are some overall jobs that generally meet the category – Water Related Careers, the rest are in specific categories. See below or on the website.

   Hydro geologist
   Hydrologist
   Assistant Hydrologic Technician
   Limnologist
   Geomorphologist

WATER SUPPLY INDUSTRY

   Water District Manager
   Water Distribution Manager
   Backflow Assembly Tester
   Water Treatment Specialist

PUBLIC HEALTH

   Local and State Drinking Water Regulator
   Environmental Health Specialist
   Water Lab Specialist
   Engineer
   Water Contamination Specialist

WASTEWATER

   Wastewater Treatment Plant Operator
   Laboratory Technician
   Chemist
   Laboratory Supervisor
   Wastewater Treatment Plant Superintendent
   Instrument Repair Technician
   Stationary Engineer

3. Have the partners or individual to agree on one of those careers. In the sentence right above the picture is the phrase "click here." The partners can go to a description page to see what that job entails.
4. Some of the descriptions are hard to understand. Remind students that most of these jobs require college degrees. In the job descriptions, it also shows the *median* pay rate. 4th and 5th grades will be mostly able to understand what median means but it would be good to discuss again. You don't normally start at the pay that is shown there.
5. If the job they picked was not on the description page, there is a website you can go to like www.wikipedia.com or www.yahooligans.com which are mostly kid based. If your school uses Encarta, that might be another resource.

**If they get information from websites, remind them that anyone can enter information which means the truth can be stretched for example, pay scales etc. *

6. Have the students find as much information as they can on their chosen job. With that information, have them create a persuasive newspaper article to get kids to apply for that job. It not always be money that interest others, it could be swimming with fish, working with really big technology etc.
7. **Have students mainly choose jobs from the "Water Related Careers" page so they truly can get a picture of what jobs are out there.

Advertisement format:

Job Title: _____

Job Description: (Can have some exaggerations to make the job look interesting)

_____

_____

_____

Salary: _____

Contact Information: _____ (make up but be creative!)

Website address: _____(make up but again be creative!!)

8. Have classmates share job descriptions with the class or in groups, which can help each other, edit as needed.

Assessment: Advertisement should be a water related job. When they present their advertisement they should be able to explain how this particular job is related.

Extension would be to create a job board and post the students work for classmates to take time and enjoy.

Vocabulary: The main word ending they will need to understand is **"-**oligist", which means the study of**.** The beginning of the word usually tells you what part of science they study.

Resources: http://www.spokaneaquifer.org/ed.htm

Title: Water Rights

Grade Level: 3-5

Overview: Students will need a background in understanding where our water comes from – Not just from our taps at home. This is difficult view for kids to understand so this lesson isn't for mastery, just exposure of facts.

Objective: Students will be able to understand that water is managed and each household only gets a certain amount.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
3.2.2 Understand that people have invented tools for everyday life and for scientific investigations.
3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affects humans' ability to survive.

Reading:

1.2.2 Apply vocabulary strategies in grade-level text
2.3.2 Apply understanding of systems for organizing information
3.2.1 Understand information gained from reading to perform a specific task.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced
Goal 5.2: Understand the Relationship between Science and Technology
Goal 5.2.1: Describe how technology helps develop tools.

Reading:

Goal 2.1: Acquire Strategies and Skills for Comprehending Text
Goal 1.8: Vocabulary and Concept Development
Goal1.8.1: Use knowledge of base words, common prefixes and suffixes to determine meaning of unknown words in isolation and in context.

Materials:

