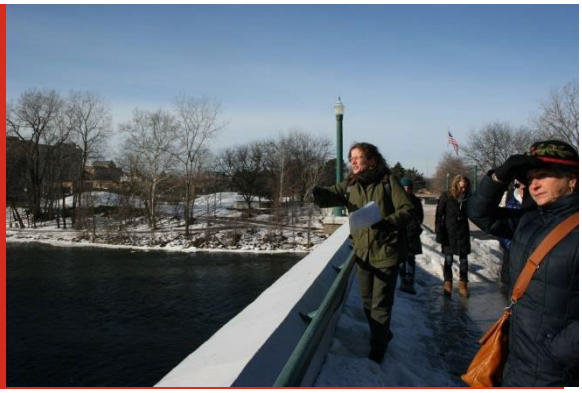

Watersheds and Nonpoint Source Pollution

❖

Lower Grand River Watershed Lessons

❖

Unit One: Watersheds Nonpoint Source Pollution

Groundswell

Communities for Clean Water

Groundswell

Written by Janet Vail (Annis Water Resources Institute)
Edited by Joanna Allerhand, Susan Loughrin, Clayton Pelon, and Amanda Syers (Grand Valley State University Center for Educational Partnerships)
Reviewed by Michelle Storey and Robert Sweet (Michigan Department of Environment, Great Lakes, and Energy)

Design and Layout by Clayton Pelon

To learn more about Groundswell, environmental stewardship education, and to view the companion videos, please visit **https://www.gvsu.edu/groundswell/**.

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OVERVIEW & LESSON

STUDENT ACTIVITY

ANSWER KEY

TEACHER RESOURCE

STUDENT READING

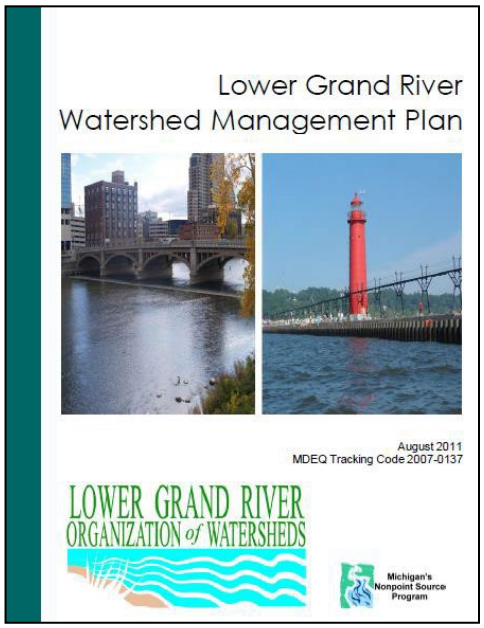
EPA

GRAND VALLEY STATE UNIVERSITY
CENTER FOR EDUCATIONAL PARTNERSHIPS

EGLE
MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

About the Lessons

The Michigan Department of Environmental Quality's Nonpoint Source Program assists numerous non-profit entities and other local, state, and federal partners to reduce nonpoint source (NPS) pollution statewide. NPS pollution comes from all over the watershed – anywhere rain falls. There is no specific source like a pipe or smoke stack. As such, the basis for this program is watershed management.



The *Lower Grand River Watershed Management Plan* (LGRWMP) is a document developed to provide a description of the watershed, identification of impairments, and goals and objectives for management and improvement of the watershed. The WMP's *Information and Education* (I&E) *Strategy* calls for educating stakeholders about the watershed and the impacts that stakeholders have on the watershed. The strategy has three steps: (1) awareness, (2) education, and (3) action.

With funding from the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Nonpoint Source Program, four lessons that draw upon information from the Lower Grand River Watershed Management Plan (WMP) have been developed for teachers. The purpose of these lessons is to further the I&E objectives that reach students as outlined in the WMP.

The three main nonpoint source pollutants of concern in the *Lower Grand River Watershed Management Plan* include sediment, pathogens, and nutrients. The lesson titles, which reflect this, are:

- Watersheds and Nonpoint Source Pollution
- Nonpoint Source Pollution: Managing Excess Sediment
- Nonpoint Source Pollution: Managing Pathogens
- Nonpoint Source Pollution: Managing Excess Nutrients

Videos have been developed to accompany each of the lessons. Lessons and videos are posted at https://www.gvsu.edu/groundswell/. Educators can select the activities about the Lower Grand River Watershed that best fit their classrooms.

About the Lower Grand River Watershed Management Plan

The current Lower Grand River Watershed Management Plan (LGRWMP) was approved by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) in 2011.

For more information: lgrow.org

The LGRWMP provides a detailed implementation plan and assigns responsibility to stakeholders to ensure the plan's actions are put into practice. The Lower Grand River Organization of Watersheds (LGROW) was formed in 2009 to provide basin-wide oversight, implement watershed-wide initiatives, and prioritize water quality concerns.

The nine key elements of the Lower Grand River Watershed Management Plan include:

1. Understanding watershed characteristics
2. Identifying and involving local agencies and citizens in the watershed planning process
3. Identifying designated and desired uses
4. Defining critical areas which are contributing a majority of the pollutants
5. Identifying and prioritizing pollutants, sources, and causes
6. Determining objectives and tasks for meeting watershed goals
7. Identifying and analyzing existing local projects, programs, and ordinances that impact water quality within the watershed
8. Informing and involving the public
9. Developing an evaluation process

The chapters in the LGRWMP reflect the nine elements.

The LGRWMP outlines a strategy to identify and restore the state's designated uses of the surface waters in the watershed, which are:

- Agricultural use
- Industrial water supply at the point of intake
- Public water supply at the point of intake
- Navigation
- Warmwater and/or coldwater fishery
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31

Navigation, industrial water supply at point of intake, and public water supply at point of intake are additional designated uses.

Sediment, nutrients, pathogens, temperature, unstable hydrology, chemicals, and habitat fragmentation have an impact on the designated uses of the Watershed. Designated uses are considered impaired if the water does not meet Michigan's water quality standards. Total Maximum Daily Loads (TMDLs), which establish the maximum amount of a pollutant allowed in a water body and serves as the starting point or planning tool for restoring water, have been developed for parts of the watershed.

Subjects/Target Grades
Science and Social Studies
Grades 5-9

Duration
Two 50-minute class periods
Classroom and schoolyard setting

Materials
Per class
- *Watersheds and Nonpoint Source Pollution* video
- Bucket of water
- Glass of muddy water
- Glass of clear water
- Transparency masters
- Answer keys

Per small group
- Copy paper cut in half
- Plastic plate
- Cup for water (25 – 50 mL)
- Cup with perforations for rain
- Water soluble makers
- *Lower Grand River Watershed* map
- *Michigan's Major Watersheds* map
- *LGRW Land Use* chart
- Venn Diagram and cards

Per student
- *Student activity* sheets
- *Nonpoint Source Pollution* reading

MI Science Standards
- Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. MS-ETS1-4.

Lesson One: Watersheds & Nonpoint Source Pollution

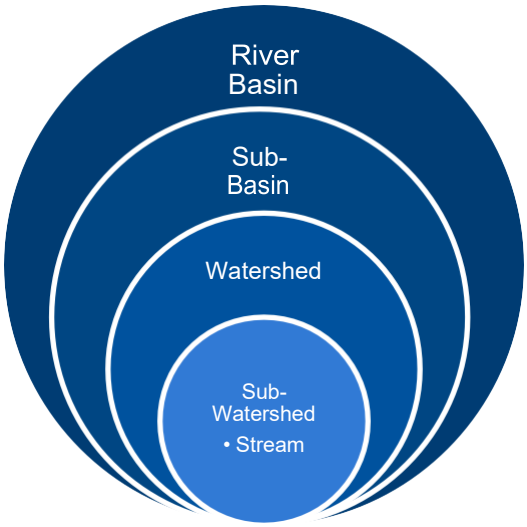
Lesson Overview
Students are introduced to scientific models that help them to conceptualize watersheds and their importance for managing nonpoint sources of pollution.

Focus Questions
Students answer these essential questions: What is a watershed? What is the relationship of the water cycle to watersheds? How does my watershed connect to the Grand River and Lake Michigan? What is nonpoint source pollution? How can actions upstream affect water quality downstream?

Objectives
Students will be able to: Construct and test a model of a watershed. Trace the connection of their watershed to the Grand River and Lake Michigan. Identify nonpoint sources of pollution and their relative impacts in various parts of the Lower Grand River Watershed.

Advance Preparation
- Assemble materials for the outdoor activity (bucket, cups).
- The model activities will require paper, plastic plates, cups, water-soluble markers, and the Lower Grand River map.
- Preview the *Watersheds and Nonpoint Source Pollution* video before showing it to the class.
- Make copies of the student activity sheets you are using.
- Available at the end of the unit are multiple resources available for handouts or display.

Background Information
We all live in a watershed. But what is a watershed? A **watershed** is an area of land, defined by hills and ridges, which drains to a common body of water.[1] It is defined by topography, hydrology, and climate. An analogy is a



household shower where water runs over the shower floor into a drain.

Like pieces of a puzzle, watersheds can be subdivided into smaller units known as "sub-watersheds," which collectively flow together to form larger sub-basins and "river or lake basins".

Most of Kent County is in the Lower Grand River Watershed (LGRW). Many creeks (Plaster, Mill, Bear, Buck), streams, and small rivers (Rogue, Thornapple, Flat) flow into the Lower Grand River. This watershed drains into Lake Michigan, as do all of the watersheds in west Michigan. The watershed to our north is the Muskegon River watershed and the Kalamazoo River watershed is to the south. Watersheds in four states (Michigan, Wisconsin, Illinois, and Indiana) are part of the Lake Michigan basin. The Great Lakes basin is the drainage area for all of the Great Lakes and this connects to the Atlantic Ocean.

Even though you may not live directly on the Lower Grand River or Lake Michigan, what you do where you live can impact the health of the watershed. **Pollution** refers to the contamination of water, land, or the air by substances that can adversely impact the environment and human health. Types of pollution include organic, inorganic, biological, and temperature (too high). In the past, many of the water quality problems were associated with an obvious cause – **point source** pollution from a specific location such as a discharge pipe or disposal site. Environmental regulations and cleanup efforts have helped to control point source pollution. However**,** water quality problems from **nonpoint source** pollution remain a challenge.


Above is an example of point source pollution on a river.

