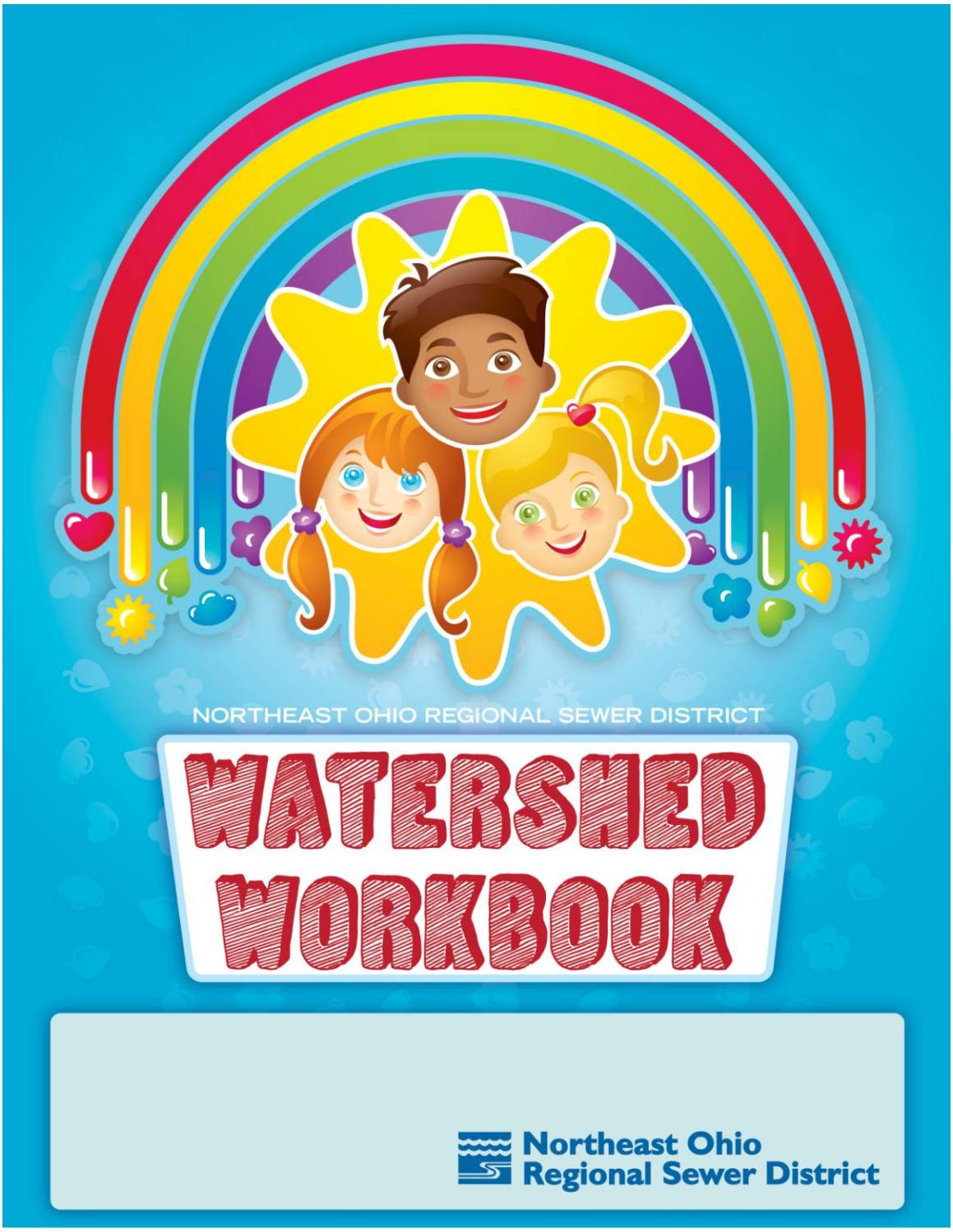


TEACHERS GUIDE

PROVIDED BY THE NORTHEAST OHIO REGIONAL SEWER DISTRICT

Northeast Ohio
Regional Sewer District

To our Northeast Ohio teachers and friends:

This curriculum was written by a group of practicing teachers with the hope that your students will gain a broader awareness of the watersheds of northeast Ohio, the water cycle and our region, and the Northeast Ohio Regional Sewer District's work present in our daily lives.

Each lesson can easily be modified to fit your classroom and meet the needs of individual students. The time frames indicated are the minimum amount of time to complete each activity. You will need to use your own judgment about how many class periods or days you will need to complete the unit.

If you have questions about the lessons, activities, or would like supplemental material, you may email us at community@neorsd.org or call (216) 881-6600 and ask to speak with our Watersheds department.

Thank you for helping us keep our Great Lake great.

Standard Alignment

The following lessons are designed to meet **Ohio's College and Career Readiness Standards in Science and Social Studies** for the fifth grade. While water and water cycle is traditionally thought of as science, these topics closely align with the social studies standards for fifth grade. The lessons also address components of the math and ELA standards.

SCIENCE:

Grade Band Theme: Interconnections within Systems

Science Inquiry and Application: During the years of grades 5-8, all students must use the following scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas:

- Identify questions that can be answered through scientific investigations;
- Design and conduct a scientific investigation;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predications; and
- Communicate scientific procedures and explanations.

Strands/Strand Connections: Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. [sic] The transfer of energy drives changes in systems, including ecosystems and physical systems.

Topic: Interactions within Ecosystems -This topic focuses on foundational knowledge of the structures and functions of ecosystems.

SOCIAL STUDIES:

Theme: Regions and People of the Western Hemisphere- In grade five, students study the Western Hemisphere (North and South America), its geographic features, early history, cultural development and economic change...

Topic: *Geography Strand- Spatial Thinking, Skills Places and Regions Human Systems*

Content Statements:

- Globes and other geographic tools can be used to gather, process and report information about people, places and environments. Cartographers decide which information to include in maps.
- Regions can be determined using various criteria (e.g., landform, climate, population, cultural or economic).
- Variations among physical environments within the Western Hemisphere influence human activities. Human activities also alter the physical environment.
- Political, environmental, social and economic factors cause people, products and ideas to move from place to place in the Western Hemisphere today.

Topic: *Government Strand-Civic Participation and Skills Roles and Systems of Government*

Content Statement:

- Individuals can better understand public issues by gathering and interpreting information from multiple sources. Data can be displayed graphically to effectively and efficiently communicate information.

Topic: *Economic Strand-Economic Decision Making and Skills Scarcity Production and Consumption Markets Financial Literacy*

Content Statements:

- The choices people make have both present and future consequences.
- The availability of productive resources (i.e., human resources, capital goods and natural resources) promotes specialization that leads to trade.

SESSION 1
Waste not, want not: Water scarcity

SUMMARY AND BACKGROUND KNOWLEDGE

Water covers three-quarters of the earth's surface. Because water covers so much of our planet it seems hard to believe that there is a need for water **conservation**. However, this valuable **natural resource** only provides us with a limited amount of usable **freshwater**.

Over 97 percent of the earth's water is **saltwater** found in the **oceans**. Two percent of the earth's water is stored as **freshwater** in glaciers, ice caps, and snowy mountain ranges. That leaves only one percent of the earth's water available to us for our daily water supply needs. Our **freshwater** supplies are stored either in the soil (**aquifers**) or in the ground (**ground water**) or in **lakes, rivers, streams** and **ponds** on the earth's surface (**surface water**).

We are fortunate to live in a part of the country that has a large supply of accessible **freshwater**. The Great Lakes which includes **Lake Erie** are the largest surface freshwater system on the Earth. **Lake Erie** and the **Cuyahoga River** are huge recreational resources, offering activities such as fishing, swimming and rowing. Our waterfronts, and the promise of clean, safe recreation, bring significant revenue into our local economy.

Students will learn:

1. The amount and types of water on our planet.
2. The Great Lakes are the largest surface freshwater system on the Earth. The Great Lakes includes Lake Erie.
3. Water is a natural resource that we all share.
4. Ways to conserve water.
5. To recognize wasteful uses of water in their own environments.

SESSION 1 AT A GLANCE

ESSENTIAL QUESTIONS

How can we ensure that we will have a freshwater supply?

If water is recycled in the water cycle then why do we have to conserve water?

When we think about conserving water why is it beneficial to live in northeast Ohio?

What concerns about freshwater do people in the rest of the world have?

MATERIALS

- Globe
- 97 blue squares
- 1 red square
- 2 green squares
- Two 2-gallon buckets
- 2 measuring cups
- "water use" cards
- Word cards with unit vocabulary words listed at right
- Ruler
- Scissors
- Glue
- Crayons or markers
- Heavy construction paper
- Watershed Workbook for each student

TIME FRAME

	Estimated
Exploring the globe	10 min.
Demonstrating with squares	13 min.
Waste not, want not	25 min.
TOTAL	48 min.