- Water Rights Timeline (1 for each student)
- Butcher paper*

* Items to be provided by teachers

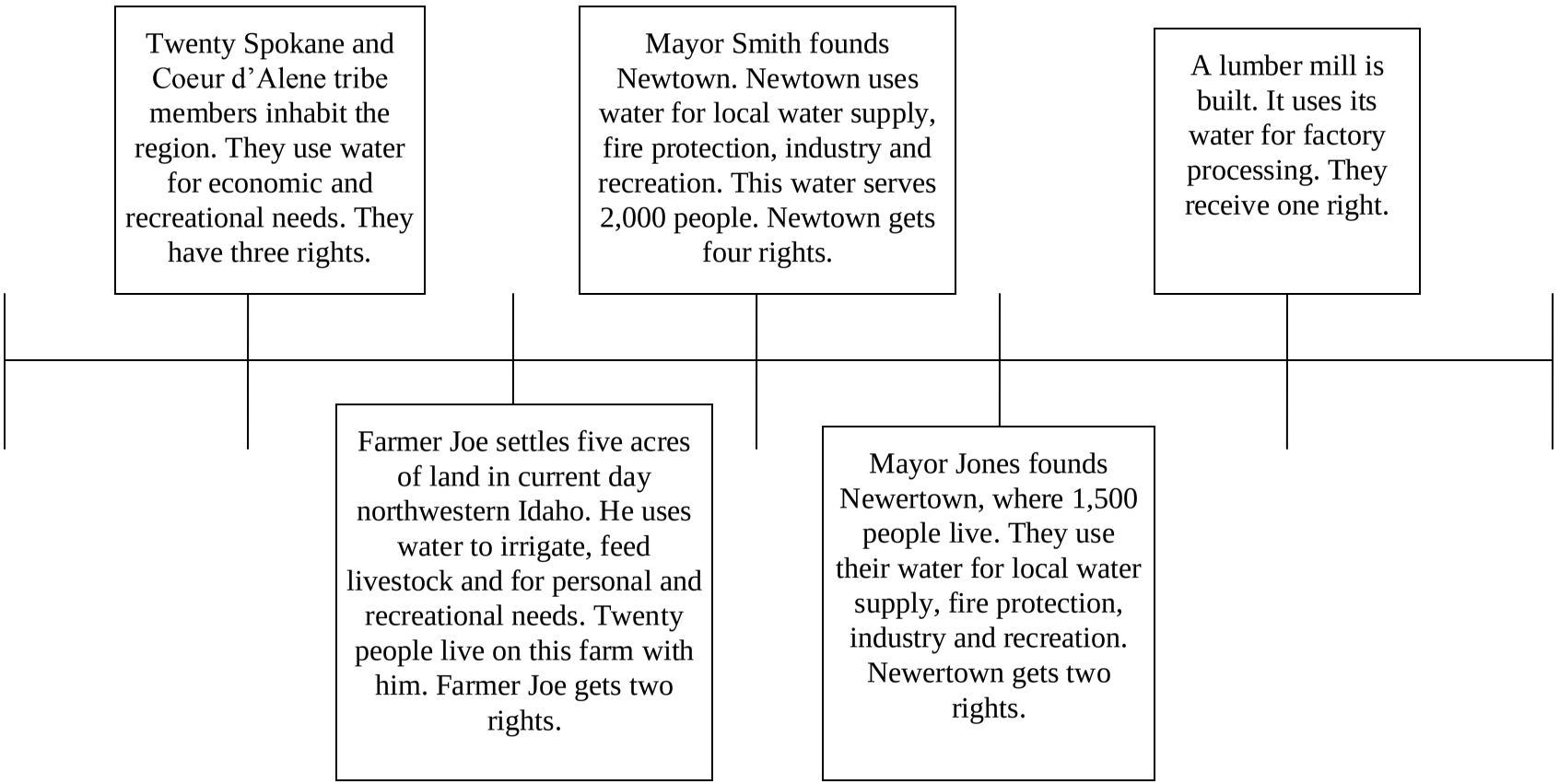
Time: 45-60 min.

Background: Students will need a background in understanding where our water comes from – Not just from our taps at home. This is difficult view for kids to understand so this lesson isn't for mastery, just exposure of facts.

Procedure:

1. Students will need to be in groups – Each group will need a timeline.
2. They need to brainstorm what they understand the timeline to be or it's over all purpose. (5 min)
3. Teacher will record on butcher paper what the class understands of the timeline. (7-10 min.)
4. Question to propose: Why do you think we need water rights? Why do think it is broken up into sections? Why do we need water rights? Who decides who gets water rights and how many? (EPA) What are they measured in? (Cubic feet per second) If water rights run low, who should have their rights taken away? (The newest) What are things that we could do, instead of taking rights away, to make sure that everyone has enough? (Conservation, trading the rights, and sharing) Read part of attached article to help with main points **italicized sentences are good points to share with students to add to butcher paper.**

Water Rights Timeline



Turning Off the Tap

Rachael Paschal, Executive Director
Center for Environmental Law and Policy, Seattle

This article appeared in Seattle-Post Intelligencer, March 3, 1996 and is reproduced here by permission of the author, ©1996 Rachael Paschal.

In early 1994 Mary Riveland, the director of the Washington Department of Ecology, was faced with a growing crisis.

Unchecked population growth was creating a huge demand for more water, and pending applications for new water rights had risen into the thousands. At the same time, growing concern for the health of the state's salmon fisheries indicated that precious little water was left for out-of-stream uses.

The agency was under attack from the Legislature as well as interest groups from the agricultural, industrial and municipal sectors. Environmental and fish advocates, along with regional Indian tribes, weren't any happier.

Riveland crafted a solution by assigning one of her top managers to run the beleaguered Division of Water Resources. Carol Fleskes didn't know much about water, but she'd had spectacular success in the difficult task of creating the state's Model Toxics program.

Fleskes took control of a program that performs a variety of tasks, ranging from inspecting dams for safety to regulating *agricultural water users*. But its primary job is to manage the state's waters, including protecting in-stream flows, while simultaneously processing applications for water rights.

To issue a water right, the state must first determine whether water is physically available from the stream or aquifer proposed for use. Traditionally, this test had involved an antiquated and inefficient case-by-case investigation.

Confronted with a backlog of nearly 5,000 applications, Fleskes made some fundamental changes. She instituted an approach to permitting that was designed to determine water availability on a watershed-wide basis, taking into account all of the competing claims on the resource.

Article Website for full article:
http://www.mrsc.org/Subjects/Environment/water/PI3-3-96.aspx

---

5. Have students go to the following website below and comeback to the group with facts from the following websites to tell the class. Have each group put their facts on bigger paper to present. (20 min.)
6. **Teacher Note** There are about 10 different questions your groups can research – Break those up between groups – You could also print the question, answers off and cut them up for groups to use instead of getting on computers -

http://mrsc.org/Subjects/environment/water/96-1804.aspx

Go to this website to investigate a water district:
http://www.spokaneaquifer.org/about.htm or to view/print an actual map:
http://www.spokaneaquifer.org/report.htm#cwsp-map

Assessment: The 10 questions are important to help build understanding and show what they know. The goal with the questions being broken up between groups helps report what they know about their section. The goal with all groups reporting is that they learn through classmates as well.

Extensions: Contact Todd Henry at Vera Water District to come and do a class visit.