Nonpoint source (NPS) pollution is pollution caused when rain, snowmelt, or wind carry pollutants off the land and into lakes, streams, wetlands, and other water bodies.[2] As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and groundwater. The top three nonpoint sources of pollution in the LGRW include **sediment, nutrients**, and **pathogens.** Temperature and chemical pollution are of concern as well.[3]

According to the EGLE, if we manage activities on the land that drains to bodies of water, we will protect and improve the water resources of the state. Almost every activity on the land has the potential to affect the quality of water in a community. The Lower Grand River Watershed Management Plan (WMP) presents an action-oriented approach to effectively manage and restore the designated uses of the watershed. It serves as an excellent resource for understanding the Lower Grand River Watershed and nonpoint source pollution sources. Watershed planning brings together the people within the watershed to address those activities, regardless of existing political boundaries. By working together, individuals within the watershed can design a

coordinated watershed management plan that builds upon the strengths of existing programs and resources, and addresses the water quality concerns in an integrated, cost effective manner.

Sources:

[1] LGROW. What is a Watershed? Retrieved from https://www.lgrow.org/watersheds

[2] EGLE. Nonpoint Source Pollution. Retrieved from https://www.michigan.gov/egle/about/organization/water-resources/nonpoint-source

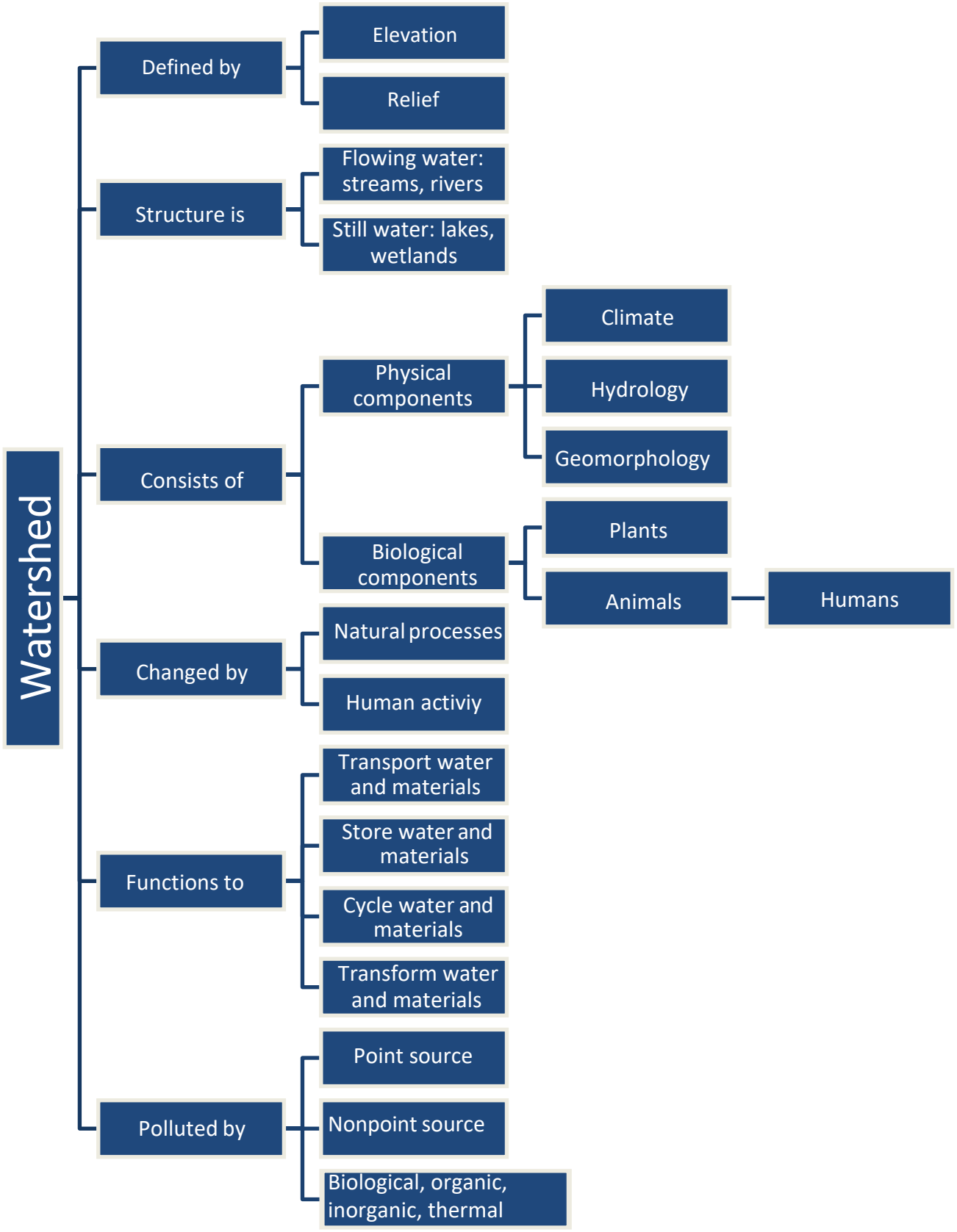
[3]LGROW. Lower Grand River Watershed Management Plan. Retrieved from http://www.lgrow.org/lgrwmp

Tips for Teaching about Watersheds

Using watersheds as an organizer for earth science, chemistry, and biology concepts can serve to integrate instruction. Incorporation of the water cycle into the study of watersheds is important to do. According to Shepardson (2007), the following concepts need to be developed in order to enhance students' conceptualization of watersheds:

- When rain falls on the land, or snow melts, some of the water soaks in to the ground, some of it evaporates back in to the atmosphere, and some of it flows over the land in a down slope direction, often toward streams, rivers, lakes, or wetlands. A watershed is the land area that provides runoff that feeds particular rivers, streams, lakes, ponds, or wetlands; that is, a watershed has a structure (i.e., flowing and still water).
- Water, nutrients, and the sun serve as energy resources within the watershed. For example, the sun's energy warms the water within a stream or pond and drives the hydrologic cycle.
- Every place on land is a part of a watershed, including the places where we live, work, play, and go to school.
- Smaller streams flow into larger rivers forming a river system, a network of tributaries that flow into a major river, which drains water from the land within the watershed.
- Watershed boundaries are defined based on topography. Topographic divides determine the direction water flows and any and every point on a stream, river, or body of water has a watershed associated with it.
- The earth's surface consists of numerous nested and joining watersheds that drain into lakes or oceans. These sub-watersheds may be further divided into smaller watersheds.
- Sediments, nutrients, and other substances and contaminants on land are transported into the stream through runoff and temporarily stored before being transported through the watershed by the river system and into joining watersheds. The contaminants transported off the land area and through the river system are often referred to as nonpoint source pollution: fertilizer and pesticide runoff, for example.
- Sediments, nutrients, and other substances are transformed and cycled within a watershed (e.g., nitrogen and carbon cycles).
- Pollutants may be organic, inorganic, toxic, thermal, or biological. Zebra mussels are a biologic pollutant—an invasive species.
- Watersheds consist of physical and biological components that influence the quality of the watershed and make each watershed unique. For example, a watershed in the Arizona desert is physically and biologically different than a watershed in Michigan.
- Watersheds are constantly changing as a result of natural and anthropocentric processes such as land use, which often interact. These changes may impact the structure, function, and components of a watershed.

Shepardson, D.P. et al. (2007). What is a watershed? Implications of student conceptions for environmental science education and the National Science Education Standards. Science Education, 91(4), 554-578.



Adapted from: Shepardson, D.P. et al. (2007). What is a watershed? Implications of student conceptions for environmental science education and the National Science Education Standards. Science Education, 91(4), 554-578.

Lesson Procedure

1. Engage your students in discovering how water flows in their schoolyard.
Fill a bucket with water and obtain enough cups for small groups or pairs of students. Take your students outdoors to an area where there is a slope, grass, and concrete. Provide a cup of water to each group or pair and instruct to students to pour water on different surfaces noting their observations. Lead a discussion about where the water went and relate this to the water cycle.

Pose these questions to the students:

What did the water in the cup represent?
[Precipitation - rain]

What happened to the water that was poured on grass?
[It soaks into the ground to become groundwater.]

Introduce the term **pervious surface** – water can pass through or seep into this type of surface.

If there was a puddle of water on the concrete, where does that water go?
[Some may soak into the concrete; some will evaporate.]

Introduce the term **impervious surface** – water does not pass through or seep into this type of surface.

Where does the water flow on a slope?
[Some flows downhill due to gravity. The steepness of the slope makes a difference.]

Where would the water flow if there was a big rainstorm?
[Answers will vary based on the topography; encourage answers that use the terms **pervious** and **impervious** surfaces as they describe the **surface runoff** - water that runs off land into a body of water.]

Did you see any storm drains and downspouts in the schoolyard?
[Answers will vary.]

2. Create a watershed model.
Challenge students to make a model of a **watershed**. This will involve defining the problem, developing possible solutions, and improving designs.

Have students suggest various types of models that they know about (physical replicas, diagrams, mathematical representations, analogies, and computer simulations) but don't provide a definition of a watershed just yet.

For creation of their models, provide each pair of students with a half sheet of copy paper and a plastic plate. They cannot write on the paper or rip the paper. Instruct them to make their watershed model but do not answer their questions at this point.

Option: Use the *Creating a Watershed Model* handout to guide student work.

3. Modify a watershed model.
After a few minutes, re-visit the challenge. Ask students to describe their models. Most likely the models won't resemble typical landforms of a Midwest watershed but accept all ideas.

Show the first part of the *Watersheds and Nonpoint Source Pollution* video, which explains what a watershed is.

[Pause at 3:07 minutes before the discussion of point and nonpoint source pollutants.]

A **watershed** is an area of land, defined by hills and ridges, which drains to a common

body of water. Follow up with a discussion of the *How Watersheds Work* resource sheet. When you are sure that your students have an understanding of watersheds, have them roll up their paper model into a ball. Then they will gently pull the corners out to create a three dimensional model. Have them identify the hills and valleys, and predict how water will flow in their modified model.

The final step is to test the model by pouring about 25 mL of water on the highest part of the model and describing the flow of water. Add food coloring to the water for effect.

Terms such as **topographic divides, precipitation, evaporation, runoff, groundwater, rivers, streams, lakes, ponds**, and **wetlands** can be applied to a discussion of their models.

4. Elaborate on watersheds.

Pose this question to the students:

We all live in a watershed. Do you know the name of your watershed?