ASSESSMENT

Water Conservation Quiz

UNIT VOCABULARY

- conservation
- saltwater
- freshwater
- aquifer
- ground water
- surface water
- natural resource
- lakes
- rivers
- stream
- ponds
- oceans
- Lake Erie
- Cuyahoga River
- Great Lakes

Exploring the globe

1. Examine a globe with the students. Have students find where they live on the globe. Ask them to point out lakes, rivers, and oceans. Explain that these are called surface waters.
2. Engage the students in a discussion about the types of water. Ask the students if they know which water bodies are saltwater and which are freshwater. Have they ever tasted saltwater? Was it good?
3. Have students locate the Great Lakes. Ask the students to find Cleveland. Why is Cleveland a good place to live? Which lake is closest to Cleveland? Explain that this is our water source and that it is one of the largest bodies of freshwater in the world.
4. Compare the amount of land with the amount of water on the globe. Ask students if they think there may be water beneath the surface of the ground that we cannot see on the globe?

Demonstrating with squares

1. Spread all of the squares on a table where everyone can see. Explain that there are 100 squares that represent all (100%) of the water in the world.
2. Using the concept of percentages, ask the students if they know what the red and green squares represent. See if they can estimate percentages. Explain that the two green squares represent water that is stored as ice in glaciers and at the poles (2%). The single red square represents the freshwater that is available for plants, animals, and people (1% of all the water on the earth). Ask the students what the remaining blue squares represent. *They represent the water that's in the ocean, 97% of all the water on earth.*
3. Remove the red square. Discuss that this square represents all of the freshwater in the world which includes the water in the Great Lakes. Write the names of the Great Lakes on the board (Huron, Ontario, Michigan, Erie, and Superior).
4. Engage the students in a discussion about what we should do to take good care of the water we use in our homes and at school. *Use only what we need.*
5. Brainstorm ways to conserve water. List all suggestions on the blackboard or overhead projector. Some ideas may include: Check toilets and faucets for leaks, keep a container of drinking water in the refrigerator, turn off the water while you brush your teeth, wash clothes only when you have a full load, wash dishes only when you have a full load, take shorter showers, or get a low-flow shower head.

6. Discuss the question, "Why should we conserve water?" *Water is a natural resource that we all share. Wasting water wastes energy.*

Waste not, want not

Prepare ahead of time by bringing two 2-gallon buckets (or similar containers). Label one "Water Supply" and one "Water Used." Fill the bucket labeled "Water Supply" with water.

Duplicate and cut out the water use cards (Set A and Set B) from pages 11-15 of this Teachers Guide.

Before

1. Have the students discuss all the various ways they use water in a single day. List them on the board, and categorize the list by having the students decide if the usage is play, work, or home.
2. Assign two students to special positions: one will be a recorder and the other will measure the amount of water used.
3. Show the students the bucket labeled "Water Supply." Measure the depth of water in the bucket with a ruler and have the "recorder" write the results on the board. Tell the students that the bucket labeled "Water Supply" represents the amount of freshwater allowed per day for the group.

During

1. Divide the class into two groups.
2. Distribute the set A "Water Use Cards" to Group 1 and the set B "Water Use Cards" to Group 2. (Explain that these cards represent how much water each person will use in a day.)
3. Begin with Group 1. As each student reads his demand on the water supply aloud, remove that amount of water from the water supply bucket and place it in the bucket labeled "Water Used." This process should continue until all the set A cards are used.
4. Measure the depth of water left in the "Water Supply" bucket. Have the recorder write the results on the board. Subtract the amount of water left from the starting amount. Record the difference for Group 1.
5. Repeat the process for Group 2, beginning with the same amount of water as before. (NOTE: If none of the water has been spilled, dumping the used water back into the first bucket should be equal to the same amount.)

6. Ask each student to read his/her demand and the amount of water needed. Continue with subsequent cards. This process should continue until all the set B cards in the group are used.
7. Measure the amount of water left in the "Water Supply" bucket and record as before.
8. Subtract the amount of water left from the starting amount. Record the difference for Group 2. Discuss the noticeable difference between the amounts left and have the students formulate explanations.

After

Students will write their observations in their Watershed Workbooks using the following questions as prompts:

- What were the differences between the two groups?
- How could group 1 have conserved more?

Extension/Center Activity

Consider the following facts about water usage:

Water Facts:

Water Consumed during Daily Activities

- Flush toilet 3-5
- Run dishwasher 15-25
- Wash dishes by hand 20
- Water a small lawn 35
- Take a shower 25-50
- Take a bath 50
- Wash a small load in a washing machine 35
- Brush teeth with water running 2-5
- The average American home uses an average of 293 gallons of water a day.

Data from EPA website
http://www.epa.gov/reg5rcra/wptdiv/p2pages/water.pdf

What can you do to conserve water in your life? Prepare a graph showing how many gallons of water you use each day.

Students can create water conservation posters to display at home and around the school.

Create a diagram showing the Great Lakes. Label each lake. Indicate with a dot where Cleveland is located.

SET A **Water Use Cards / Group 1**

I have been playing basketball and need to take a bath. **3 CUPS**	Mom said my shoes were dirty, so I ran them through the washing machine. **2 CUPS**
It is time for lunch and I need to wash my hands with the faucet running. **1 CUP**	Flush the toilet, please. **1 CUP**
I just ate ice cream. I brushed my teeth with the faucet running. **1 CUP**	I noticed the faucet leaking but it's nothing more than a drip. **1 CUP**

I have been working in the sun and am very thirsty. I would like some cold water to drink. **1 CUP**	Mom asked me to wash the lunch dishes, so I put them in the dishwasher and turned it on. **2 CUPS**
Since it's so hot outside, I want to fill up the wading pool. **2 CUPS**	Mom wants me to wash her car tonight. **2 CUPS**
Dad and I are growing a garden. Since plants need water, turn the sprinkler on, please. **2 CUPS**	Our grass needs water to grow every day. **1 CUP**

SET B **Water Use Cards / Group 2**

I have been working in the sun and am very thirsty. There is a cold bottle of water in the refrigerator. **1/2 CUP**	Mom asked me to wash the lunch dishes. I will wait until our dishwasher is full. **1/2 CUP**
Since it is so hot outside, I want to fill the wading pool, but I don't need to fill it to the top. **1 CUP**	Mom wants me to wash her car, so I'll use the water I saved from the kitchen and bathroom sinks instead of letting the water run down the drain. **0 CUPS**

Dad and I are growing a garden. We use a soaker hose and mulch the plants. I'll also use rainwater we have saved. **1/2 CUP**	Our grass needs water to grow, but not every day. We use a soaker hose. **1/2 CUP**
It is time for lunch and I need to wash my hands. I'll just fill the sink halfway and not run the faucet. **1/2 CUP**	Please flush the toilet. (There is a plastic bottle filled with stones in the tank to reduce the amount of water it takes to fill it.) **1 CUP**

I just ate ice cream. I need to brush my teeth. I never leave the water running. **1/2 CUP**	I noticed the faucet leaking so I told my dad and we fixed it. **0 CUPS**
I have been playing basketball and need to take a bath but I'll only fill the tub part way. **1 CUP**	Mom said my shoes were dirty so I put them in the wash with dirty towels. **1/2 CUP**

This page is found in the students' Watershed Workbook:

Why do we consider the Great Lakes one of our greatest natural resources?

4

This page is found in the students' Watershed Workbook:

WATER CONSERVATION QUIZ: SAVING OR WASTING?

Print an S on the line if the action SAVES water.

Print a W on the line if the action WASTES water.

_____ 1. Take long showers.

_____ 2.Fill the bathtub full.

_____ 3. Delay fixing a leaky faucet.

_____ 4. Fix a leaky toilet.

_____ 5. Wash only full loads in the laundry or dishwasher.

_____ 6. Fill the bathtub 1/4 full.

_____ 7. Turn off water while brushing teeth.

_____ 8. Fix leaky faucet.

_____ 9. Wash a few clothes every day.

_____ 10. Let water run while brushing teeth.

5

SESSION 2
A fish story: Water Pollution

SUMMARY AND BACKGROUND KNOWLEDGE

In Northeast Ohio, we are fortunate to have an abundance of freshwater for all our needs from Lake Erie. The problem of keeping this water resource clean is a big challenge for everyone. There are two sources of pollution, point source pollution and non-point source pollution. Point source pollution originates from a specific, identifiable place like a factory, pipe, or livestock feedlot. Through the Clean Water Act regulations are in place to address these sources and quality of point-source pollution. The specific origin of non-point source pollution is more difficult to identify and manage.

Non-point source pollution is caused by water (rain or snow melt) moving over the surfaces and picking up pollutants like oil, grease, pesticides, fertilizers, pet waste, salt and litter. This surface runoff that is carrying the pollutants enters our waterways directly or are carried through storm drains and discharged into our waterway. In our region the final destination of non-point source pollution is our local waterways that include the Cuyahoga River and Lake Erie. Non-point source pollution accounts for 60% of the surface water quality problems in Ohio.