Vocabulary:

Water Provider or Purveyor: A designated system or district that operates one or more wells, drawing water from underground and delivering it to customers on a 24/7 basis.

Resources:

http://www.spokaneaquifer.org/about.htm
http://www.mrsc.org/Subjects/Environment/water/PI3-3-96.aspx

Title: Aqua Duck's New Sidekick

Grade level: 3-5

Background: Students will have an understanding of the aquifer / watershed and its components and have knowledge of the aquifer mascot, Aqua Duck.

Objective: Students will be able to explain which native Spokane/ North Idaho animals rely on the aquifer / watershed.

Overview: In the computer lab, students will research native Spokane / North Idaho animals and choose which aquifer/ watershed-reliant animal they would like to "campaign" for. Students will design and illustrate a poster of the Spokane/ North Idaho animal that relies on the aquifer. (The poster should have the animal, a slogan, and could also have a costume.) This animal will become Aqua Duck's sidekick, helping to share the "story" of the aquifer/ watershed with the residents of Spokane/ North Idaho and abroad. On the back of their poster, students will write and explain why their chosen animal relies on the aquifer/ watershed.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
1.2.4 Understand that Earth's system includes a mostly solid interior, landforms, bodies of water, and an atmosphere.
1.2.6 Understand that organisms can be a single cell or many cells that form parts with different functions.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 3.3: Understand the Cell is the Basis of Form and Function for All Living Things
Goal 4.1: Understand Scientific Theories of Origin and Subsequent Changes in the Universe and Earth Systems

Materials:

- The Aqua Duck Comic Books: *The Adventures of Aqua Duck: Defender of the Aquifer*. Volumes 1 and 2
- Watershed Protection by Project WET
- Art supplies*
- Computer lab*
- www.projectwet.org *
- www.spokaneaquifer.org *

* Items to be provided by teachers

Time: Two 50-minute sessions

Procedure:

1. Begin by reading Volume 1 of *The Adventures of Aqua Duck*. Have students brainstorm what this "superhero" is like/what his job is, etc. Explain that Aqua Duck is so busy that he has decided to choose a sidekick. The student's job is to research and design a poster that will help to convince Aqua Duck to choose their animal.
2. In the computer lab, have students research native Spokane / North Idaho animals that rely on the aquifer/ watershed.
3. After the research is completed, students can begin to design their poster. The poster should have a drawing of the animal "sidekick," a slogan, and (on the back) a paragraph or two explaining why this specific animal relies on the aquifer/ watershed.
4. After students have completed their posters, have them share their posters with the rest of the class and explain why their chosen animal should be Aqua Duck's new sidekick.
5. Have students vote on who they think should be Aqua Duck's new sidekick and their reason for doing so.

Title: The History of Our Aquifer

Grade Level: 5

Overview: Each student will need to understand what the aquifer is and when completed with lesson understands how the aquifer came to be. Students will have a better understanding of their city or can lead to history lessons. Some history of the Spokane area will help students have a better understanding of lesson. Understanding a timeline is necessary.

Objective: Student will understand how the aquifer was discovered and the growth of knowledge about the aquifer acquired throughout the years.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
3.2.2 Understand that people have invented tools for everyday life and for scientific investigations.
3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affects humans' ability to survive.

Reading:

1.2.2 Apply vocabulary strategies in grade-level text
2.3.2 Apply understanding of systems for organizing information
3.2.1 Understand information gained from reading to perform a specific task.

Idaho State Content Standards:
Science:

Goal 1.7: Understand That Interpersonal Relationships Are Important in Scientific Endeavors
Goal 4.2: Understand Geo-chemical Cycles and Energy in the Earth System
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced
Goal 5.2: Understand the Relationship between Science and Technology
Goal 5.3: Understand the Importance of Natural Resources and the Need to Manage and Conserve Them

Reading:

Goal 2.1: Acquire Strategies and Skills for Comprehending Text
Goal 1.8: Vocabulary and Concept Development

Materials:

- Sample timeline
- Groups of cards cut out to put in order
- Map of Spokane

- Article for each child or partners
- Highlighters
- Computers (if you choose to use those for research.)*

* Items to be provided by teachers

Time: 45-60 minutes

Background: Some history of the Spokane area will help students have a better understanding of lesson. Understanding a timeline is necessary.

Procedure:

1. High vocabulary so this activity needs whole class participation. Discuss their knowledge of the timeline and background knowledge on what they think it was like during those years.

2. Each student needs a copy of the article or partner up. There is a website you could use instead. As a class read through the article discussing important dates and high light. Hand out cards for the students to put together from the beginning to the end. Have the students and see if there are some clues in cards to help them put them in order, for example, are their dates, other important numbers or facts? The goal is for the students to use their prior knowledge of Washington State and/or Spokane to help them figure out history of our area and context clues. If just beginning 3rd grade it could be a great way to tie in Spokane history.

3. Let the students know that most of their information comes from the article, then the remaining cards they have may give hints, the last step would be process of elimination.

4. Once each group figures out their independent/partner answer, starting in 1881 and sees if they can do a whole class timeline with what they have found in their groups or individually. Display timeline on board or big piece of butcher paper.

5. Discuss as a class how this relates to other parts of history they know about Spokane.

6. Attached are some questions to reflect as a class or independently to help with understanding.

Assessment: They should be able to match up facts with dates from the article. It is showing process of elimination skill and reading for meaning. Discussion questions can help with showing understanding of what has been learned.