After some discussion, have students work through the map interpretation exercise, *What's your watershed* student activity, which uses the *Michigan's Major Watersheds* map and *What's My Watershed Address*.

Pose another question to the students:
We all live in a watershed but do we live in just one watershed? [no]

Follow up with showing the following sequence of resource sheets and then re-visit the question:

- Lower Grand River Watershed map
- Major watersheds of the Grand River
- Lake Michigan Basin
- The Great Lakes Basin

5. Explore what affects water quality in a watershed.
Show students a glass of muddy water and a glass of clear water. Engage them in a discussion of which they think has better water quality.

Would they think differently if *the clear water was from a toilet? Or if the clear water contained fertilizer?*

Appearance isn't the whole story, as they will see in the video.

Continue showing the *Watersheds and Nonpoint Source Pollution* video starting at 3:07 minutes.

Follow up with a definition and discussion of **nonpoint source pollution**, highlighting the examples in the video. Differentiate between the three types of water pollution of most concern in the Lower Grand River Watershed (i.e., sediment, nutrient, and pathogens).

Use the *Lower Grand River Watershed* student activity map to make another three-dimensional model.

This will help students conceptualize flow of pollutants in a watershed. Review what the numbers indicate on the map (1 = Grand River, 2 = direct drainage to the Grand

River, 3 = Flat River, 4 = Rogue River, 5 = Thornapple River). Have them locate their school on the map.

Based on the information from the video and the *Lower Grand River Watershed Land Use* chart, have students label and indicate the percentages of the main types of land use in the 2-5 numbered areas of the map (A = agriculture, F = forest, D= developed areas/urban).

Encourage students to think about sources of possible **nonpoint source pollution** in each of the numbered areas based on land use.

Assign and **discuss** the *Nonpoint Source Pollution* student reading.

Based on land use, would the amount and type of pollution be expected to differ?

Use different color water soluble markers or water colors to indicate the relative proportion of pollution (**sediment**, **nutrients**, or **pathogens)** that they think is in each area of the watershed.

Note: the next three lessons will go into more detail about the three main pollutant types and how watershed management planning can improve watersheds.

Crumple the paper along the outside ridgelines and pour or spray water on the model noting the paths of water and changes in color. This could be a teacher demo if you want the students to retain their maps.

Have students write a paragraph about their model and their observations about how the water and pollutants moved through the Lower Grand River Watershed.

Optional: The *Water Quality Pollutants Cards* student activity, where the *Venn Diagram of Water Quality Pollutants* is created, can be assigned. Other approaches to modeling NPS are found in the resources listed in the Extensions section.

6. Tying it all together

Remind the students of their walk outside to see where water goes and the video.

Summarize what students have learned about watersheds by having them re-visit the task: "Design a model of a watershed that will show how a watershed works."

This time they will create diagrams with labels using the *Tying it all together* student activity to answer the following questions:

How is the water cycle related to a watershed?

[Water is always moving. It evaporates, condenses as precipitation, moves downhill, and infiltrates into the ground. The sun drives the hydrologic cycle.]

How does my watershed connect to the Grand River and Lake Michigan?

[Topography defines watersheds. Students should be able to show the location of their school in relation to the Grand River and Lake Michigan.]

How can our upstream activities affect water quality downstream and in Lake Michigan and what are the main nonpoint source pollution categories of concern?

[It is all connected! Sediment, nutrients, and pathogens are the main nonpoint pollution categories of most concern for the Lower Grand River Watershed.]

Encourage discussion and cooperative effort among class members as they work through this task. The teacher resource on *Grand River Watershed: Pollutants and Sources* will be helpful in directing discussion.

Extensions

1. Use an *Enviroscape* model to illustrate nonpoint source pollution. See http://www.enviroscapes.com/. *Enviroscape* models are available for loan from the EGLE and some conservation districts. Contact the EGLE Nonpoint Source Staff (517-284-5520) for details. **Extension 1-A**

2. The *Do you get my (non) point?* lesson from University of Maryland Extension is another way to illustrate water quality in a watershed. **Extension 1-B**

3. *Whatzzzup-Stream?* is a nonpoint source activity package where students study rivers and waterways around them. **Extension 1-C**

4. The *Discovering the Watershed Lesson Plan* from Purdue Extension has a creative journey through a watershed game that weaves in indicator species. **Extension 1-D**

5. *An Introduction to Michigan Watersheds* by Michigan Sea Grant could be used for a student reading assignment. **Extension 1-E**

6. Using topographic maps of the Lower Grand River Watershed, delineate the watershed and subwatershed boundaries based on topography. **Extension 1-F**

7. *Lesson 3 Do you know your watershed?* from the Michigan Environmental Education Curriculum Support Water Quality Unit complements this lesson. **Extension 1-G**

Additional Resources

Adopt Your Watershed

Website links can be found at: https://www.gvsu.edu/groundswell/

EPA's Adopt Your Watershed program links you with your community's activities to protect and restore your local watershed. The site has a database of more than 2,600 watershed groups lists with opportunities to get involved in activities such as volunteer water monitoring, stream cleanups, and storm drain marking. **Link 1-A**

After the Storm

This half-hour video highlights three case studies - Santa Monica Bay, the Mississippi River Basin/Gulf of Mexico, and New York City. Key scientists, water quality experts, and citizens involved in local and national watershed protection efforts provide insight into the problems as well as solutions to water quality issues. **Link 1-B**

A Very Impervious Situation

In this lesson from the Great Lakes Aquarium, students review the concept of watershed. They learn how much water collects from impervious surfaces in a 1-inch rainstorm and discuss what happens to that water. Along with this introduction to stormwater sewers, they explore ways they can minimize stormwater pollution. **Link 1-C**

GVSU Annis Water Resources Institute

AWRI's mission is to integrate research, education, and outreach to enhance and preserve freshwater resources. Its K-12 outreach and education program focuses on water quality. The Lower Grand River Watershed Management Plan **Link 1-D**

How to Build a Watershed Model
This article from Outdoor America has instructions for creating a watershed model. Link 1-E

Lower Grand River Organization of Watersheds (LGROW)
LGROW promotes community education and sustainable use of our river resource. It brings together local municipalities and community stakeholders in a unique format to address watershed issues facing the Lower Grand River and its watersheds. Link 1-F

Michigan Department of Environment, Great Lakes, and Energy (EGLE)
The Michigan Department of Environment, Great Lakes, and Energy promotes wise management of Michigan's air, land, and water resources to support a sustainable environment, healthy communities, and vibrant economy. Link 1-G

Nonpoint Source Kids Page
This U.S. EPA site has activities on a variety of water topics. Link 1-H

Plaster Creek Stewards
Plaster Creek Stewards focus on education, research, and on-the-ground restoration. Their goal is to educate the community about watershed ecology, and to develop a growing group of people who understand the strengths, needs, and problems affecting the Plaster Creek Watershed. Link 1-I

Surf Your Watershed
Surf Your Watershed gathers environmental information, which is available by geographic units. The watershed pages contain links that provide information by watershed. Topics are Environmental Profile, Water, Land, Air and People. Link 1-J

U.S. Environmental Protection Agency
Build Your Watershed has directions for creating a watershed model. The model shows how water flows from higher elevations to lower elevations, and how watersheds are interconnected. The students will understand how the placement of buildings, roads, and parking lots can be important to watershed runoff, and how careless use and disposal of harmful contaminants can have a serious effect on downstream watershed. Link 1-K

West Michigan Environmental Action Council (WMEAC)
WMEAC's water program includes Teach for the Watershed (T4W) training. T4W provides teachers and students with tools to help them learn about and take action in protecting West Michigan's watersheds and Great Lakes. Link 1-L

WikiWatershed
WikiWatershed® is a suite of web-based tools designed to assist citizens in managing water resources. One of the tools is Model My Watershed® is an innovative web-based hydrologic model that uses real GIS data to show how land use impacts local hydrology. The model allows users to change conditions to see how best-management practices decrease runoff. Link 1-M

Name_____

Creating a Watershed Model

Your challenge is to create a model of a watershed using a half of a piece of paper. Do not tear or write on the paper. You will eventually test your model to see if it effectively illustrates a watershed.

1. What are some types of models?

2. What do you think a watershed is?

Model 1. Design a model of a watershed that will show how a watershed works.

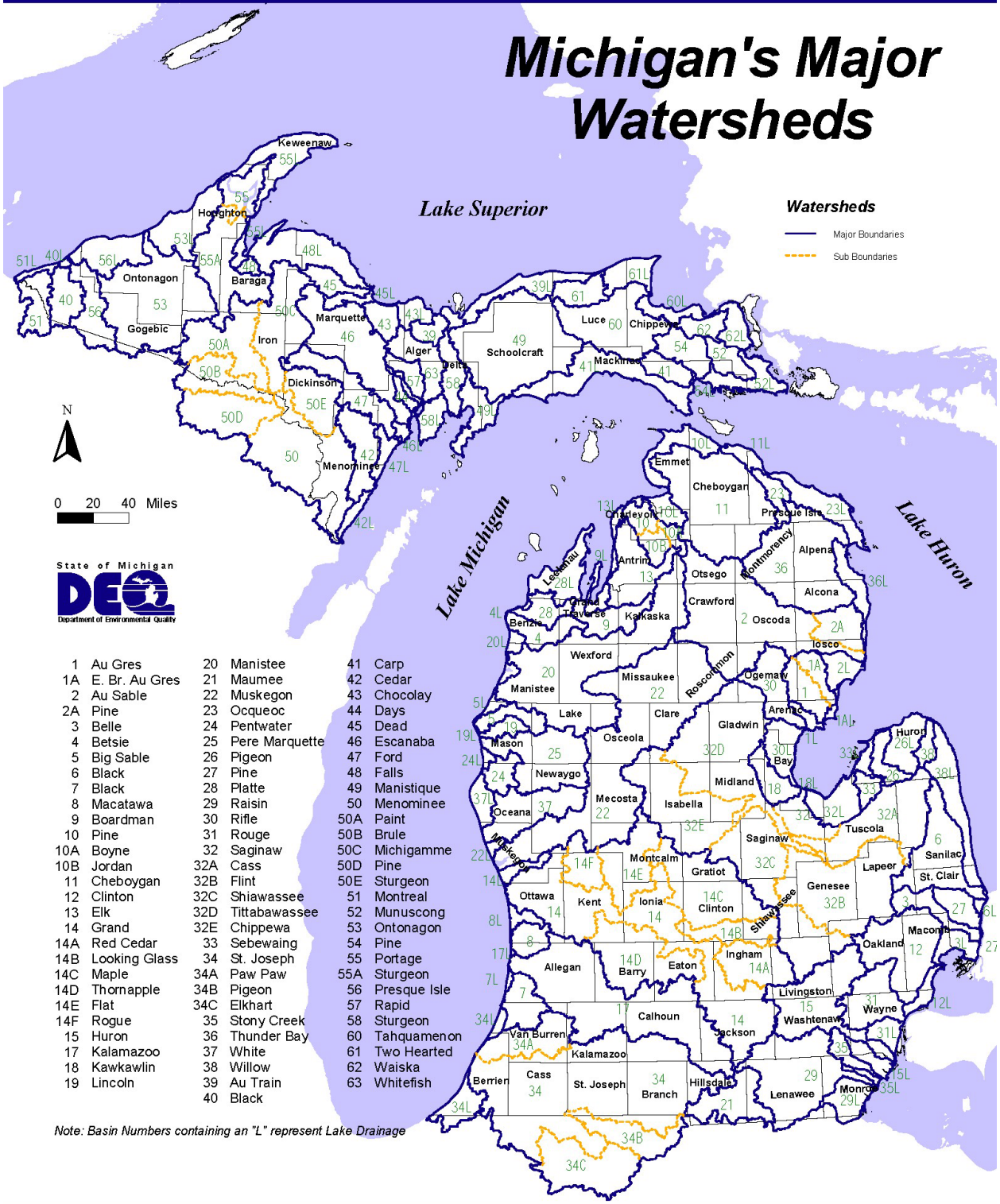
Sketch and label the model:	How can you test your model?
	What do you predict will happen when you test your model?

