AN INTRODUCTION TO

Michigan Watersheds

FOR TEACHERS, STUDENTS AND RESIDENTS

MICHIGAN SEA GRANT

An Introduction to Michigan Watersheds

The diagrams, explanations and teaching resources in this guide are intended to complement the use of the Michigan Watersheds Map (shown on cover). This guide helps illustrate and explore the following points:

- *We all live in and depend on watersheds.*
- *Michigan's geology, climate and land use influence the flow of water through our watershed and rivers.*
- *Our actions on land impact the health of our groundwater, rivers and lakes.*

Note: All bolded words are in the glossary on page 13.

An Abundance of Water

All life depends on water, but clean water is about more than just survival – exceptional lakes and streams are part of what makes Michigan special. No point in Michigan is more than six miles from an inland lake or stream or more than 85 miles from one of the Great Lakes. Michigan's abundant freshwater supports a vibrant recreation and tourism industry, supplies clean water for agriculture and manufacturing, and enhances the quality of life for all residents.

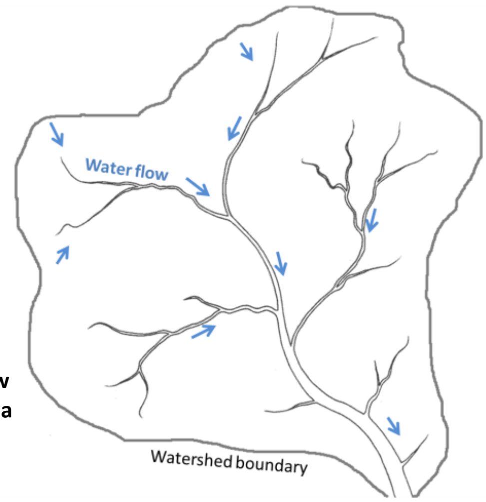

Figure 1. Water flow through streams in a watershed.

Contemplate a River

Before delving into the Michigan Watersheds Map, think about familiar rivers and lakes.

- Where does the water in a lake come from?
- Where does a river begin? Where does it end?
- What determines which direction a river flows?
- Why might a river flow faster some days or overflow its banks? Why might a river dry up?
- What causes a river to look muddy sometimes?

The land around a river or lake sustains it. Rivers begin in higher areas of land, where rainwater or spring water collects in a wetland, pond or gully and then begins to flow downhill as a small creek. Two creeks that meet will combine to form a single stream that grows larger as it flows downhill and merges with other streams (Figure 1). Although a river might change names, in most cases, you can trace its path until it flows into a large lake, like one of the Great Lakes, or the ocean.

The land that catches rain or snow and funnels the water towards a single river is known as the **watershed** of that river. A watershed can also be called a river basin, catchment or **drainage basin**. Watershed boundaries – or drainage divides – are high points in the landscape. Rain water that lands within a river's watershed will flow down towards that river; rainwater that lands outside a river's watershed will flow to a different river (Figure 2).

Teaching about Watersheds

The Michigan Watersheds Map illustrates that nearly all creeks and rivers in Michigan eventually flow into the Great Lakes. We encourage teachers to foster student curiosity and questioning as they explore the map. For example, ask:

- Which watershed do you live in? When rain lands in your watershed, where does it go, which river does it flow into? Trace the path of the biggest river in your watershed.
- Find Lansing on the map. What river is next to the city? Which direction does this river flow? Where does it end?
- What other cities are on a river? How might a city benefit by being next to a river?
- Find the river closest to Flint. Which direction does this river flow? Where does it end?
- Identify five rivers that drain to Lake Michigan. These rivers and their watersheds are all within Lake Michigan's watershed.
- Use your finger to trace the boundaries of Lake Michigan's watershed. (Hint: The divide runs down the middle of the lower peninsula).
- Can you find any areas of Michigan where the streams do not flow to one of the Great Lakes? (Hint: Look along the border of Wisconsin.)