Extensions: Pasadena Park offers tours of their water well and Upriver Dam gives tours of the history of the dam.

Vocabulary:

- **water-bearing rock**: a layer of permeable rock, sand, or gravel through which groundwater flows, containing enough water to supply wells and springs
- **chronology shown pictorially**: a linear representation of significant events in a subject area, for example, the history of art, shown in chronological order
- **main pipe bringing water:** a large underground pipe supplying water
- **supply using something's own weight:** a mechanism or process for supplying something such as fuel to a boiler or materials to a manufacturing process by their downward movement under the influence of gravity
- **floodgate:** a valve or floodgate that controls the water in a sluice.
- **channel for sluice water**: an artificial channel into which water flows from a sluice

Resources:

Website: www.Spokanewater.org/history

SPOKANE WATER HISTORY

1800s

The City of Spokane's water system was born in 1884, when the budding city bought a small waterworks located on Havermale Island from several early civic-minded businessmen. Located in the old Echo Mill it consisted of a few hundred feet of wooden water mains and pumps operated by hydraulic power.

By 1888 the city had leased a larger site near Post Street, had a power plant built and moved the Echo Mill pumps into a building with two additional new pumps. As the city increased in size, it was apparent a larger waterworks in an area where fresh clean water was plentiful was required and a search was underway.

Many ideas were introduced, including a series of gravity fed canals from Hayden, Spirit and Twin lakes. Building a dam east of town to impound clean water was another idea, and the present day site of Upriver dam was eventually selected. Opinion was divided and it took until 1894 to begin construction of Upriver Dam and Pumping Station. One year after construction started, a timber crib dam with a sluiceway that allowed log rafts to pass and a pumping station with a capacity of 10 million gallons a day were completed.

Eventually, the waterworks would have 13 hydraulic pumps an improved dam, canal, steel flumes and draft tubes to allow hydraulic turbines to power the original pumps. It was during the construction of this facility that high quality ground water was first discovered. This would become important as the problem of contaminated drinking water arose once again.

1900s

In 1907, test wells were dug and exceptionally pure drinking water with a constant temperature of 48 degrees was discovered. At the time this was considered to be an inexhaustible supply. Three wells were dug, of which one is still present today, and the pumps were modified to pump from the wells instead of the river. Spokane now had some of the cleanest and highest quality drinking water in the region.

The city continued to grow and it was determined that a city this size should not be dependent on a single source of power or a single location for all its water needs. Beginning in 1910, electrically powered pumps were installed at Upriver Dam. This increased the pumping capacity to nearly 30 million gallons a day. Booster stations were constructed to reach the growing areas north and south of downtown. Some of these are still in use today in a modernized form.

By 1933, the timber crib dam and original pumps at Upriver were becoming damaged, worn and in need of replacement. Federal grant money was available and construction began on a new concrete dam and 3900 KW powerhouse. Improved in the 1980's and still in use today the Upriver Dam generates over 70 million kilowatts of electricity annually. The electricity is used to pump water to every part of the city and the excess power is sold to Avista. The City of Spokane's drinking water is some of the highest quality and lowest cost drinking water in the state. Additional federal grants were used in 1937 and 1938 to construct new wells at Ray and Hartson to supply the south hill area and at Hoffman Avenue to supply the recently annexed Hillyard area and the North Hill. Parkwater Pumping Station was completed in 1950 to augment Upriver and ensure a constant supply of water if Upriver Pumping Station ever flooded or lost electrical power. It is still the single largest pumping station in the system. Wells were added again in the 1960s to increase the capacity of the system, including the Central Pumping Station, which has two hand dug wells over 270 feet deep.

Upriver Dam

In 1894 construction began on the Upriver Dam and Pumping Station. The original timber crib dam had a sluiceway allowing log rafts to pass along the Spokane River. The original site's pumping station had a capacity of 10 million gallons a day.

Post Falls Dam begins operation in 1906.	Grand Coulee Dam is constructed (built) which took about **5 years**. (Hint)
Idaho becomes the 43rd state. (1890)	
A survey of all major rivers and waterways found the Spokane River the foulest water body in the state of Washington after we had been a state for about 49 years. (*Washington State year + 49 = _____)*	Spokane purchases a private waterworks located in the old Echo Mill on Havermale Island (Riverfront Park) as the beginning of the city water system using the Spokane River as a water source.
Washington becomes the 42nd state. When did Washington become a state? _____	Upriver Dam and a pump station are built to provide 10 million gallons of water river daily to the city. While building the pump station foundation, so much water is encountered that the foundation is built 6 feet higher than planned. Unrecognized at the time, the contractor had discovered the aquifer.
Under contract to the Washington Water Power Company, E. R. Fosdick prepares the first comprehensive study of groundwater in the Spokane Valley and Rathdrum Praire *9 years before Mr. Paradee presents information of Ice Age……*	For the next few years, Spokane investigates potential water sources for its expanding water system. Under consideration are: springs near the Little Spokane River, Hayden Lake, and a dam east of the city. *They ended up leasing a larger site near Post Street.*
Between 1898 and 1905 Spokane upgrades the pumping capacity at the Upriver Dam several times. In **1905** while excavating for a new pump station foundation, workers encounter the same high water conditions found near the site 1894. This time, city engineers deduce the existence of the Aquifer.	Expo '74 opens Spokane, Washington, with the theme: Celebrating Tomorrow's Fresh New Environment." Havermale Island is where this event took place, which is now Riverfront Park.
Northern Pacific Railroad arrives and provides an economic boost to our region. *This is how Spokane began……therefore what does this mean?*	Boil order in effect for all river water in 1907. After testing the Aquifer water, City officials authorize construction of a well near the Upriver Dam site. By the fall of **1907-1908**, the Aquifer becomes the City's primary drinking water source.