Model 2. Your teacher will give you directions in how to modify your model and how to test it.

Sketch and label the model:	What do you predict will happen when you test your model?
	What happened when you tested your model?

3. How did Model 2 improve your understanding of a watershed?

Water Resources Division



1	Au Gres	20	Manistee	41	Carp
1A	E. Br. Au Gres	21	Maumee	42	Cedar
2	Au Sable	22	Muskegon	43	Chocolay
2A	Pine	23	Ocqueoc	44	Days
3	Belle	24	Pentwater	45	Dead
4	Betsie	25	Pere Marquette	46	Escanaba
5	Big Sable	26	Pigeon	47	Ford
6	Black	27	Pine	48	Falls
7	Black	28	Platte	49	Manistique
8	Macatawa	29	Raisin	50	Menominee
9	Boardman	30	Rifle	50A	Paint
10	Pine	31	Rouge	50B	Brule
10A	Boyne	32	Saginaw	50C	Michigamme
10B	Jordan	32A	Cass	50D	Pine
11	Cheboygan	32B	Flint	50E	Sturgeon
12	Clinton	32C	Shiawassee	51	Montreal
13	Elk	32D	Tittabawassee	52	Munuscong
14	Grand	32E	Chippewa	53	Ontonagon
14A	Red Cedar	33	Sebewaing	54	Pine
14B	Looking Glass	34	St. Joseph	55	Portage
14C	Maple	34A	Paw Paw	55A	Sturgeon
14D	Thornapple	34B	Pigeon	56	Presque Isle
14E	Flat	34C	Elkhart	57	Rapid
14F	Rogue	35	Stony Creek	58	Sturgeon
15	Huron	36	Thunder Bay	60	Tahquamenon
17	Kalamazoo	37	White	61	Two Hearted
18	Kawkawlin	38	Willow	62	Waiska
19	Lincoln	39	Au Train	63	Whitefish
		40	Black		

Note: Basin Numbers containing an "L" represent Lake Drainage

www.michigan.gov/hydrology

STUDENT ACTIVITY

Name_____

What's your watershed?

We all live in a watershed and there are many different watersheds in Michigan. Use the *Michigan's Major Watersheds* map to find out more.

1. The names listed in 1 through 63 in the key in *Michigan's Major Watersheds* are generally names of what?

2. What does "L" mean in the key?

3. Almost all of Kent County is in which watershed?

4. What are three rivers in Kent County that drain into this watershed?

5. Which watershed is north of Kent County?

6. Which watershed is south of Kent County?

7. Are all watersheds along the west side of Michigan associated with a major river?

8. Which two watersheds in Michigan appear to have the largest area?

9. What is the name of watershed #11 and into which Great Lake does it drain?

10. What is the name of watershed #49 and into which Great Lake does it drain?

11. What is the name of watershed #9 and into which Great Lake does it drain?

12. What is the largest watershed in the Upper Peninsula that also includes Wisconsin and to which Great Lake does it drain?

Optional: Using the map of Kent County that is shown in *What's My Watershed Address*, determine the code and sub-watershed name for where your school is located.
Go online to https://www.lgrow.org/lgrwmp and look at the map of your sub- watershed if it is available.

Write a paragraph about what you have learned about your sub-watershed by looking at the map and the summary.

ANSWER KEY

What's your watershed?

We all live in a watershed and there are many different watersheds in Michigan. Use the *Michigan's Major Watersheds* map and *What's My Watershed Address* to find out more.

1. The names listed in 1 through 63 in the key in *Michigan's Major Watersheds* are generally names of what? *Rivers in Michigan*

2. What does "L" mean in the key? *Lake drainage*

3. Almost all of Kent County is in which watershed? *Grand River Watershed*

4. What are three rivers in Kent County that drain into this watershed?
   Thornapple, Flat and Rogue

5. Which watershed is north of Kent County? *Muskegon River watershed*

6. Which watershed is south of Kent County? *Kalamazoo River watershed*

7. Are all watersheds along the west side of Michigan associated with a major river? *No.*

8. Which two watersheds in Michigan appear to have the largest area?
   Grand River and Saginaw River

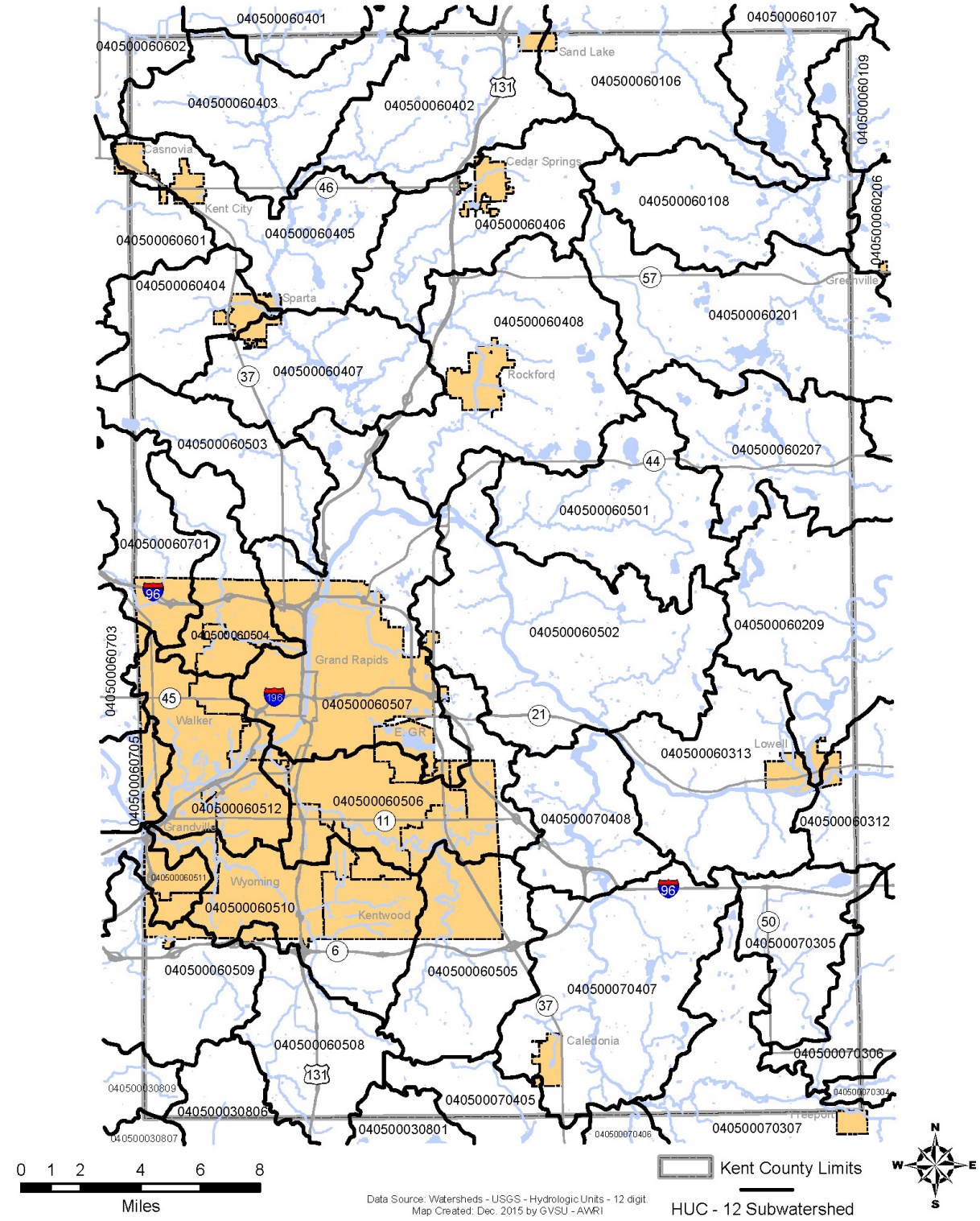
9. What is the name of watershed #11 and into which Great Lake does it drain?
   Cheboygan, Lake Huron

10. What is the name of watershed #49 and into which Great Lake does it drain?
    Manistique, Lake Michigan

11. What is the name of watershed #8 and into which Great Lake does it drain?
    Macatawa, Lake Michigan

12. What is the largest watershed in the Upper Peninsula that also includes Wisconsin and to which Great Lake does it drain? *Menominee, Lake Michigan (Green Bay)*