In our urban environment we have large areas of impervious surfaces. Impervious surfaces include roadways, parking lots and rooftops. These impervious surfaces reduce the areas for the stormwater to naturally infiltrate. This increases stormwater runoff, and provides more opportunities to pick up and deliver non-point source pollutants to our waterways. The increase in impervious surfaces also increases the volume and velocity of the runoff entering our waterways and storm sewers. This creates more flooding, erosion and water quality problems.

Students will learn:

1. Water in Lake Erie and the Cuyahoga River is affected by Stormwater discharges.
2. The causes and effects of water pollution.
3. The differences between point source and non-point source pollution and how they affect our lake water.

SESSION 2 AT A GLANCE

ESSENTIAL QUESTIONS

How do our everyday activities affect the quality of water available to us?

How can our weather impact the quality of the water in Lake Erie?

MATERIALS

- Word cards with these Unit Vocabulary words listed at right
- *A River Ran Wild* by Lynne Cherry (Harcourt, 1992
- Watershed Workbook for each student
- Plastic box
- Soil
- Spray bottle
- Sand
- Pebbles
- Leaves
- Video **Where does it go?** (from the NEORSD website)

TIME FRAME

	Estimated
Lake Erie is our reservoir	15 min.
Causes and effects of water pollution	15 min.
Point source vs. non-point source pollution	18 min.
TOTAL	48 min.

ASSESSMENT

Complete a cause/effect graphic organizer listing causes and effects of water pollution.

UNIT VOCABULARY

- contaminants
- non-point source pollution
- point source pollution
- separate sewers
- combined sewers
- interceptors
- water treatment plant
- pervious surface impervious surface
- stormwater
- runoff
- water quality

Lake Erie is our reservoir

1. Write these facts on the board, overhead or sentence strips.
    - Water covers 70% of our planet, but only a fraction of that is usable to us
    - 97% of water found in oceans is undrinkable saltwater
    - Of the 3% that is freshwater, two-thirds is frozen in icecaps, glaciers and on snowy mountain ranges
    - Less than 1% of the planet's water is usable to humans and almost half of this water is used to grow agriculture
    - Most of the usable freshwater is underground.

2. Ask students how they think we get water to drink and water for various other uses considering these facts.

3. Introduce the word reservoir. Explain that there are manmade reservoirs in many areas of the country but that northeast Ohio has a natural reservoir, Lake Erie. This is where we get our water. Show the video **Where does it go?** (from the NEORSD website)

4. Discuss these questions with the students following the video:

    - What is the difference between a **combined sewer** and a **separate sewer**?
    - Describe what an **interceptor** does?
    - Why is it important to stay out of Lake Erie after a heavy storm?
    - What are **pervious** and **impervious** surfaces and where does the water flow from each surface?
    - Where does our water go? (All of the water we use inside our home goes directly to the sewer system to a treatment plant where it is cleaned and released back into Cuyahoga River and Lake Erie cleaner than when it started.)
    - How about the water from our yards, driveways, roads, ditches and parking lots? Where does this water go? (It is not always easy to see after it goes down the drain, but often the rain water that falls in our yard overflows into a stream before it can be cleaned).

Causes and effects of water pollution

1. Begin by having students' access prior knowledge about water pollution using a K-W-L chart. The chart should have three columns: *What I Know*, *What I Want to Know*, and *What I Learned*. Ask students what they know about water pollution and record their responses. Pause for discussions as necessary for understanding and to clear any misconceptions.
2. Ask students what they would like to learn about water pollution and record responses under the *W* section of the chart.
3. With students still gathered in a group, read aloud *A River Ran Wild* by Lynne Cherry.
4. After the read-aloud, discuss the story. Ask guiding questions to help students understand the book. Talk about the changes that took place over the years with the Nashua River and what caused the changes to occur. Possible questions or comments might include:
    a. Why was the Nashua River important to the Nashua people?
    b. What are some of the things that the river provided to the Nashua people?
    c. Why was it important to take care of the river?
    d. Name some things that began to change the river.
    e. Why did the animals stop coming to the river?
    f. Why was it important to restore or clean up the river?
5. Discuss the history of the Cuyahoga River with the students. Read the following excerpt about the Cuyahoga River Fire.
    a. *"A serious fire in 1952 that burned for three days caused $1.5 million in damage. In fact, the Cuyahoga had caught fire on at least a dozen occasions since 1868. Most of those earlier fires were much more devastating than the 1969 blaze: A fire on the Cuyahoga in 1912 killed five people. A fire in 1936 burned for five days. The 1969 fire, by contrast, lasted just under thirty minutes, caused only $50,000 in damage, and injured no one. The first reported Cuyahoga River fires were well over a century ago. Indeed, it appears that burning oil and debris in rivers was somewhat common. Due to the volume of oil in the river, the Cuyahoga was "so flammable that if steamboat captains shoveled glowing coals overboard, the water erupted in flames" (Nordhaus & Shellenberger, 2007)*
6. Ask the students why they think the Cuyahoga River caught fire so often. (Answers may include oil spills, industrial discharges, trash, other answers pertaining to industry, neglect, or lack of awareness)

7. Inform the students that, due to pollution, the Cuyahoga River caught fire more than a dozen times since the first fire in 1868. Ask the students why they think no one ever did anything about the fires back then (answers may include – they didn't know how, they didn't know what was causing it, they were too busy with other problems like finances and illness).
8. Tell students that because of these fires the Clean Water Act was enacted in 1972. As a result several water pollution control organizations have been formed that include the United States Environmental Protection Agency (USEPA), the Ohio Environmental Protection Agency (OEPA), and the Northeast Ohio Regional Sewer District (NEORSD).
9. Have students add new information to the K-W-L chart based on what they learned.

Point source vs. non-point source pollution

1. Explain to students that pollution is generally categorized by how it enters a body of water like Lake Erie or the Cuyahoga River as either point source or non-point source pollution.
2. Define Point Source Pollution as contaminants that enter a water body that can be traced back to a specific source, location, and offender. Point source pollution is easier to manage compared to non-point source pollution.
3. Define Non-Point Source Pollution as contaminants that enter a water body that cannot be traced back to a specific source, location, and offender. Rather, this pollution comes from many sources and often enters in small amounts but can become concentrated in lakes and other freshwater resources.
4. Engage students in a discussion about point source and non-point source pollution by asking the following questions:

    - What kinds of contaminants contributed to the polluting of the Nashua River?
    - What kinds of contaminants contributed to the polluting of the Cuyahoga River?
    - Were these contaminants examples of point source or non-point source pollution?

5. Explain that non-point source pollution is the leading remaining cause of water quality problems. These pollutants have harmful effects on drinking water supplies, recreation, fisheries and wildlife.
6. Have students work in pairs and read and reflect on A Fish Story. Students will write their reflections in their Watershed Workbooks.

Extension

1. Construct a model of a reservoir using a clean, clear plastic box. Line the bottom of the box with small pebbles and then layer sand, soil, and leaves on top.
2. Carefully spray water on the four corners of the model until the soil mixture is saturated and the water has seeped through to the open area (the reservoir).
3. The story of the Nashua in *A River Ran Wild* is similar to the story of the Cuyahoga, a river that burned numerous times during the 1950s and 60s because of waste from factories. The burning of the Cuyahoga spurred the Clean Water Act. Since then, factories act responsibly, and the river hosts numerous species, and people are able to boat in sections of it. Have students rewrite the book, A *River Ran Wild* using the story of the Cuyahoga River.
4. Select one of the following tips that residents are encouraged to consider and create a poster to display.
    - Rain barrels: Capture free water from the roof for plants
    - Rain gardens: Native plants might not need chemical sprays
    - Cars washed on lawns: Keeps water out of storm drains, allows vegetation to draw pollutants out of the water before it seeps into the ground
    - Pesticides and fertilizers: Using little, none, or eco-friendly brands
    - Pet waste: Bacteria affects water quality
    - Hosing yard and sidewalk debris: Sweeping is better
    - Composting or recycling yard waste
    - Green cleaning products instead of chemicals to reduce water pollution
    - Unused medicine: Should not be flushed or washed down a drain. Should be safely discarded in the trash or taken to a local pharmaceuticals-collection event. You can find details about these events online.
    - Planting trees: They provide enormous support in managing stormwater by reducing runoff and controlling erosion
    - Oil, paint, other garage-related fluids: Should not to be dumped into sinks or storm drains

The following story appears in the students' Watershed Workbook, pages 4-6.

Session 2: A fish story

Imagine a river as it meanders through the countryside, past the farmer's field, widening into a lake, but narrowing again as it passes through the city. In this river lives a fish. Put a fish in the clear blue water in the plastic container.

The fish swims down river past an eroding stream bank. When it rains what will happen to the bank? What if it rains a lot? *Put soil into the water*. What does this do to the fish?

Suppose part of the soil eroding into the water came from farm land. The farmer has just put fertilizer on the field. Instead of staying on the field and helping the crops, the fertilizer rides "piggyback" on the eroding soil and goes into the river.

What effect will the fertilizer have on the plants in the river? If the plants grow too abundantly and too fast, the river can't support them and supply the necessary nutrients. They die, fall to the bottom, and start to decompose. Decomposing things use oxygen.