1881 –

1884 –

1888 –

1890 –

1894 –

***1900's*--------**

1905 –

1906 –

1907/1908 –

1923 – Dr. J. Harlen Bretz makes two presentations to the Geological Society of America proposing that the Channeled Scablands of eastern Washington were formed by catastrophic flooding. He discovered the geologic process that created the Aquifer. His idea was not generally accepted for another 20-30 years.

1929 – 1934

1938 –

1940 – Joesph T. Pardee, the USGS geologist, presents a paper to the American Association for the Advancement of Science proposing that an Ice Age glacial lake (Lake Missoula) in present day Montana had drained rapidly. Pardee had discovered the source of Bretz's catastrophic floods.

1974 –

Reflection-

If you were Dr. J. Harlen Bretz in 1923, how would you feel after the presentation of the aquifer when no one would listen to your findings?

_____

_____

_____

_____

When were his ideas finally listened to?

_____

_____

_____

_____

In 1938, Spokane River, which had provided water to most of our city, was compared to other surrounding waters the foulest water body in the state of Washington. There was also a boil order in 1908 for the river water, what do you think boil order means?

_____
_____

After they boil the water, what do you think they did with the water? Explain your thinking.

_____
_____

News was delivered either by radio or newspaper about our water source, Spokane River. As a resident of Spokane now and you heard that news about the aquifer what would be your reaction? How do you think you can help prevent water pollution?

_____

_____

_____

_____

What do you think is going on with our Aquifer in the 2000's? What are we doing to help our Aquifer now?

_____

_____

_____

_____

Quantity

Title: Conserving Water in Your Life

Summary: Students will record and evaluate personal water usage habits in their homes. Life style changes and water conservation awareness should follow.

Objectives: Students will monitor personal water usage to assess water's importance in everyday life.

Standards and GLEs:

Washington State Grade Level Expectations:

Science:

2.1.5. Understand how to report investigations and explanations of objects, events, systems, and processes.

3.1. Designing Solutions: Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.

3.1.1. Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.

Idaho State Content Standards:

Science:

Goal 603.01a: Compare and contrast different systems.

Goal 624.01b Students will collect data and perform an analysis.

Duration: up to 3 days

Materials: Recording Worksheet , Water Conversion chart

Procedure:

Instruct students to keep track of the ways they use water directly for a twenty-four hour period. (This includes flushing the toilet, drinking, cooking, showering, etc.) Use the provided recording worksheet to collect the data.

After the students have collected their information, have them do the following analysis by listing ways they over-use water in their lives and ways they can conserve/change water usage habits.

Variations/Extensions:

Students discuss adaptations plants and animals make in their use of water

Chart and graph water usage

Collect data for a class-wide usage chart

Resources:

www.earth911.org

http://www.wateruseitwisely.com

www.epa.gov

Name_____

Directions: For the next 24 hours, try to keep track of the water that you use directly. Use the data table below to monitor your water usage.

Type of Usage	**Quantity**
Flushing toilet	
Personal hygiene (brushing teeth, bathing, washing hands, face, etc….)	
Laundry (number of loads)	
Cooking with water (washing veggies, fruit, Doing dishes after meal, etc…)	
Drinking	
Other Usage:	

Name_____

Water Conversion Chart

Toilet	**3-5 gallons/flush**	
Shower	**7 gallons/minute**	
Bathtub	**35 gallons/full**	
Clothes washer	**30 gallons/load**	
Dishwasher	**15 gallons/load**	
Bathroom Faucet	**2-5 gallons/minute**	
other		

Title: We Can All Help Save Our Aquifer!

Grade Level: 4-6

Overview: Students will generate a list of ways they and their families can conserve water, then implement their plan for three days and record their results.

Objective: The student will be able to generate a list of things people can do everyday to use less water.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

3.1. Designing Solutions: Apply knowledge and skills of science and technology to design solutions to human problems or meet challenges.
3.2.2. Understand that people have invented tools for everyday life and for scientific investigations.

Math:

1.2 Understand and apply concepts and procedures from measurement.
3.1.1 Analyze and compare numerical, measurement, geometric, and/or statistical information in familiar situations.
4.1 Gather information
4.2.1 Understand how to organize numerical, measurement, geometric, and/or statistical information to communicate for a given purpose.
4.2.2 Understand how to represent numerical, measurement, geometric, and/or statistical information in graphs or other appropriate forms.

Idaho State Content Standards:
Science:

1.2 Understand concepts and processes of evidence, models, and explanations
1.6 Understands scientific inquiry and develop critical thinking skills

Math:

4.3 Apply graphing in two dimensions
5.5 Make predictions and decisions based on data
2.1 Understand and use U.S. customary measurement
5.2 Collect, organize, & display data
5.1 Understand data analysis

Materials:

Measurement Tools at home:

- measuring cups
- quart or gallon container for measurement
- data recording sheet

Time: Day 1 = 45 minutes, Days 2 & 3 = 20 minutes to discuss results, Day 4 = 45 minutes

Background: Students understand domestic water comes from the aquifer. Students are familiar with simple line graphs.