What's My Watershed Address



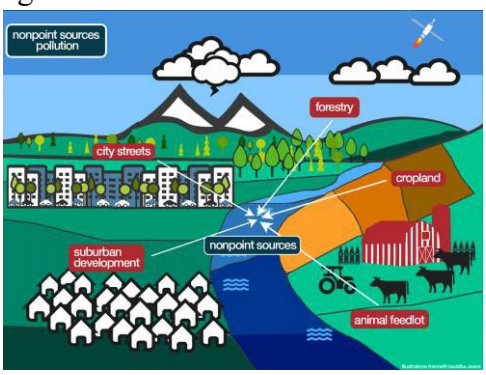
What's My Watershed Address

HUC-12	Subwatershed Name
04050006 0101	Clear Lake-Black Creek
04050006 0102	Fifth Lake
04050006 0103	Townline Creek-Flat River
04050006 0104	Mud Lake Flat River
04050006 0105	Hunter Lake-Flat River
04050006 0106	Alder Creek-Black Creek
04050006 0107	Clear Creek
04050006 0108	Coopers Creek
04050006 0109	Perch Lake-Flat River
04050006 0201	Wabasis Creek
04050006 0202	Farm Pond-Dickerson Ck.
04050006 0203	Twin Lakes-Dickerson Ck.
04050006 0204	Long Lake
04050006 0205	Dickerson Creek
04050006 0206	Sanderson Lake-Flat River
04050006 0207	Seely Creek
04050006 0208	Honey Lake-Flat River
04050006 0209	Flat River
04050006 0301	Taylor Drain-Libhart Creek
04050006 0302	Libhart Creek
04050006 0303	Bacon Creek-Prairie Creek
04050006 0304	Ross/Branch-Prairie Creek
04050006 0305	Bow Pond
04050006 0306	Prairie Creek
04050006 0307	Dry Creek-Grand River
04050006 0308	Sessions Creek
04050006 0309	Bellamy Creek-Grand R.
04050006 0310	Crooked Creek-Grand R.
04050006 0311	Lake Creek
04050006 0312	Toles Creek-Grand R.
04050006 0313	Lee Creek-Grand R.
04050006 0401	Hickory Creek-Rogue R.
04050006 0402	Duke Creek
04050006 0403	Spring Creek-Rogue R.

HUC-12	Subwatershed Name
04050006 0404	Nash Creek
04050006 0405	Ball Creek-Rogue River
04050006 0406	Cedar Creek
04050006 0407	Freska Lake-Rogue River
04050006 0408	Stegman Creek – Rogue R.
04050006 0501	Bear Creek
04050006 0502	Egypt Creek-Grand River
04050006 0503	Mill Creek
04050006 0504	Indian Mill Creek
04050006 0505	Headwaters Plaster Creek
04050006 0506	Plaster Creek
04050006 0507	Lamberton Creek-Grand R.
04050006 0508	Sharps Creek-Buck Creek
04050006 0509	East Branch Rush Creek
04050006 0510	Buck Creek
04050006 0511	Rush Creek
04050006 0512	Walker-Grand River
04050006 0601	N. Branch Crockery Creek
04050006 0602	Eastland Drain-Crockery Ck
04050006 0603	Rio Grand Creek
04050006 0604	Lawrence Drain-Crockery C
04050006 0605	Crockery Creek
04050006 0701	East Fork
04050006 0702	Headwaters Sand Creek
04050006 0703	Sand Creek
04050006 0704	Dear Creek
04050006 0705	Ottawa Creek-Grand River
04050006 0706	Bass Creek
04050006 0707	Bass River
04050006 0708	Jubb Bayou-Grand River
04050006 0709	Pottawatomie Bayou
04050006 0710	Norris Creek
04050006 0711	Spring Lake
04050006 0712	Grand River

Nonpoint Source Pollution

When it rains or when snow melts, water runs off streets, parking lots, lawns, and agricultural fields and carries with it pollutants such as road salt, motor oil, sediment, fertilizer, bacteria and pesticides. These pollutants are then carried, untreated, to the nearest stream or lake through surface water runoff or storm sewers; or they infiltrate into groundwater.



Nonpoint source pollution is so named because the pollutants do not originate at single point sources, such as industrial or municipal wastewater discharge pipes (**point source pollution**), but come from many diverse sources in the environment. While some nonpoint source pollution is naturally occurring, most of it is a result of human activities.

Environmental Impacts:

Sediment is the number one pollutant of our nation's waterbodies. When excessive soil enters a waterbody as a result of erosion, it prevents sunlight from reaching aquatic plants, clogs fish gills, chokes other organisms, smothers macroinvertebrates and interferes with fish spawning. Water also becomes murky and unpleasant for swimming or fishing.

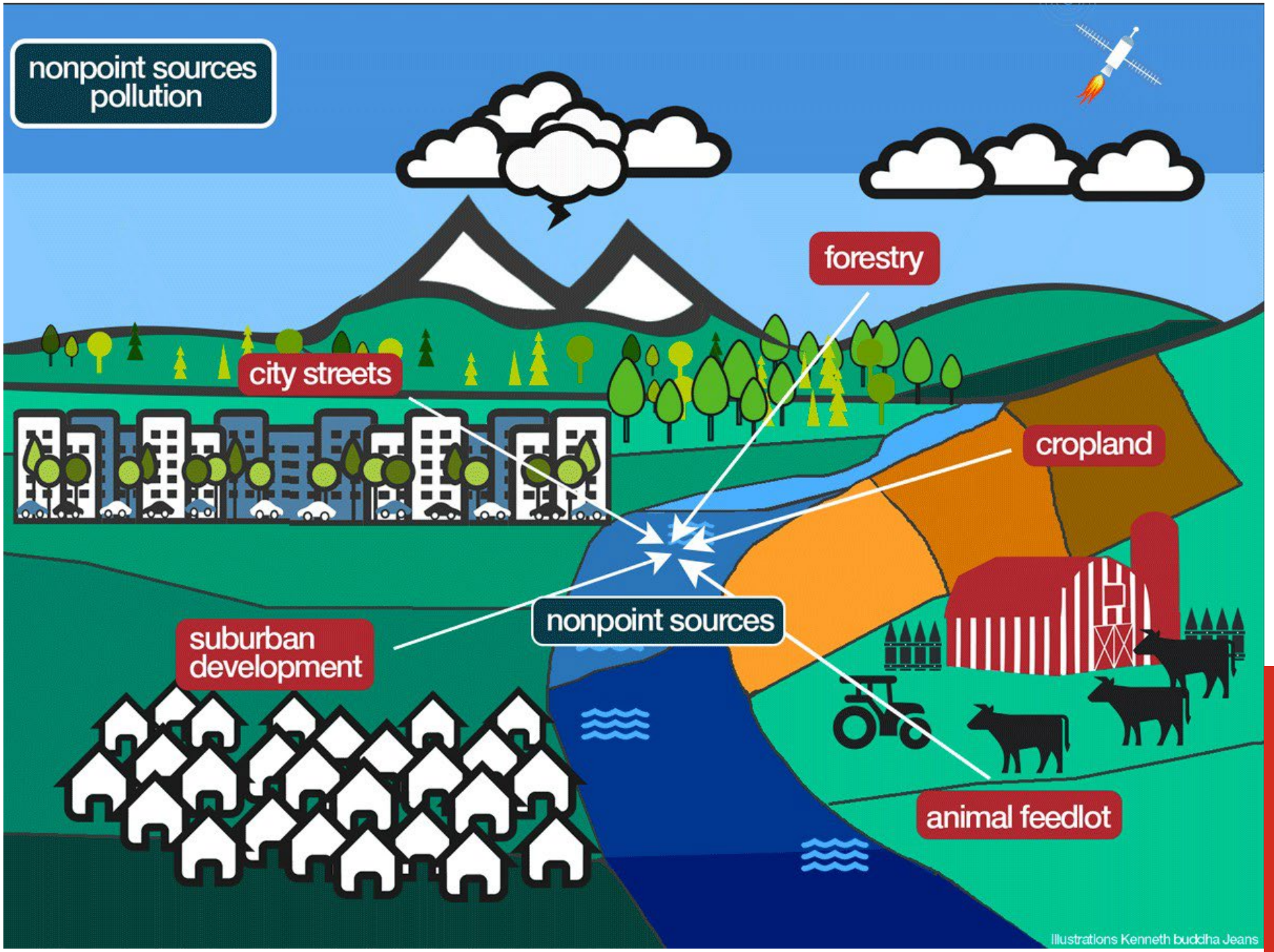
Chemical fertilizers contain nitrogen and phosphorous - **nutrients** that help plants grow. Using excessive amounts of fertilizer or applying it close to a shoreline allows the nutrients to run off. Once in the waterbody, the nutrients feed algae, causing it to grow rapidly and turn the water green or cause algal blooms. Large amounts of algae reduce oxygen levels in the water and compromise overall water quality – sometimes causing a fish kill.

Bacteria (including *E. coli*) in surface waters are a threat to human health. **Pathogens** (agents that cause disease) are a top cause of stream impairment.

Ways to Help Reduce Nonpoint Source Pollution:

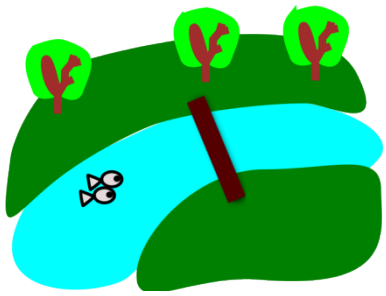
- If you must fertilize, use phosphorus-free lawn fertilizer and follow the directions. Avoid getting fertilizer on driveways, sidewalks, storm drains or nearby waterbodies.
- Don’t dump anything down a storm drain. It goes straight to a waterbody.
- Wash your car on a grassy area, use soap (preferably non-phosphate) sparingly, or better yet – take your car to a car wash where water can be cleaned or recycled.
- Make sure your car is working properly. Oil is a major pollutant from road and parking lot runoff.
- Pick up after your pet. Bacteria can run off into storm drains.
- Make sure there is adequate vegetation growing in erosion prone areas - especially embankments along rivers, pond and lakes. Don’t leave soil bare and vulnerable to erosion.
- Use porous materials such as wooden planks or bricks for walkways and patios. Porous surfaces allow substances to soak into the ground where they are filtered by the soil.
- Maintain your septic system so it is functioning properly. A failing or improperly functioning septic system contributes bacteria and nutrients to groundwater or nearby ditches and rivers.
- Get involved with watershed planning and implementation efforts in your watershed!

Source: Indiana Department of Environmental Management



STUDENT READING

Water Quality Pollutants Cards



Teacher instructions: Cut up the water quality pollutants cards and have each group of students place the cards in the appropriate spots in the *Venn Diagram of Water Quality Pollutants*. The icons on the Venn diagram represent sediment, pathogens, and nutrients, which are of the most concern in the Lower Grand River Watershed. Temperature is represented as well. Note that some scenarios may be associated with multiple water quality impairments. Other examples could be developed for chemicals such as paint, pesticides, used oil, household hazardous waste, etc. and the Venn diagram could be modified for this.