What else in the river needs oxygen? What does this do to the fish?

Farm fields aren't the only source of fertilizer in a river. Homes may also be a source, too. Where the river flows into a lake, several families have built their homes. Perhaps their lawn fertilizer has washed into the water.
What does this do to the fish?

As the lake flows into a river, our fish continues downstream past the city. Even though the city people don't pollute the water directly, what they do at home can affect the quality of the water in the stream. Have you ever seen a car leaking oil? Or litter flowing into a street drain? Where does this polluted water go? *Put oil into the water*. What does this do to the fish?

In the winter, what do we put on our roads to make it easier to drive? Does it stay on the street, or does it flow anywhere else? *Put salt into the water*. What does this do to the fish?

As the river leaves the city, it winds past several factories along the way. Factories must protect the water around them, but some companies have broken the law and polluted nearby streams. *Put detergent into the water*. What does this do to the fish?

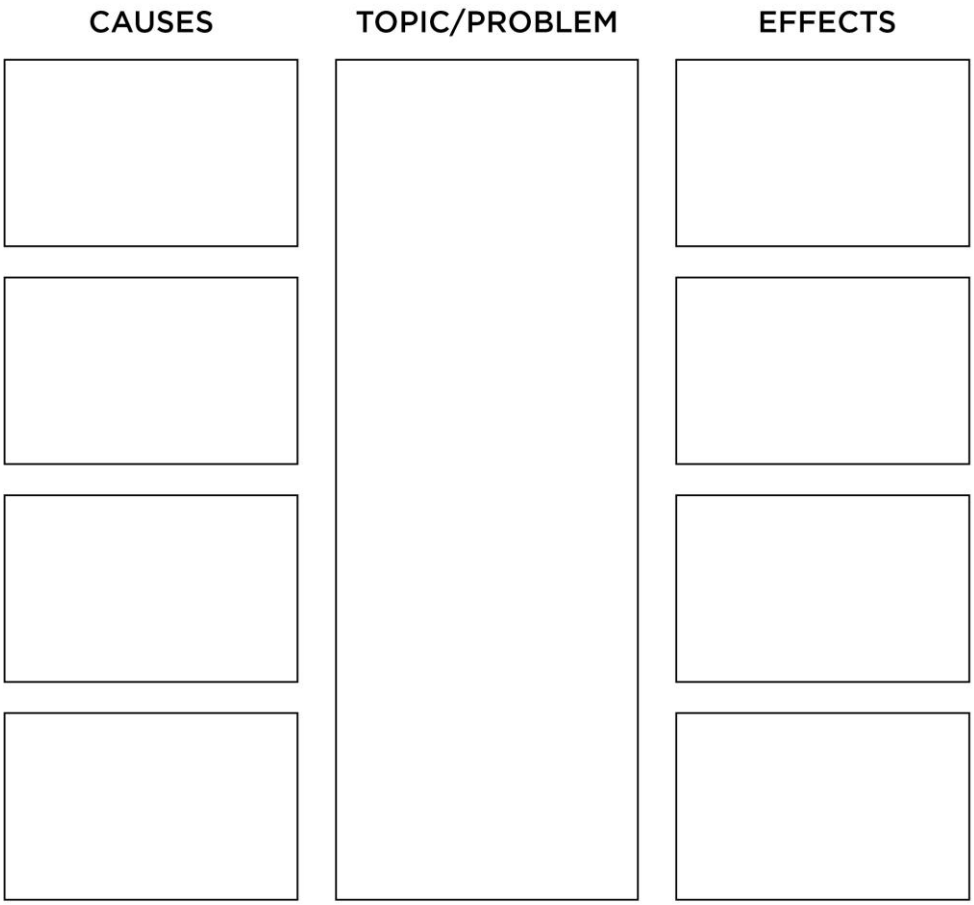
The wastewater treatment plant for the city is also located along this section of the river. Treatment plants clean wastewater before it is released to the river, but in some cities, old sewers overflow during heavy rain storms, and some wastewater never makes it to the treatment plant. It would be like putting 2 drops of this food coloring into this jar of water. The amount of pollution in one overflow might be small, but put it is still polluted. *Put two drops of food coloring in the water. Stir it.* What do you see? What does this do to the fish?

_____

Written for Groundwater Education in Michigan (http://www.gem.msu.edu/), 1998. Adapted for NEORSD.

CAUSE AND EFFECT GRAPHIC ORGANIZER

List the topic or problem that you are exploring in the center of your organizer. Under the CAUSES section, record what you think makes the problem happen. Under the EFFECTS section, record what happens because of the causes.

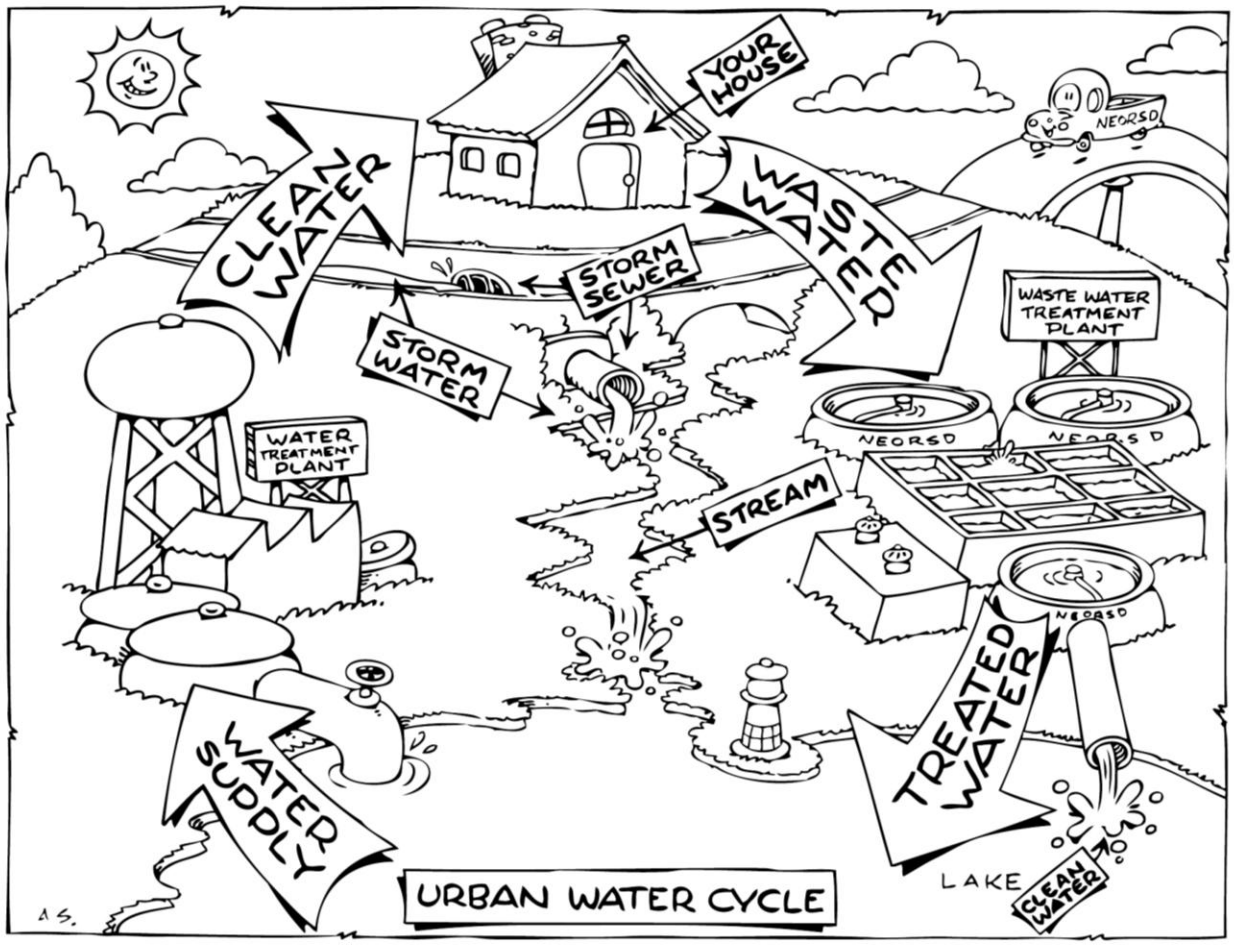


SESSION 3

The urban water cycle and wastewater treatment

SUMMARY AND BACKGROUND KNOWLEDGE

The **water cycle** is the natural circulation of the Earth's water through precipitation, collection, evaporation and transpiration, and condensation. In developed areas, this natural cycle is affected as water is transported, cleaned and returned to the environment by physical means. This may be called the **urban water cycle**.



In this session, we will focus largely on the wastewater side of the urban water cycle.

A **wastewater** collection system gathers used water from homes and businesses and directs it to the conveyance system, which carries the flow to a wastewater treatment plant where it can be cleaned.