Procedure: Day 1

Small Group*:* discuss and record ways in which students and their families use domestic water every day.

Whole Group:

- Compile lists into one combined class list.
- Students choose 3 uses from the list that they will monitor for water consumption

Demonstrate how to measure and record results on the data sheet at home tonight. Day 1 data does not include any conservation measures taken; it is the baseline to which conservation measures will be compared. (Data sheet can be found on last page of lesson plans)

Procedure: Day 2

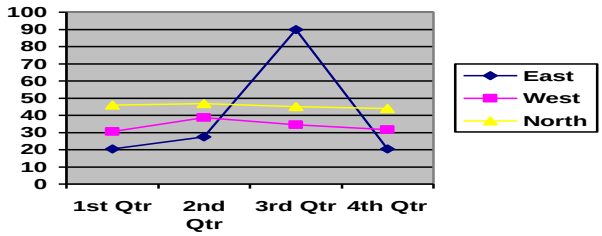
On day 2 discuss results without any conservation efforts and then brainstorm in small groups how students might conserve water while doing the same three activities they chose and reported on for day 1. Then as a whole group, share conservation ideas. Introduce Day 2 on the data collection sheet again demonstrating how to measure and records results at home tonight.

Procedure: Day 3

Repeat procedure from day 2. Kids may continue their plan or decide on a new plan of conservation, based on the success or lack of success from their conservation attempts at home on day 2.

Procedure: Day 4

Using their completed data sheet, students will complete a simple triple line graph plotting use against day and using three different colors to represent their three activities. They will then complete the data sheet questions under their graph.



Sample triple line graph

Assessment:

Students will explain their graphed results to a small group. They will then create a brochure describing how individuals can conserve water and help the aquifer.

Extensions:

- Using their data; students could predict how much water their family could save in a month and a year if they implement the same conservation strategies for the periods of time.
- Students could explore how much water could be conserved in one day or week if all of the students in the school used these 3 conservation methods.
- Students could discuss how many people use the aquifer for their water and how each person's use really add up. It is important what individuals do to conserve water!

Resources:

- http://www.greenbuilder.com/sourcebook/WaterBudget.html
- http://www.mead.k12.wa.us/NWOOD/Round/SAJB%20Tour%20Questions.htm
- http://www.epa.gov/safewater/kids/teachers_k-3.html
- http://nces.ed.gov/nceskids/createagraph/default.aspx

We Can All Help Save Our Aquifer Data Collection Worksheet

Name: _____

Day 1 – no conservation measures taken…complete table

	Task	Amount of Water Used
1		
2		
3		

Day 1 – conservation measures taken…complete table

	Task	Amount of Water Used
1		
2		
3		

Day 3 – conservation measures taken…complete table

	Task	Amount of Water Used
1		
2		
3		

We Can All Help Save Our Aquifer
Day 4 Activity: Graph/ Answer Questions

Name: _____

Create a line graph below that plots time (days 1,2,3) against water used for three tasks (each represented by a different color). Be sure to give your graph a title and labels.

1. **About how much water could you save in one day using your plan? _____**

2. **How many people are in your family? _____ How much water could your family save in one day? _____**

3. **How much could your family save in one week? _____**

Water Quality

Title: Keeping Our Aquifer Clean

Grade Level: 2-4

Overview: Students will use simulations to understand the sources of contaminants in the aquifer and describe ways the aquifer is tested for these contaminants and how it is treated if they are found.

Objective: Students will be able to identify possible sources of pollutants to the aquifer.

Standards/GLEs:
Washington State Standards:
Science:

1.1.1 Understand simple properties of common natural and manufactured materials and objects. Understand how to use properties to sort natural and manufactured materials and objects.
1.1.5 Understand how to classify rocks, soils and water into groups based on their chemical and physical properties.
1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
1.3.1 Understand that an organism's ability to survive is influenced by the organism's behavior in the ecosystem in which it lives.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 2.1: Understand the Structure and Function of Matter and Molecules and Their Interactions
Goal 2.1.1: Use instruments to measure properties.
Goal 3.2: Understand the Relationship between Matter and Energy in Living Systems

Materials:

- Aquifer Purveyor Map & List
- Aquifer Model-from WVOLC or Reanette Boese-Spokane County Utilities
- Chart paper for each group*
- Simulation Handouts & materials
- straw*, beaker of water, pH test paper, clear plastic container lid*, sand*, grape drink powder, spray bottle, pencils*, community map copy, 4 beakers, water w/blood food color, clear water*, graduated cylinder, index cards, wood or metal poles*, broomsticks*,
  or meter sticks*, ruler*

* Items to be provided by teachers

Time: One forty-five minute period + 1-2 field trips (1/2 day).

Background: Students need an understanding of what the aquifer is and how pollutants enter it.

Procedure:

Whole Group:

- Using aquifer model review properties of liquids & how pollutants get into the aquifer.
- Generate ideas on how to monitor our aquifer for pollutants
- Discuss possible ways to treat the water should it become polluted

Student Activity in Groups:

1. Student groups will be assigned one or more of the following *Project Wet* simulations:
   - Pucker Effect (locate leak in storage system)
   - Grave Mistake (find source of contamination)
   - Reaching Your Limits (understand effort to meet drinking water standards)

Whole Group: Each group will share what they learned with the large group.