Answers:	
1. Pathogens, nutrients	6. Nutrients
2. Temperature	7. Pathogens, nutrients, sediment
3. Pathogens, nutrients, sediment	8. Sediment
4. Nutrients	9. Pathogens, nutrients
5. Pathogens, sediment, temperature	10. Sediment, temperature

Source: Adapted from *Lesson Plan – Types of Pollution*, Virginia Department of Education
Information Sources: *Lower Grand River Watershed Management Plan*

Water Quality Pollutants Cards

1. Workers on a chicken farm bulldoze all of the farm's chicken manure into piles that are left unprotected from the rain and wind. The piles are at the back of the farm along a ditch.

2. All of the trees have been cut along a stream reducing the shade but the banks have been stabilized to reduce runoff.

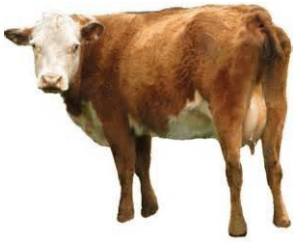
3. A person who lives in the city puts dog waste mixed with garden soil and grass cuttings into the street in front of his house.

4. A homeowner is fertilizing her lawn. She wants it to look nicer than her neighbor's lawn. She reads the directions on her water-soluble fertilizer and decides to use more than necessary to ensure success.

5. A waterfront property owner plants grass along the water, which attracts geese that eat the grass. Bare ground is left at the edge of the water.

6. A farmer plants the same crop in the same large field every year instead of rotating crops. The field is right next to a stream. He spends thousands of dollars on fertilizer each year

7. Cows are allowed to overwinter along a stream corridor, where livestock are kept and fed throughout the winter months. There is uncontrolled access to the stream banks.

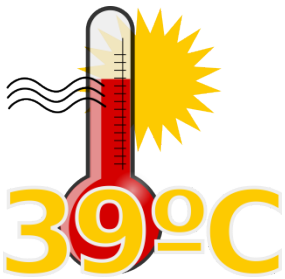


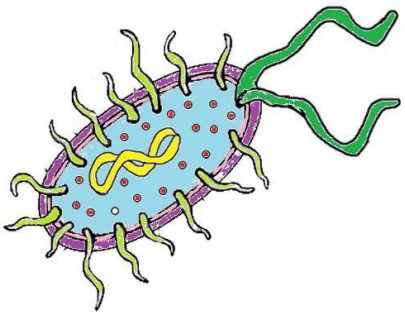
8. While building a house in a new subdivision, the builders decide to cut down and sell all the large trees for extra money, even though only one-fourth of the lot needs to be cleared for the house and septic field. For the time it takes to complete the house, the builders leave the entire lot as bare soil.

9. A homeowner in a rural area has been meaning to get his septic tank pumped, but hasn't gotten around to it. It should be pumped every 3–5 years, but it has been 8 years since he last had it pumped. As a result, many solids have accumulated in the tank. The system fails, sending untreated water into the backyard that runs off into a stream.

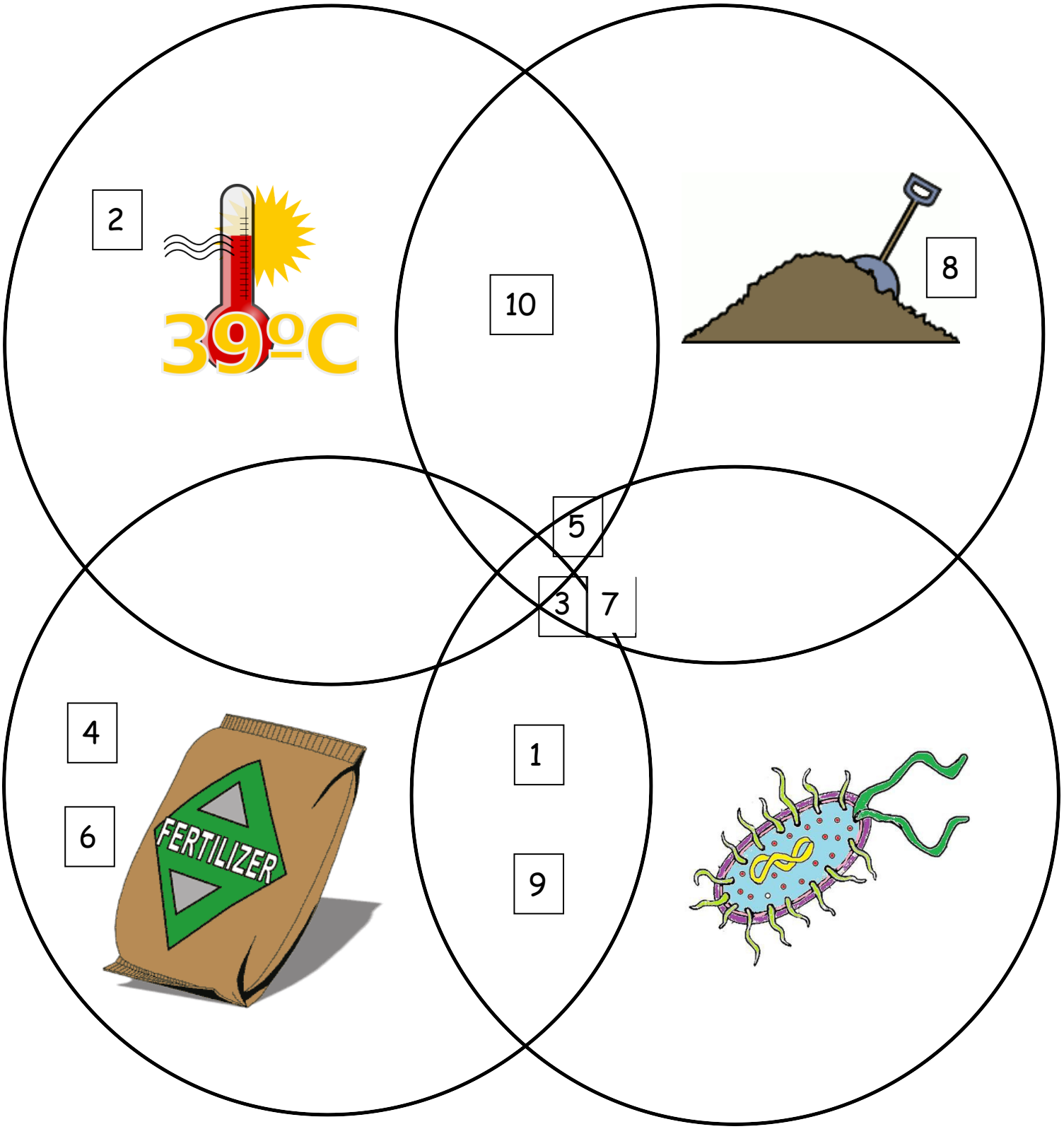
10. When developers build a new shopping center, they pave the entire parking area and leave no vegetation. They also bulldoze the winding stream and the wildflowers and shrubs growing on its banks to replace it with a neater, more professional looking, concrete stormwater channel.

Venn Diagram of Water Quality Pollutants





Venn Diagram of Water Quality Pollutants




Lower Grand River Watershed
This fabulous artwork was made by:
State of Michigan
Lake Michigan
Grand Haven
Coopersville
Rockford
Greenville
Grand Rapids
Lowell
Ionia
Portland
Hastings
Colors
1 Lake Michigan & Grand River
2 Direct Drainage To Grand River
3 Flat River Watershed
4 Rogue River Watershed
5 Thornapple River Watershed
Mark where you live!
Miles
0 5 10 20 30 40
N E S W
LOWER GRAND RIVER ORGANIZATION of WATERSHEDS
www.LGROW.org

Lower Grand River Watershed Land Use

Land Use (% Total)

	Agriculture	Forest	Urban
Direct Drainage to Grand River	33%	26%	24%
Flat River	50%	20%	6%
Rogue River	45%	30%	5%
Thornapple River	69%	15%	3%

Source: *Lower Grand River Watershed Management Plan*, Appendix 4.1: Subwatershed Management Unit Summary Sheets & Figures. https://www.lgrow.org/lgrwmp

Lower Grand River Watershed: Pollutants and Sources

Pollutant	Source
Pathogens and Bacteria	1. **Cropland** – over or improper application of manure
	2. **Livestock** – uncontrolled access, lack of buffer or setback
	3. **Septic Tanks** – aging systems, lack of regulation
	4. **Ducks and Geese** – lawn at water's edge, overpopulation
	5. **Sanitary sewers** – aging/leaking sewers
Sediment	1. **Cropland** – tillage practices, lack of buffers, dense drainage network
	2. **Urban landscapes** – impervious surface, dense drainage network
	3. **Stream banks** – altered morphology & hydrology, uncontrolled livestock access, removal of vegetation
	4. **Rill and gully erosion** – agricultural practices, roadside ditches
	5. **Lakeshore erosion** – boat traffic/seawalls/ wave action
Nutrients	1. **Livestock** – over or improper application of manure, see above
	2. **Septic tanks** - aging systems, lack of regulation
	3. **Cropland and urban landscapes** - over or improper application of manure, lack of riparian buffer
	4. **Ducks and Geese** – lawn at water's edge, overpopulation
	5. **Sanitary sewers** – aging/leaking sewers

Source: *Chapter 4 – Identification and Prioritization of Pollutants, Sources, and Causes; Lower Grand River Watershed Management Plan*

Name_____

Tying it all together

Question 1: How is the water cycle related to a watershed?