Some of the components of a collection system include: gravity sewers, force mains, manholes, regulators and lift stations. Proper maintenance of the collection system ensures that **wastewater** is not allowed to back up and overflow into the street, someone's home, or into the streams, rivers, the Cuyahoga or Lake Erie.

Conveyance of wastewater is achieved through a system of local sewers, combined sewers, intercommunity relief sewers, interceptor sewers, automated regulators and pump stations. Proper operation and maintenance of the conveyance system ensures that wastewater is safely and efficiently transported to wastewater treatment plants. In our region the Northeast Ohio Regional Sewer District provides wastewater treatment and releases the clean water into Cuyahoga river and Lake Erie.

Wastewater treatment cleans water so that it may be safely released to the lake or river, and it usually consists of two major stages: primary and secondary treatment. **Primary treatment** separates sand, grit and larger solids from the wastewater, but solids still remain. **Secondary treatment** removes these solids mainly through a biological process.

Most communities in our area receive the water they use in their homes from the City of Cleveland Water Department. The source of the water is Lake Erie.

Students will learn:

1. How our water comes from Lake Erie and flows back to Lake Erie after it has been cleaned.

2. Why there is a need for wastewater treatment.

3. Stages of wastewater treatment.

SESSION 3 AT A GLANCE

ESSENTIAL QUESTIONS

Why is it essential to treat water before and after we use it?

How does the Northeast Ohio Regional Sewer District protect our health and our water resources?

_____

MATERIALS

- Word cards with the Unit Vocabulary words listed at right
- Video **So if you ever wondered…** (from the NEORSD website)
- Large bowl or jar of "dirty water" (Perhaps from a stream, or created with tap water and debris such as mulch, dirt, sand, food coloring, soap suds, etc.)

TIME FRAME

	Estimated
Urban water cycle discussion and "So if you ever wondered" video from NEORSD	30 min.
Explaining the system	15 min.
TOTAL	45 min.

ASSESSMENT

Respond to the following questions following the discussion of the wastewater treatment process:

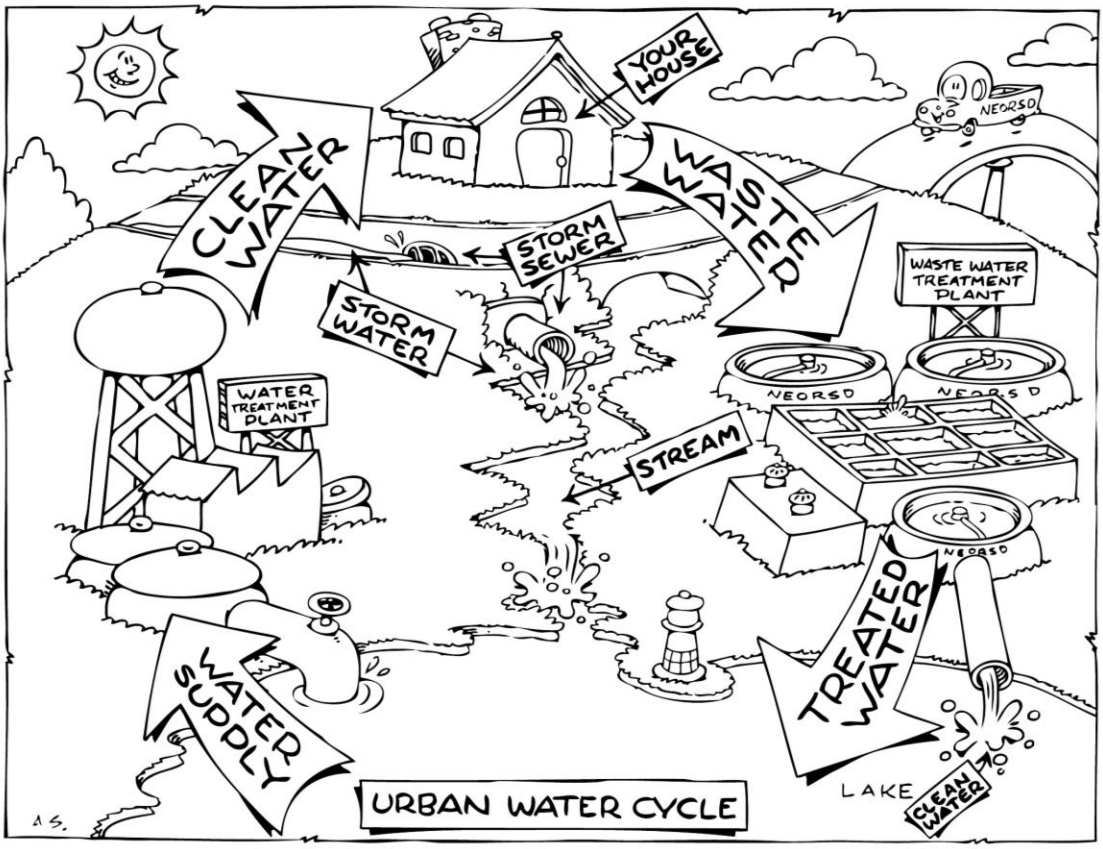
1. What would happen of the dirty water that leaves our homes was not cleaned properly?
2. How would it affect the urban water cycle?

UNIT VOCABULARY

- impurities
- aeration
- sedimentation
- filtration
- disinfection
- microorganisms
- bacteria
- wastewater
- primary treatment
- secondary treatment

Introducing the urban water cycle

1. If you have a sink or drinking fountain in the classroom, run the water for a moment, and ask the class "Where does this water come from?" Allow them to respond and hear the variety of answers. Do not share the correct answer (Cleveland Division of Water) yet, just allow them to state their thoughts.
2. After answers have been shared, ask, "When the water goes down the drain, where does it go?" or "When you flush a toilet, where does that water go?" Allow them to respond and hear the variety of answers. Do not share the correct answer (sewers, wastewater treatment plant, or Northeast Ohio Regional Sewer District) yet, just allow them to state their thoughts.
3. Show students a glass of "dirty" water that contains the debris referenced in the Materials list. Ask students to describe this water. Explain that this is how dirty water can be (and it can be even dirtier) after we use it (for washing, cleaning, flushing, etc.). This dirty water has **impurities**.
4. Ask students, "Does the used, dirty water get thrown away forever, or does it get recycled and reused? (A student may have answered this in the previous question.) Would you ever drink the water that's going down the drain right now?" The series of questions is to show there is a relationship between the water that comes into our homes and the water that goes out—We are not and can not make "new" water, we can only learn to use and care for ("recycle") the fresh water we have.
5. Show the students the Urban Water Cycle drawing on page 8 of the Watershed Workbook (also shown below).



6. Ask the students to identify the "kinds" of water in the drawing: Lake water/supply water, clean water, wastewater, treated water, and stormwater.
7. In their workbooks, ask them to answer the questions, "Where does the water come from? Where does the wastewater (dirty water) go? Where does the stormwater go?"
8. Show the video **So if you ever wondered…** (http://vimeo.com/wally). This video is intended to share how water moves in our neighborhoods, and how water systems relate to each other. We will spend most of the discussion on the wastewater side of the cycle.

Explain the wastewater treatment system

1. Explain how the Northeast Ohio Regional Sewer District cleans the wastewater in our area to returns it to the Cuyahoga River and Lake Erie. The Northeast Ohio Regional Sewer District provides wastewater

treatment and regional stormwater management. (The City of Cleveland provides water treatment for home use across most of the region.)

2. Use the glass/jar of "dirty" water to review the steps of the Northeast Ohio Regional Sewer District's wastewater treatment by asking the following questions:
   - "If we were going to clean this water, what would be the first thing we would need to remove?" Answer: Get rid of the biggest debris. In wastewater treatment, this is known as **Preliminary treatment,** which removes debris like cans, leaves, and rocks from the water that has been flowing through the sewers.
   - "What's the next biggest thing you might see in this dirty water? (Sand, dirt, smaller particles floating or suspended in the water) Can we just scoop them out?" Smaller particles are easier tom remove once they have sunken to the bottom of the jar. In wastewater treatment, this is known as **Primary treatment,** which slows the water down to let solids sink to the bottom and grease float to the surface so it can be removed.
   - "What about the color (food coloring) or the suds (soap suds). Think of that as the waste in dirty water that might be too small for us to see. How do we clean that?" Answer: That waste is tasty. Microorganisms are good germs that love to eat the tasty waste in wastewater, like food waste and biological material from the environment. The Sewer District uses **Secondary treatment** to let good germs eat the waste. When the good germs are full, they are removed from the water and used again later.
   - "Could there be any bad germs left over even after this?" Answer: Yes. The Sewer District uses **Disinfection** to remove any leftover germs (**bacteria**) right before the water is safely returned to the river and lake.

CONCLUSION: On page 11 of the Watershed Workbook, below the process diagram, ask the students the following:

1. Write down what would happen to our lake or rivers if the water we used every day was not cleaned properly. (Answers may include pollution, sickness, floating trash and litter, poor health of fish, animals or other organisms.)
2. How would this affect the urban water cycle? (Answers may include harder work cleaning the water for us to drink/use at home, lake/river pollution, sickness in our homes and neighborhoods)

Extension

Students can write story about Wally Waterdrop and an adventure he has traveling from a home drain back to Lake Erie safely.