- Schedule one or both of the following field trips:

UpRiver Dam and Water Testing Facility	509-742-8141
Pasadena Park	509-926-5535

Assessment:

You are now working for the Spokane Water Department and someone has called to inform you that their water has a bad taste and smell. Explain what you might do to find the cause of the problem and how you might correct it.

Extensions:

Use "hack" kits to perform several water quality tests. These kits are available from the West Valley Outdoor Learning Center.

Students write a letter of inquiry to the area water districts asking them to describe their methods of monitoring and treating pollution of the water should it occur. Then allow students to compile the similarities and differences in procedures used by the different purveyors.

Vocabulary:

- Monitor- to study continually
- Pollutant-substance added to the aquifer which adversely affects its quality
- Water quality- purity of the water

Resources: County Water Purveyor Map and List, West Valley Outdoor Learning Center

Title: How Do the Pollutants Get Down There?

Grade Level: 2-4

Overview: Students will understand certain scientific properties of liquids and how these properties may contribute to aquifer pollution.

Standards/GLEs:
Washington State Grade Level Expectations:
Science:

1.1.1 Understand simple properties of common natural and manufactured materials and objects. Understand how to use properties to sort natural and manufactured materials and objects.
1.1.5 Understand how to classify rocks, soils and water into groups based on their chemical and physical properties.
1.2.1 Analyze how the parts of a system go together and how these parts depend on each other.
1.3.1 Understand that an organism's ability to survive is influenced by the organism's behavior in the ecosystem in which it lives.

Idaho State Content Standards:
Science:

Goal 1.1: Understand Systems, Order, and Organization
Goal 2.1: Understand the Structure and Function of Matter and Molecules and Their Interactions
Goal 2.1.1: Use instruments to measure properties.
Goal 3.2: Understand the Relationship between Matter and Energy in Living Systems

Objectives: Students will be able to describe how the properties of liquids contribute to the polluting of the aquifer.

Materials:

- 4 - 4" squares each of wax paper & newspaper
- Small cups containing each of the following : corn syrup*, auto oil*, water*, dry Kool-Aid or other powdered drink mix, liquid dish soap*
- Droppers for each cup
- Observation Chart from Day # 1 of this lesson
- Homework worksheets from Day # 1 of this lesson
- Liquids, cups, droppers from Day # 1 of this lesson
- 2 liter bottle (top cut off)*
- Sand*, clay*, rocks*, water* as found from KSPS "Thirstin Builds and Aquifer" http://www.epa.gov/safewater/kids/teachers_k-3.html
- Pieces of Scotch Brite (green scrubbing material)

* Items to be provided by teachers

Time: Two forty-five minute periods.

Background: Students need an understanding of what the aquifer is.

DAY # 1 –Properties of Liquids

Materials:

- 4 - 4" squares each of wax paper & newspaper
- Small cups containing each of the following : corn syrup, auto oil, water, dry Kool-Aid or other powdered drink mix, liquid dish soap
- Droppers for each cup

Procedure:

Whole Group Demonstration on Properties of Liquids #1 :

- Pour colored water from 1 shaped container into a different shaped container. What does it do? Can a solid do this? (*takes the shape of the container)*
- Pour the water out of the container. What direction does it go? Why? (*Liquids flow downhill due to gravity)*
- Pour water into a container filled with rocks. Where does the water go? (*water fills the spaces)*

Student Activity in Groups:

- Students will follow this procedure for each liquid on wax paper and newspaper to discover the properties of liquids and compare how the four liquids behave on each substance (wax paper vs. newspaper).

Cohesion*: attracts like droplets…drops of same substance attract one another*
Viscosity*: Consistency of the liquid (runny, thick, sticky, etc.)*
Adhesion: *Liquids behave differently on different substances (roll around, absorb into, etc.)*
Solubility: *Some substances dissolve (form solutions) when combined and others do not.*

1. Place 1 drop of liquid on wax paper and move the paper to observe **how** it moves (*viscosity).*
2. Add another drop of same liquid and see if they join together when touching (*cohesion).*
3. On one paper square, add 1 drop of each of the different liquids and see if they join together or stay separate. *(cohesion/ solubility)*
4. Repeat steps 1-3 on newspaper square. Observe similarities and differences on this new substance (*adhesion).*

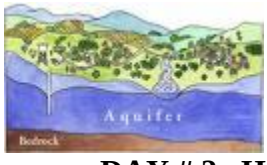
Whole Group Demonstration on Properties of Liquids #2 (recap)

- Try mixing the powder drink mix with the different liquids. Does it always mix together (dissolve). Some substances dissolve in some liquids and others are not soluble. Discuss the properties of liquids as just discovered. Specific vocabulary mastery may not be necessary depending upon grade level. It is necessary for students to understand the ways that liquids act and transfer this knowledge on lesson #2 to understand how this will contribute to the way the aquifer can be polluted.
- Create whole group chart of the observations the small groups have made concerning the properties of liquids. (to use for lesson #2)

Assessment: Students choose two of the liquids they have observed and complete a Venn diagram describing the similarities and differences of their properties.

Extensions: As homework the students, with parent permission, choose 4 liquids from home to observe and fill out the following table:

LIQUID	DROPS CONNECT?	RUNNY OR THICK?	ACT DIFFERENTLY ON DIFFERENT SURFACES?	DISSOLVE IN WATER?
Example- pepsi	Yes	runny	yes	yes
1.				
2.				
3.				
4.				



DAY # 2 –How Do Pollutants Enter the Aquifer?