Diagram with labels	Explanation

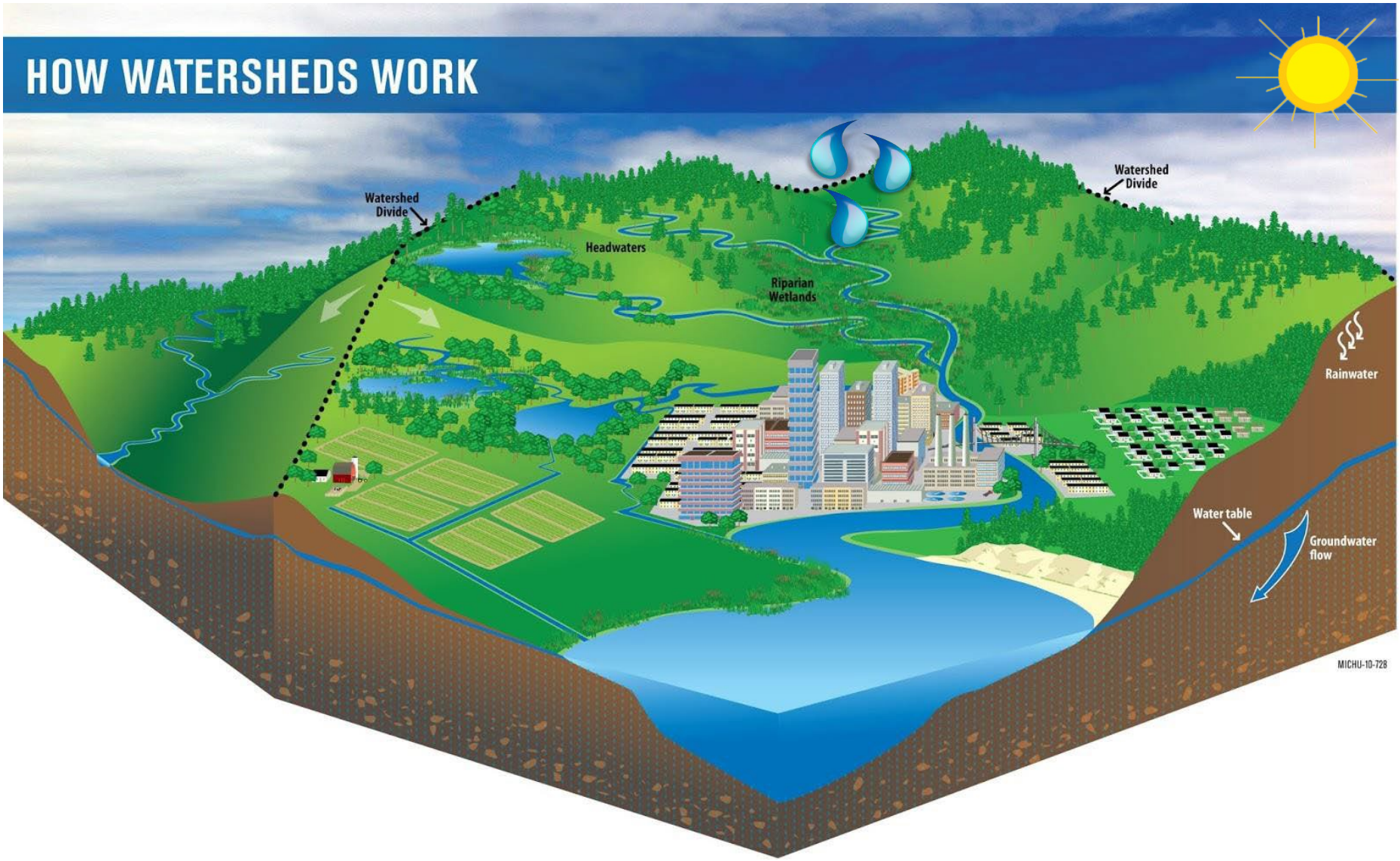
Question 2: How does my watershed connect to the Grand River and Lake Michigan?

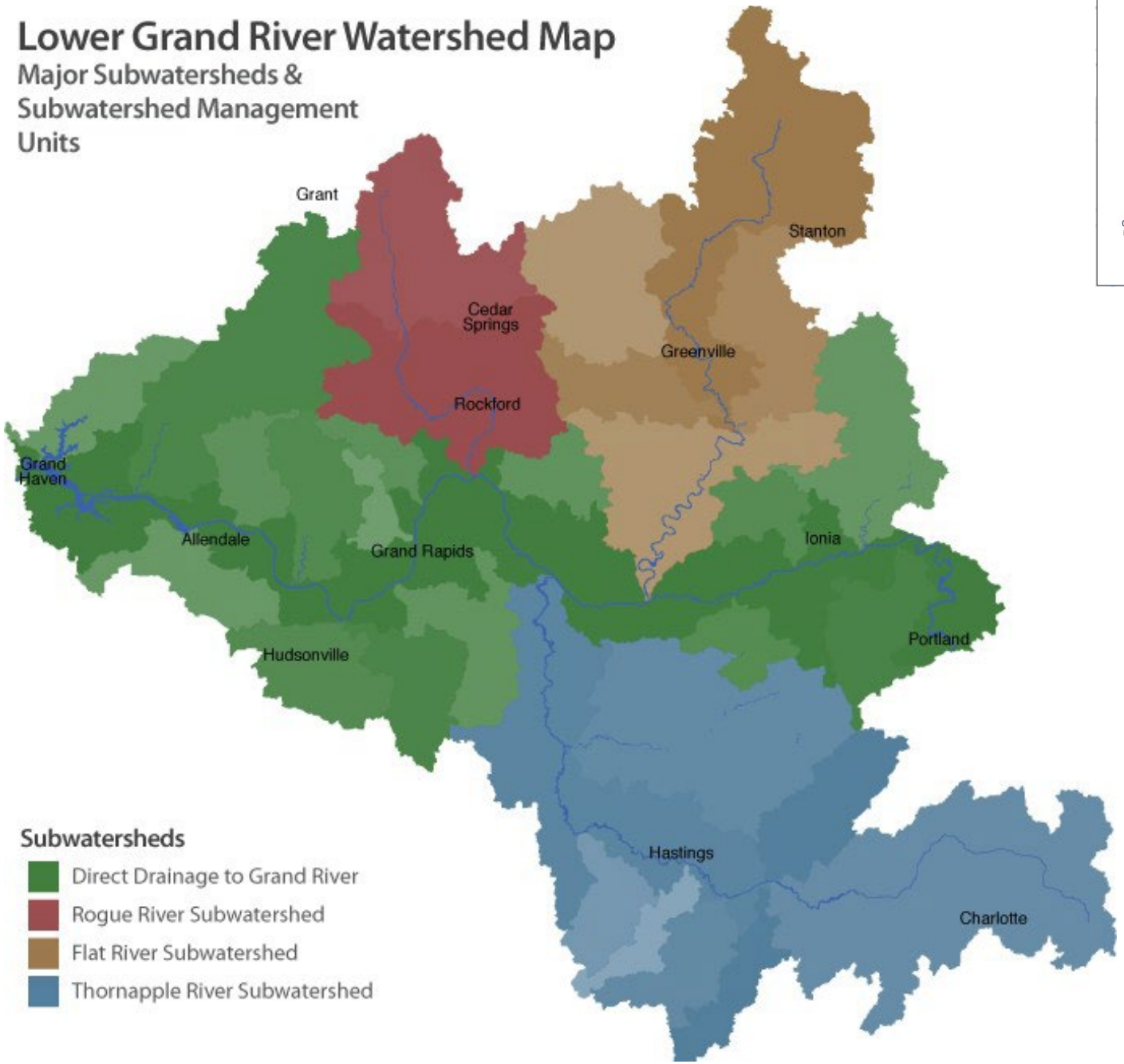
Diagram with labels	Explanation

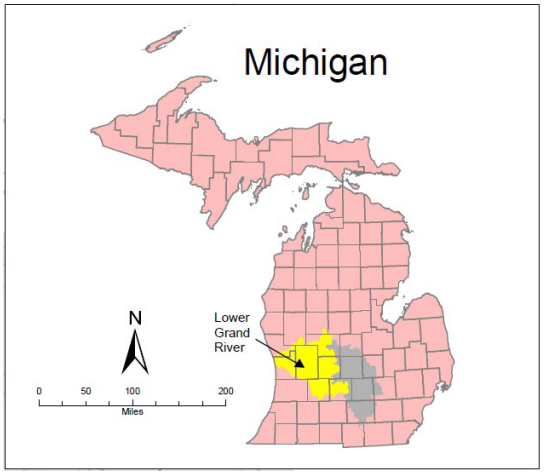
Question 3: How can our upstream activities affect water quality downstream and in Lake Michigan? Indicate the main nonpoint source pollution categories of concern.