SESSION 4

Watersheds and stormwater management

SUMMARY AND BACKGROUND KNOWLEDGE

A **watershed** is the area of land where all water drains into a common body of water. The largest **watershed** in Northeast Ohio is Lake Erie. Water from all rivers and streams in Cuyahoga County flow into Lake Erie. Protecting the Lake Erie **watershed** and the more than two dozen smaller **watersheds** that drain to the lake is important to the environment, public health, and the economic well-being of Greater Cleveland. When stormwater runoff is not managed properly, the result is flooded streets and properties, **erosion**, and water quality.

Students will learn:

1. About our local Lake Erie **watershed**
2. Water flows downhill and pollution of any water source can affect Lake Erie water quality
3. Water quality can be negatively affected by runoff

SESSION 4 AT A GLANCE

ESSENTIAL QUESTIONS

How do each individual's actions help or harm the **watersheds**?

MATERIALS

- Word cards with Unit Vocabulary words
- Newspapers
- Aluminum pans
- Clay
- Spray bottles with water
- Follow the Water from Brook to Ocean by Arthur Dorros
- Various small items such as: sugar crystals, soil, jello/pudding powders

TIME FRAME

	Estimated
Our local watersheds	5 min.
How does water flow?	15 min.
How does water become polluted?	15 min.
Why would I be concerned with the water quality in rivers and streams?	13 min.
TOTAL	48 min.

ASSESSMENT

Choose one of the following:

- Write a persuasive paragraph explaining how pollution of water sources affects others.
- Make a poster advertising how to prevent the pollution of our water sources. Include common pollutants and how to prevent these pollutants from entering our waters.
- Draw and label a watershed. Show how what happens at the start of a watershed can affect others that share that watershed.
- Design a game that would teach others about watersheds and pollution.

UNIT VOCABULARY

- watershed
- erosion

Our local watersheds

1. Have students look at the watershed map in their Watershed Workbooks (pages 10-11). Engage the students in a discussion using questions such as these:
    - What body of water is near our school?
    - Where does the water in the Cuyahoga River flow? (Lake Erie)
    - What ocean does the water in Lake Erie flow into? (Atlantic Ocean)
    - How does the water from Lake Erie get to the ocean? (Lake Erie to Lake Ontario, Lake Ontario to the St. Lawrence River, St. Lawrence River to the Atlantic Ocean)
2. Look at a globe or a map of the United States. Point out the Atlantic and Pacific oceans. Point out the Great Lakes. Point out Lake Erie, Cuyahoga River and the watershed.
3. Point out the tributary that is closest to the school.
4. Explain that the United States could be divided into Atlantic and Pacific watersheds, then into smaller watersheds of rivers and lakes and then even smaller watersheds of streams and ponds. Each of the Great Lakes has its own watershed. (A watershed is an area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater). Watersheds are almost always part of a larger watershed.

How does water flow?

1. Have students respond to this question in their Watershed Workbooks (page 11): What happens to Stormwater as it flows downhill?
2. Group students in clusters of 3 or 4. Give each group clay, and aluminum pan, newspaper and a spray bottle.
3. Have students in each group place a large piece of newspaper under the aluminum tray.
4. Have students form a small hill with several indentions and valleys out of the clay.
5. Ask students to predict where the water will flow if it rains.
6. Spray the top of the hill with water several times and watch the flow of water. Observe what happens to the water. Discuss observations.
7. Ask: Where did the water go? Why?
8. Have students choose a spot on the model to build a home. They can mark their home using a colored toothpick. Discuss how the pollution of the water next to each of their homes could affect others.
9. Students will return to the question in their Watershed Workbook that they responded to at the beginning of the activity. Have students add to their responses based on what they learned.

How does water become polluted?

1. Brainstorm ways that water can become polluted.
2. Discuss with students how pollution can affect an area. Follow-up with a question to students. Can pollution affect more than one area?
3. In their small groups have students carefully dump out water from first activity.
4. Give each group the sugar crystals, soil, jello, and chocolate pudding powder to place on their clay model.
5. Brainstorm with the group what type of pollution each item will represent. (List this on the board to avoid later confusion).
6. Spray the model again with water several times and watch the flow of the water. Observe what happened to the items that were placed on the model. Ask: How do pollutants enter the water?
7. Engage students in a discussion about water movement. Water doesn't stop when it hits the ground. It moves through the watershed and sometimes quite often connects to other watersheds. Students just observed how pollutants can enter the water by runoff as well as direct contact with the water initially.
8. In their Watershed Workbooks have students make a list of living things that can be affected by pollution. Talk about plants and animals that depend on lakes, rivers, ponds, streams and oceans for their home or water source.

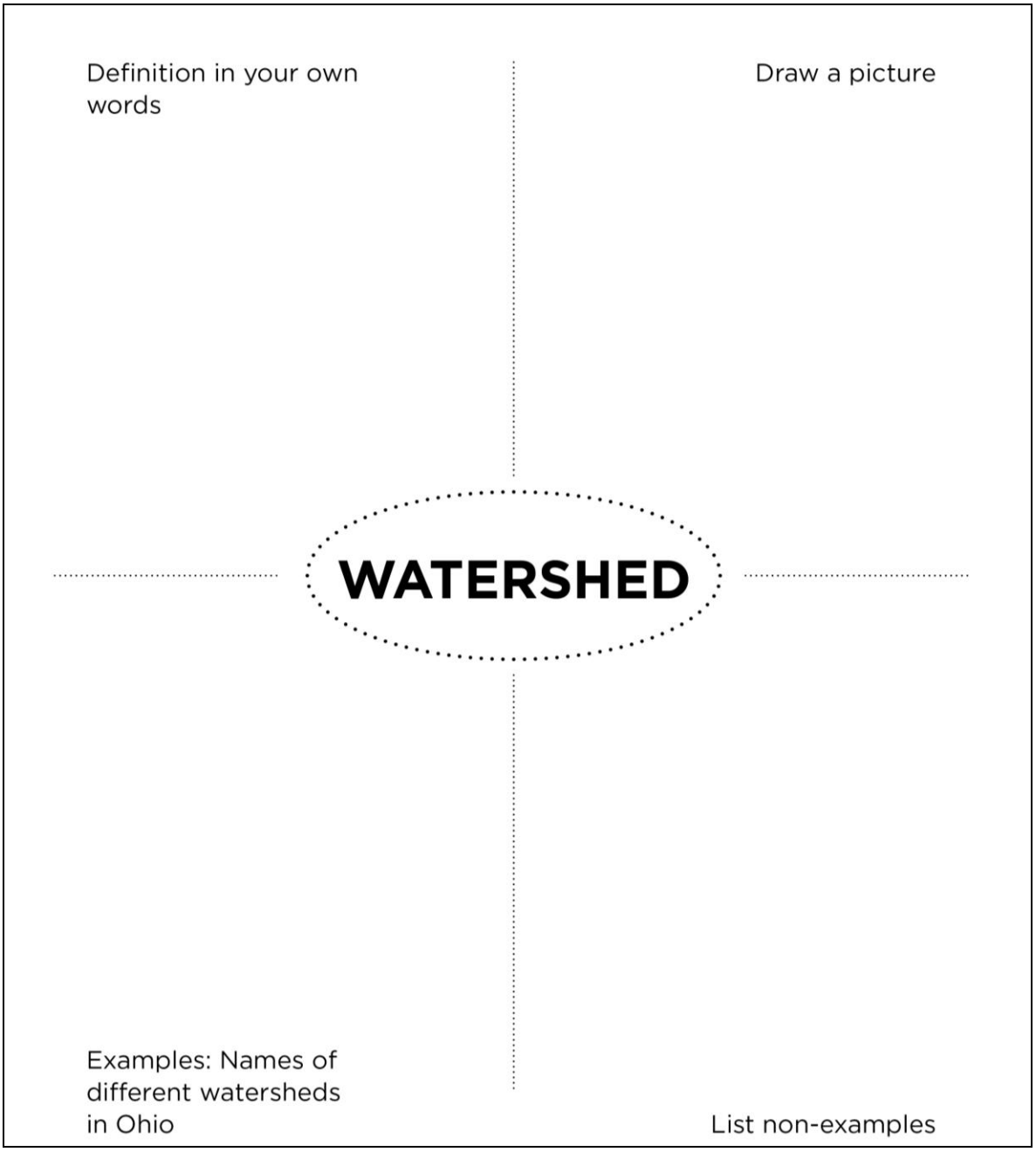
   Be sure that students understand that Northeast Ohio Regional Sewer District cleans the water of pollutants before it returns it to the lake. This is important because as water moves, it can carry pollutants to the lakes, rivers, streams and ponds.

Why would I be concerned with the water quality in rivers and streams?