Materials:

- Observation Chart from Day # 1
- Homework worksheets from Day #1
- Liquids, cups, droppers from Day # 1
- 2 liter bottle (top cut off)
- Sand, clay, rocks, water as found from KSPS "Thirstin Builds and Aquifer" http://www.epa.gov/safewater/kids/teachers_k-3.html
- Pieces of Scotch Brite (green scrubbing material)

Procedure:

Whole Group:

- Review information from yesterday's charts and homework concerning the properties of liquids.
- Review what the aquifer is and how it is important to us by building an aquifer as in step 1 below. Either have student groups build their own as you demo or have them ready built for the students to use.

Use above KSPS website to build an aquifer in a bottle. Layer the following from the bottom up: sand / slightly dampen, modeling clay pancake folded over half of the sand, gravel slanted to form a "mountain" , small chunk of scotchbrite "plants &soil".

Small Groups:

- Use aquifer in bottle from whole group demo above
- Begin to add drops of liquids to the top scotchbrite layer and discuss what these might represent in real life: oil=cars, corn syrup=waste from factories & spills, dish soap=cleaning products, colored water=storm water, dry Kool-Aid=fertilizer and sprinkled with water=rain. Add enough of each to soak through the 'grassy' layer.
- Have one student from each group act as a recorder and record their observations to share later.

Large Group:

- Discuss what happened with each liquid. Did anything NOT enter the aquifer?
- Review the properties of liquids and how these liquids affected to aquifer.
    - fertilizer (Kool-Aid) dissolves in water and soaks into the aquifer
    - oil-corn syrup are thick and heavy so they soak in slower
    - colored water (storm water) adheres and soaks into the ground (like with the newspaper)
    - all liquids travel downhill due to gravity
    - the liquids fill the spaces between rocks and sand as they take the shape of the container that holds them
    - the liquids join with the water in the aquifer (pollute)

Assessment: Kids draw in comic format three possible causes for aquifer pollution.

Extensions: Students design a poster to help people identify how they can help stop aquifer pollution.

Vocabulary:

- **Liquid-substance:** a substance which can take the shape of a container it is poured into
- **Gravity:** earth's downward force
- **Cohesion**: attracts like droplets…drops of same substance attract one another

- **Viscosity**: Consistency of the liquid (runny, thick, sticky, etc.)
- **Adhesion:** Liquids behave differently on different substances (roll around, absorb into, etc.)
- **Solubility:** Some substances dissolve (form solutions) when combined and others do not.

Resources:
http://www.epa.gov/safewater/kids/teachers_k-3.html

INSIGHTS: Liquids - An Elementary Hands-on Inquiry Science Curriculum. NSF, 2nd Edition

Title: Our Future Drinking Water

Grade Level: 3-5

Overview: Each student needs to understand that we have little freshwater compared to salty water. They also need to have an understanding of our Aquifer and groundwater. Additionally students need to understand that water can be contaminated by our actions and we shouldn't waste water.

Objectives: Students will be able to brainstorm together in groups and learn from each other what they can do to help conserve and protect their drinking water.

Standards and GLEs:
Washington State Grade Level Expectations:
Science:

3.1.1 Understand problems found in ordinary situations in which scientific design can be or has been used to design solutions.
3.2.4 Understand how humans depend on the natural environment and can cause changes in the environment that affects humans' ability to survive.

Language Arts:

3.2.1 Understand information gained from reading to perform a specific task

Idaho State Content Standards:
Science:

Goal 1.6: Understand Scientific Inquiry and Develop Critical Thinking Skills
Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced

Language Arts:

Goal 2.1: Acquire Strategies and Skills for Comprehending Text

Materials:

- Butcher paper*
- Markers
- Tape

* Items to be provided by teachers

Time: about 1 hour

Procedure:

What if...?

In groups of two to four students, make up some "what if" questions for the rest of the class. Each of your groups will make up four such situations and present them to the class for discussion.

Option: Select one of the "what if" situations to role play or act out.

Sample situations:

- What if you saw a neighbor pouring used car oil down a storm sewer?
- What if you watched your neighbor (for the umpteenth time) allowing his Great Dane to use your lawn for a bathroom without cleaning up?
- What if you were with a wilderness camping group and you met a group leaving garbage around?
- What if you were at a town meeting where politicians wanted to spray your local park with herbicides for weeds?
- What if you saw a broken fire hydrant and it's pouring water down the street?
- What if you saw your sprinklers running while it was raining?
- What if you saw your family member leaving the water running while brushing his teeth?
- What if you saw your neighbor hosing off their dusty driveway with the garden hose?

Assessment:

After students have acted out their situations, have each group record on butcher paper their situation and their solution. Hang around the room.

Questions to discuss: What other situations could we add to our lists that are problems to our drinking water? Can you students help in all these solutions? Why do you think we did this activity?

Extensions:
Have someone do a classroom visit from the Department of Ecology to help with school gardens, recycling at your school etc. www.ecy.wa.gov/

Vocabulary:

- **Freshwater** – provincial: located inland and considered provincial and unsophisticated
- **Aquifer** – water-bearing rock***:*** a layer of permeable rock, sand, or gravel through which groundwater flows, containing enough water to supply wells and springs
- **Groundwater** – underground water***:*** water held underground in soil or permeable rock, often feeding springs and wells
- **Herbicides -** chemical substance for killing unwanted plants: a chemical preparation designed to kill plants, especially weeds, or to inhibit their growth

Resources: www.ecy.wa.gov/