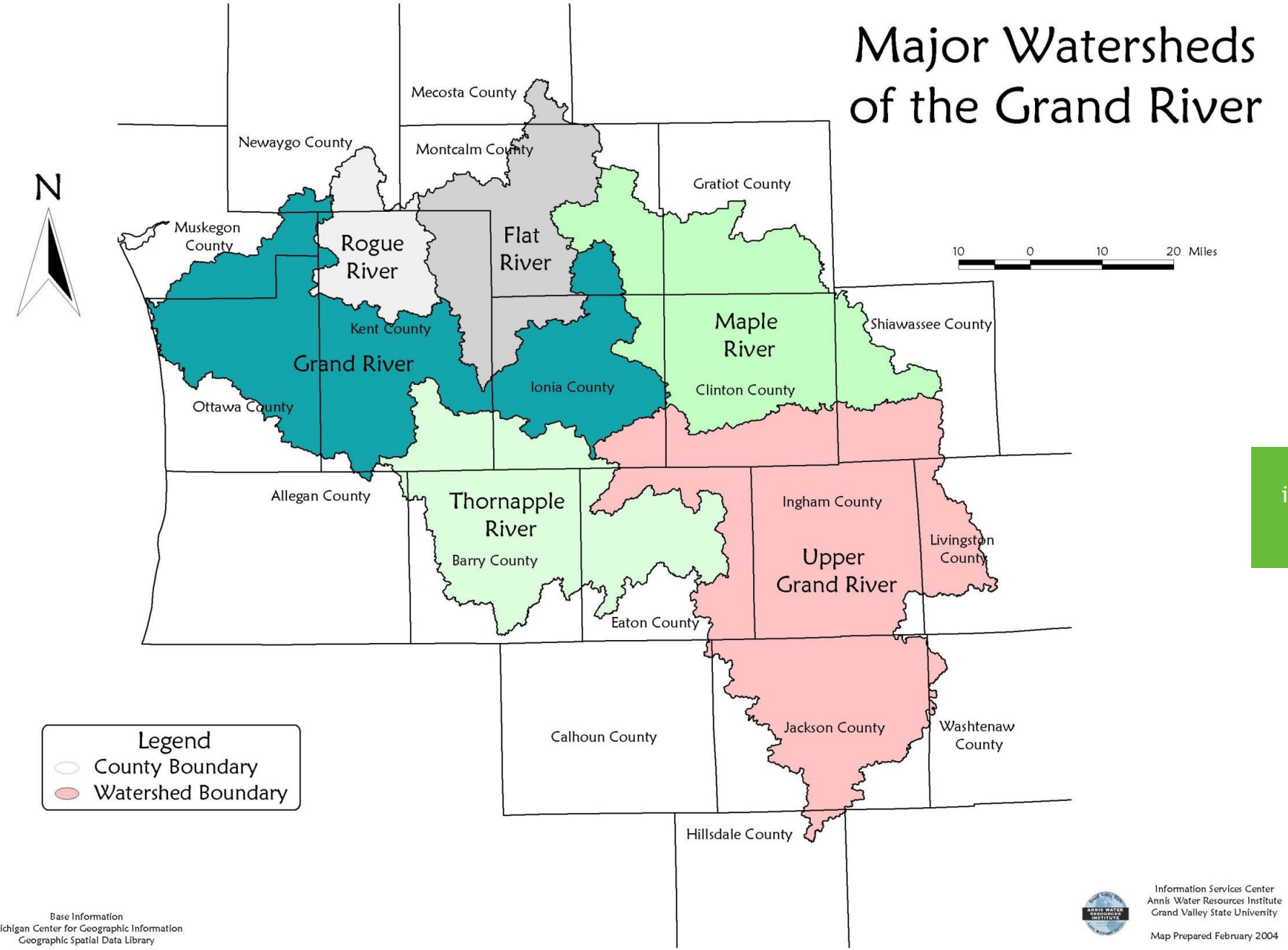
Diagram with labels	Explanation

Source: Modified from Michigan Sea Grant



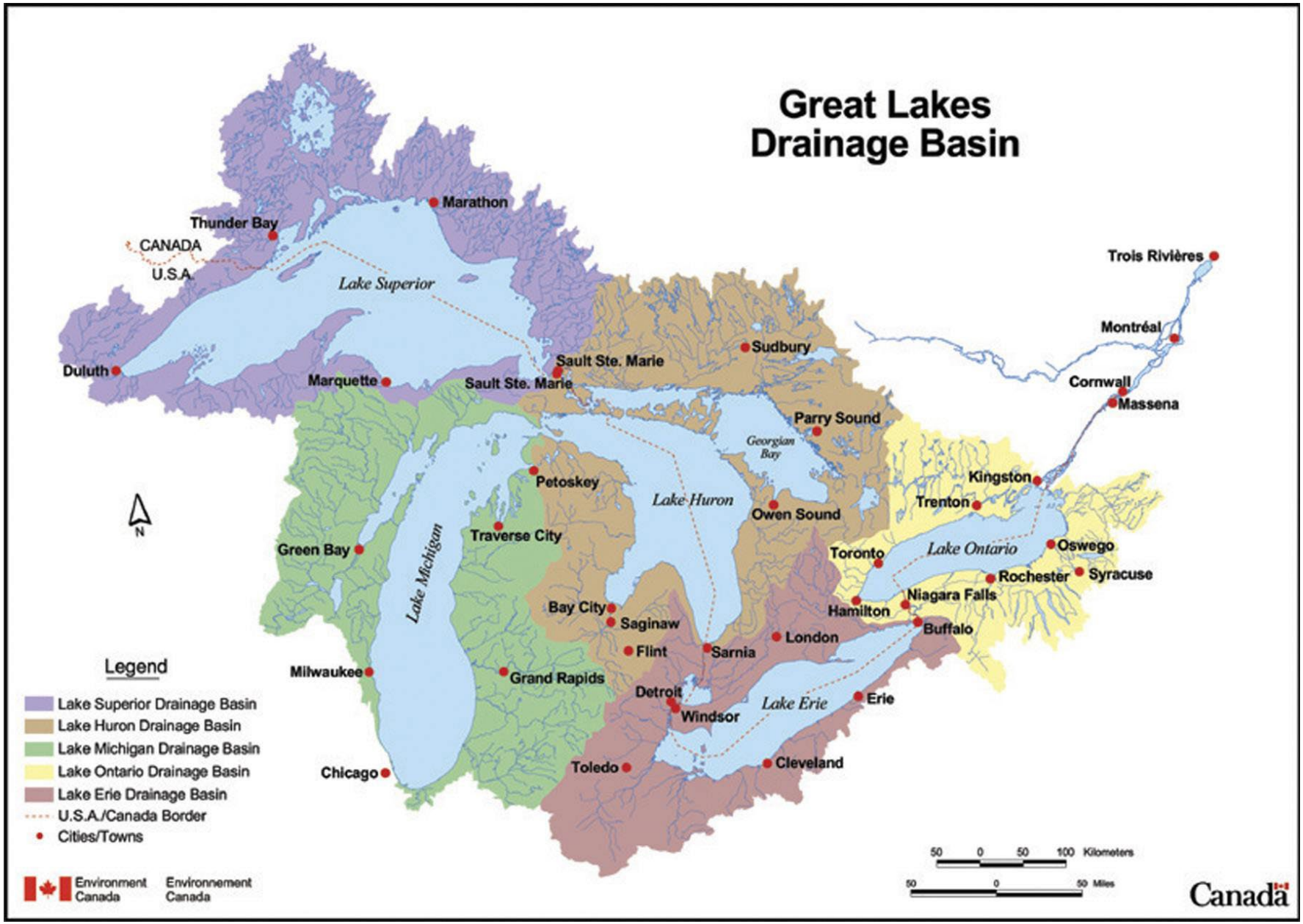

Lower Grand River Watershed Map
Major Subwatersheds &
Subwatershed Management
Units
Grant
Stanton
Cedar
Springs
Greenville
Rockford
Grand
Haven
Allendale
Grand Rapids
Ionia
Portland
Hudsonville
Hastings
Charlotte
Subwatersheds
Direct Drainage to Grand River
Rogue River Subwatershed
Flat River Subwatershed
Thornapple River Subwatershed


Michigan
N
Lower
Grand
River
0
50
100
200
Miles



For more information: lgrow.org


Lake Michigan Basin
Minnisota
Wisconsin
Iowa
Illinois
Indiana
Michigan
Ohio
CANADA
Lake Superior
Lake Michigan
Lake Huron
Lake Huron
Legend
Lake Michigan Basin
Basin Counties
Other Counties
State Boundary
0 12.5 25 50 75 100
Miles
N
W
E
S
Baraga
Gogebic
Iron
Marquette
Alger
Luce
Schoolcraft
Mackinac
Vilas
Dickinson
Delta
Florence
Oneida
Forest
Menominee
Marinette
Langlade
Oconto
Marathon
Shawano
Door
Portage
Waupaca
Outagamie
Brown
Kewaunee
Waushara
Winnebago
Calumet
Manitowoc
Adams
Marquette
Green Lake
Fond du Lac
Sheboygan
Columbia
Dodge
Washington
Ozaukee
Waukesha
Milwaukee
Racine
Kenosha
Lake
Cook
Lake
Porter
LaPorte
St. Joseph
Berrien
Cass
St. Joseph
Elkhart
LaGrange
Steuben
Noble
DeKalb
Kosciusko
Whitley
Hillsdale
Branch
Van Buren
Kalamazoo
Calhoun
Jackson
Washtenaw
Allegan
Barry
Eaton
Ingham
Livingston
Ottawa
Kent
Ionia
Clinton
Shiawassee
Muskegon
Montcalm
Gratiot
Oceana
Newaygo
Mecosta
Isabella
Mason
Lake
Osceola
Clare
Manistee
Wexford
Missaukee
Roscommon
Benzie
Grand Traverse
Kalkaska
Crawford
Leelanau
Antrim
Otsego
Charlevoix
Emmet
Cheboygan
Data Sources: Watershed - Great Lakes Information Network. Base Data - The National Map.
Map Created: Jan.. 2016 by GVSU - AWRI



Source: https://foca.on.ca/great-lakes/

RESOURCE LINKS

The number and letter codes preceding the title of each resource listed corresponds with the number and letter codes used in the text of the lesson.

Extensions:

Extension 1A- EGLE Nonpoint Source Pollution https://www.michigan.gov/egle/about/organization/water-resources/nonpoint-source

Extension 1B- University of Maryland Extension https://extension.umd.edu/programs/4-h-youth-development/curricula/agsploration/

Extension 1C- Whatzzzup-Stream? http://water.epa.gov/learn/resources/midsh/what.cfm.

Extension 1D- Discovering the Watershed Lesson Plan https://mdc.itap.purdue.edu/item.asp?Item_Number=FNR-476-W#.Vh6eQG7G-pQ

Extension 1E- An Introduction to Michigan Watersheds https://www.michiganseagrant.org/lessons/lessons/by-broad-concept/earth-science/exploring-watersheds/activity-diy-watershed/.

Extension 1F- topoView https://ngmdb.usgs.gov/maps/TopoView/viewer/#4/39.98/-100.06

Extension 1G- MEECS PBS LM https://wgvu.pbslearningmedia.org/collection/meecs-water-quality/

Links:

Link 1A- Adopt Your Watershed http://water.epa.gov/action/adopt/index.cfm

Link 1B- After the Storm http://water.epa.gov/action/weatherchannel/

Link 1C- A Very Impervious Situation https://glaquarium.org/resources/a-very-impervious-situation-an-introduction-to-stormwater-runoff/

Link 1D- GVSU Annis Water Resources Institute https://www.gvsu.edu/wri/isc/lower-grand-river-watershed-management-plan-312.htm.

Link 1E- How to Build a Watershed Model https://www.iwla.org/docs/default-source/how-to/how_to_build-a-model-watershed.pdf?sfvrsn=8

Link 1F- Lower Grand River Organization of Watersheds (LGROW) http://www.lgrow.org/

Link 1G- Michigan Department of Environment, Great Lakes, and Energy (EGLE) http://www.michigan.gov/nps

Link 1H- Nonpoint Source Kids Page http://water.epa.gov/polwaste/nps/kids/

Link 1I- Plaster Creek Stewards https://calvin.edu/plaster-creek-stewards/

Link 1J- Surf Your Watershed, now How's My Waterway: https://www.epa.gov/waterdata/hows-my-waterway

Link 1K- U.S. Environmental Protection Agency http://www3.epa.gov/safewater/kids/activity_grades_9-12_buildyourownwatershed.html

Link 1L- West Michigan Environmental Action Council (WMEAC) http://wmeac.org/water

Link 1M- WikiWatershed http://wikiwatershed.org/