1. Introduce the read aloud *Follow the Water from Brook to Ocean* by Arthur Dorros. Discuss water terms—brook, stream, river, ocean. Review how water flows from a smaller body into a larger body. Define watershed as the area of land where water flows into a specific body of water. Point out each of the "watersheds" in the book.
2. Ask the students to listen and look for animals that are in or near the water as you read.
3. Read the story. The first time you read the story, you may choose to have the students to look for the animals that live near water.
4. Things to point out during the story:
   - Pages 4 and 5. Talk about the areas in the illustration where water would be absorbed or repelled. This could lead to a later discussion about water absorbing and water repelling surfaces.
   - Pages 6 and 7. Discuss the flow of water. What types of things would speed up, slow down or change direction of the water?

- Pages 8 and 9. Discuss why individuals should be concerned with the water quality in rivers and streams.
- Pages 10 and 11. This would be a good time to have someone explain/review the water cycle.
- Pages 12 and 13. What are the negative and positive effects of algae in a water system?
- Pages 14 and 15. What are other ways that people use water for fun?
- Pages 16 and 17. Discuss how erosion can change the way the earth looks. Talk about the negative effects of erosion on a water habitat. Discuss ways to slow down or prevent erosion.
- Page 23. Review the causes of a flood.
- Pages 24 and 25. Discuss how humans can control the flow of water.
- Pages 26- 29. Make a list of ways that you can prevent pollutants from entering the waterways.

Diagram found in students' Watershed Workbook page 14



Extension:

Draw a map showing Lake Erie and its watershed. Draw arrows showing where the water drains.

Draw a diagram showing how the water in Lake Erie travels to the Atlantic Ocean.

Adapted from a lesson developed by:
Felicia Hester, Camp Creek Elementary
This activity is a product of the Rivers to Reef Teacher Workshop sponsored by the Georgia Aquarium and NOAA Gray's Reef National Marine Sanctuary. For more information about this workshop, Georgia Aquarium, or Gray's Reef National Marine Sanctuary, please visit our websites at www.georgiaaquarium.org or http://graysreef.noaa.gov/

Diagram found in students' Watershed Workbook page 13

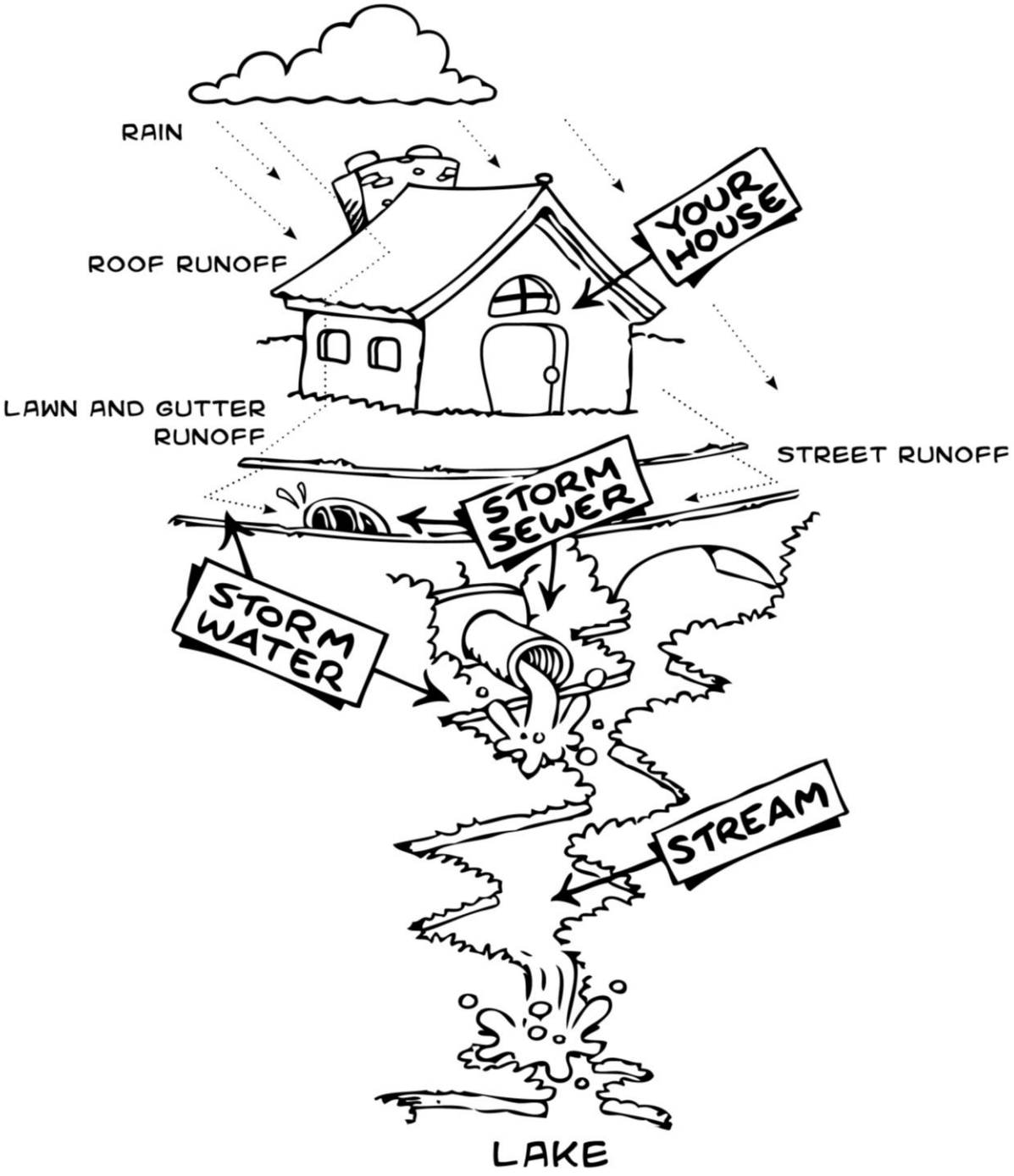


Diagram found in students' Watershed Workbook page 12

SESSION 4

Stormwater management

Look at the illustration on the next page. Identify **nonpoint sources** of pollution. Why should we be concerned with stormwater runoff that ends up in local streams untreated? How can we reduce nonpoint source pollution?

Make a list of living things that can be affected by water pollution.

Culminating Activity: Lapbook

SUMMARY AND BACKGROUND KNOWLEDGE

A lapbook is simply a file folder that contains a variety of "mini books," foldables, and other material and is laid out in a creative manner that fits in the student's lap. In this culminating activity, the lapbook will include information on the water cycle, soil erosion and runoff, and the water purification system. Black line masters have been provided but what is included in your lapbook is entirely up to you and your students so be as creative as you want. The benefits of a lapbook are first and foremost, a fantastic hands-on educational tool. The lapbook itself is highly interactive – from the creation to the finished product. And each component of the lapbook has given the learner an opportunity to concentrate on a specific aspect of the greater topic. You may want students to complete their lapbook individually, with a partner, or even in a small group.

Students will learn:

- Review the amount and types of water on our planet and the need for conservation
- Review the causes and effects of water pollution.
- Review the importance of water purification and the interconnectedness of watersheds
- Create a lapbook containing all of their newly gained knowledge.

LAPBOOK AT A GLANCE

ESSENTIAL QUESTIONS

What did I learn throughout the Watershed Curriculum?

How will using this newly gained information help me to care for my environment?

MATERIALS

For each student/pair/small group:

- 1 file folder for each student
- Copies of the blackline masters (already included in the Watershed Workbooks)
- Scissors
- Glue
- Crayons/markers/colored pencils

TIME FRAME

	Estimated
Review	10 min.
Explaining the culminating project	8 min.
Making a lapbook	30 min.
TOTAL	48 min.

ASSESSMENT

The assessment of student understanding will be based on the completion of the student created lapbook and the information contained within it.

UNIT VOCABULARY

- conservation
- saltwater
- freshwater
- aquifer
- ground water
- surface water
- natural resource
- lakes
- rivers
- stream
- ponds
- oceans
- Lake Erie
- Cuyahoga River
- contaminants
- non-point source
- pollution
- point source pollution
- sanitary sewer
- separate sewers
- combined sewers
- interceptors
- water treatment plant
- pervious surface
- impervious surface
- Stormwater
- impurities
- aeration
- coagulation
- sedimentation
- filtration
- disinfection
- microorganisms
- bacteria
- wastewater
- primary treatment
- secondary treatment
- watershed
- erosion

Review

1. Review the key points on water conservation from session 1 with the whole class.
2. Next, review the causes and effects of water pollution.
3. Go over the steps in the water filtration procedure from session 3.
4. Discuss the interconnectedness of watersheds.

Explaining the culminating activity

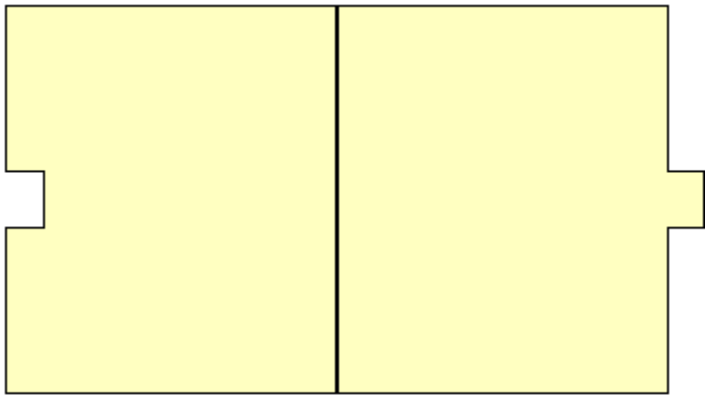
1. Explain to the students that they will be making a lapbook. A lapbook is file folder that contains a variety of "mini books," foldables, and other material and is laid out in a creative manner that fits in the student's lap. The students' lapbooks will include information on the water cycle, soil erosion and runoff, and the water purification system.
2. If technology is available, show this short video clip on how to make a lapbook. http://www.youtube.com/watch?v=t1inXbba3cg or follow the direction on the following pages.

Making a lapbook

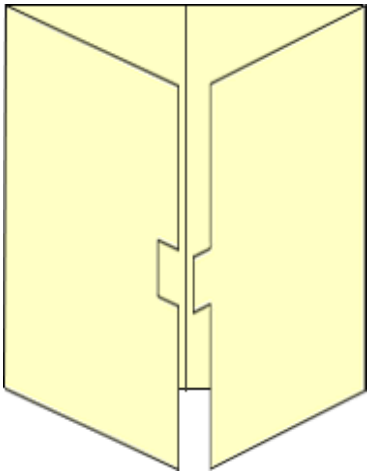
1. Model for the students how to fold their file folders as done in the video.
2. Next, students will complete each of the black line masters with information they have learned throughout this unit. They may color each foldable and glue into their lapbooks.
3. If time permit, students may wish to share their lapbooks with their classmates.

How to fold a lapbook

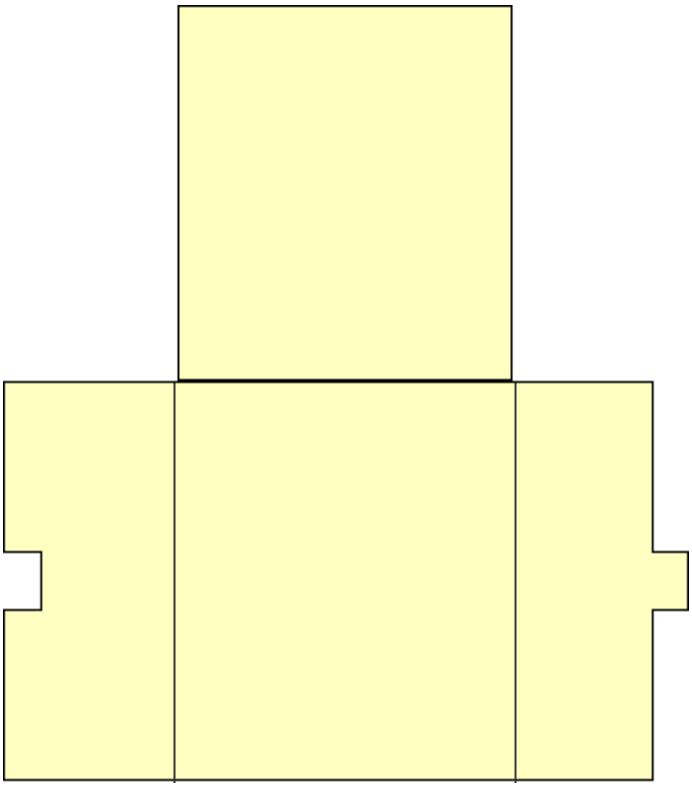
For each **lapbook**, you will need a file folder. Open up the folder.



Fold each side in to meet in the middle. You will glue each of the activities into this to make a **lapbook**.

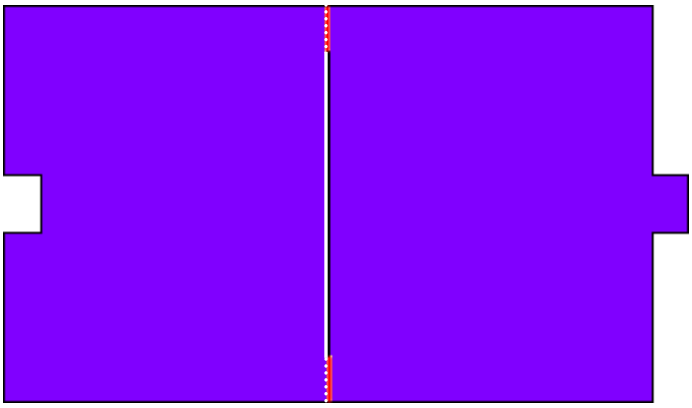


If you need additional room, you can add an extension. Use a sheet of card stock, or cut a file folder in half. Use wide packing tape to tape it to the top of your **lapbook**. Fold it down to close the book.

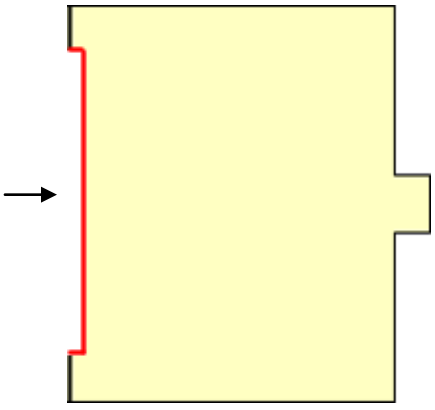


How to create a lapbook with multiple sections

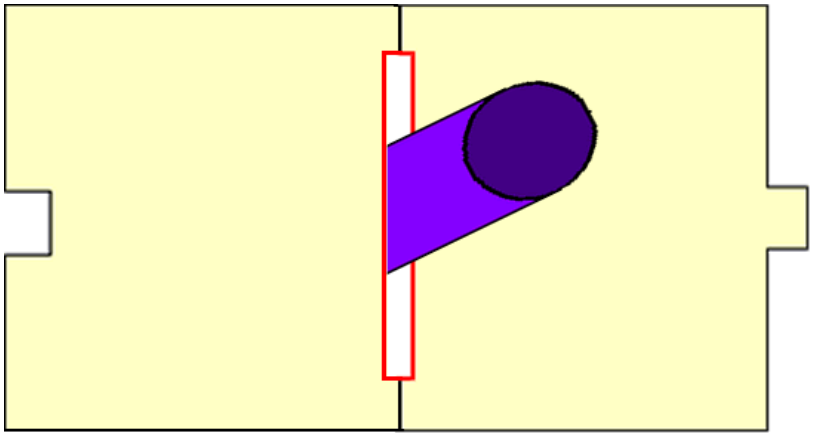
If you need an even bigger lapbook, you can put multiple file folders together to create a book of multiple sections. After you determine how many folders you will need to hold all of your information, measure down one inch on each side of the folded edge. On one folder, you will cut along the crease to the one-inch mark as indicated by the dotted lines in the picture below.



On the rest of the folders, you will cut where the arrow indicates below, starting and ending at the one inch marks, on the folded folders.



Stack together all of these last folders. With the first folder open, roll it from the bottom to the top and insert it into the slits in the middle of the other folders. When the rolled folder is halfway through, unroll it and line up the pages, sliding the slits over the creases in the stack of folders.



Lapbook GRADING RUBRIC

	4 ADV	3 PRF	2 PRG	1 BEG
Vocabulary • Multiple literacies • Science	All vocabulary words are included. Each word has a colored picture, definition and sentence.	No more than three vocabulary words are missing. Words have a colored picture, definition and sentence.	No more than seven vocabulary words are missing. Many words are missing a sentence, definition, or colored picture.	More than seven vocabulary words are missing. Notes are incomplete or illegible.
Notes • Science • Writing	Student took legible notes. He/she wrote in complete sentences explaining his/her learning. Answers are written in paragraph form.	Student took legible notes. Answers are written in complete sentences.	Notes are messy and illegible. Answers are written in complete sentences.	Notes are messy and illegible. The student did not answer all journal questions. Answers are incomplete.
Charts/Data/Graphs • Science • Multiple literacies	All charts are completed and attached to or enclosed in the lapbook.	Charts are completed, but not attached to the lapbook.	Charts are partially incomplete but included in the lapbook.	Charts are blank or missing from the lapbook.
Other • Science • Effort	All other pieces of the lapbook are completed.	One piece of the lapbook is missing. Remaining pieces are completed legibly.	Two pieces of the lapbook are missing. The remaining pieces are illegible.	Several pieces of the lapbook are missing, and the included pieces are illegible.

4 ADV = Advanced
3 PRF = Proficient
2 PRG = Progressing
1 BEG = Beginning

This rubric is included in your students' Watershed Workbook, page 16.

Northeast Ohio Regional Sewer District
3900 Euclid Avenue
Cleveland, Ohio 44115

(216) 881-6600 | community@neorsd.org

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