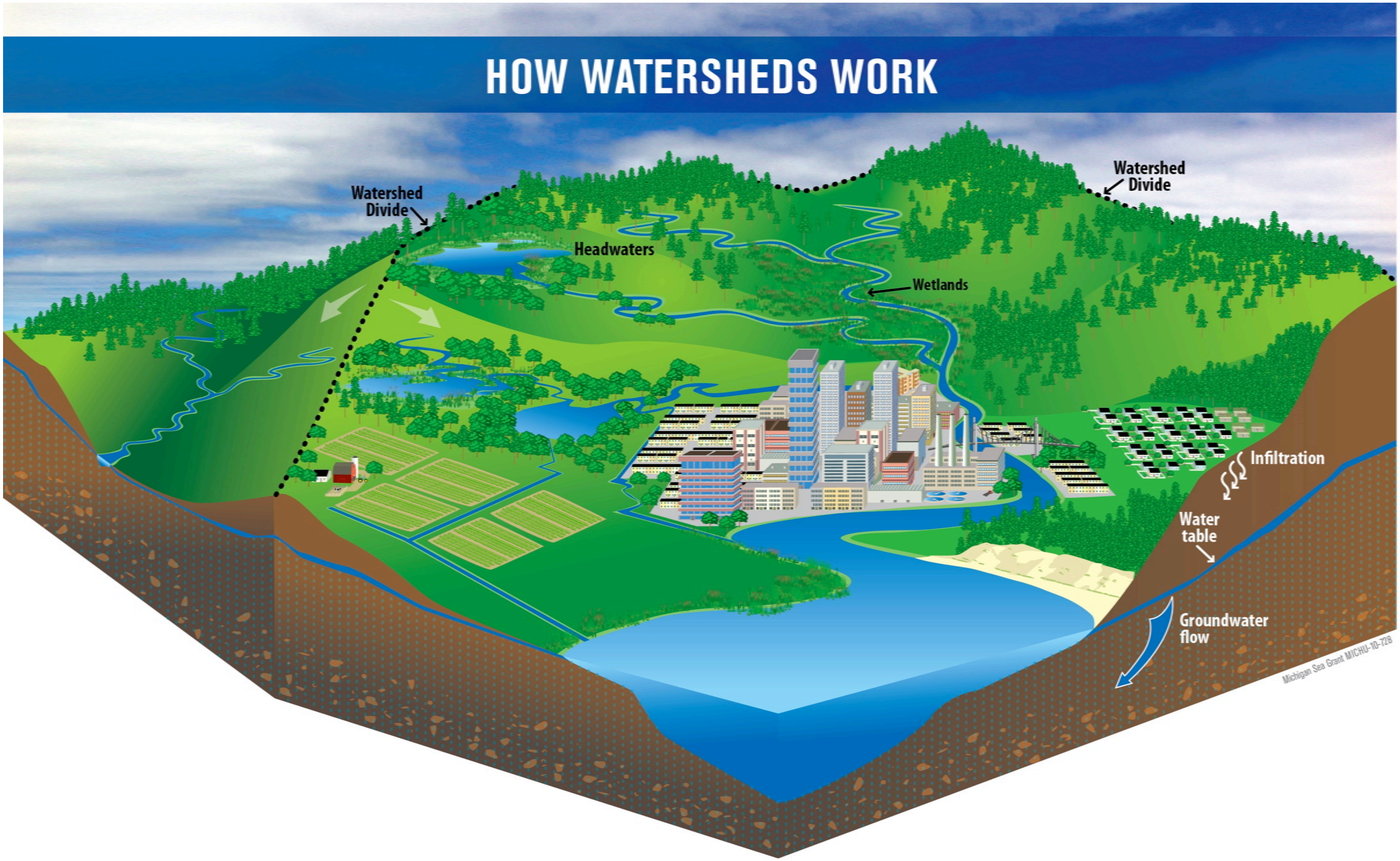

Figure 2. Watershed divides are high points in the landscape. Precipitation that lands within a river's watershed will flow down toward that river; rainwater that lands outside a river's watershed will flow to a different river. Towns, farms and other development will influence the quality of the water downstream.

From Clouds to Rivers

Each of Michigan's rivers has its own personality. The Saginaw River swells in the spring and the water becomes muddy. The Clinton River is very moody. After a rain storm the water rises very quickly, but it can dry out in the summer. The Au Sable River is cool and steady year round with fantastic trout fishing.

What affects the character of a river? Even before reading the rest of this guide, you probably have a good hunch that differences in rain and snowfall, soils and geology, and human development influence the personality of a river. But how exactly does this work?

Start with this seemingly simple question: where does the water in a river really come from?

Rain and snow feed Michigan's streams and lakes, but the amount and type of **precipitation** depends on the season and location (Figure 3). Southwest Michigan and parts of the Upper Peninsula receive nearly 40 inches of precipitation a year, including a lot of snow, while the northeast parts of the Lower Peninsula receive only 26- 30 inches of precipitation a year. On average, rain falls nearly one day out of every three days in Michigan, but where does all that rain go?

Surface Run-off. About 10% of rainfall in a naturally vegetated area will run over the ground surface and flow into streams directly.[1] Streams, rivers and lakes are considered **surface water** and they tend to flow quickly from higher areas to lower areas within the watershed.

Infiltration to Groundwater. In natural areas, roughly 50% of rainfall soaks into the soil and replenishes groundwater reserves.[1] Below the surface of the ground, groundwater continues to flow towards lower areas, but much more slowly than surface water. Groundwater will gradually flow into streams, lakes and wetlands lower in the watershed and sustain them in times of drought.

Evaporation and Transpiration. In areas with plant cover, roughly 40% of rainfall is quickly returned to the atmosphere, through **evaporation** directly from land and water surfaces or through **transpiration** from plant leaves. The U.S. EPA estimates that one acre of corn plants that are actively photosynthesizing can lose 4,000 gallons of water each day through their leaves![1] This is why many crops require on-going irrigation.

Ultimately, precipitation is the source of all of Michigan's freshwater, but rain can reach rivers and lakes through three different pathways (1) landing directly on them (precipitation), (2) washing over the ground and into creeks, which flow into other rivers and lakes (runoff), and (3) soaking into the ground and then gradually seeping into rivers (groundwater).

It turns out that *how* rivers get their water – from groundwater or from runoff – determines a lot about that river. Runoff can pick up **sediments**, **nutrients, pathogens** and contaminants and carry these into our waterways. In addition, runoff warms streams and can cause flooding. So why would some rivers in Michigan receive a lot of runoff while others are mostly fed by groundwater? The answer involves geology, soils and land use.

Figure 3. Average annual precipitation in Michigan. Data is from 1960-1990. (NationalAtlas.Gov)

Key Points

- Rain can either soak into the ground, wash over the surface of the ground or return to the atmosphere.
- Michigan's rivers are fed by groundwater and run-off from higher areas within the watersheds.

Discussion Questions

- How much precipitation does your watershed receive? How much of this precipitation falls as snow? What happens to rivers during snow melt?

Rocks, Soils and Groundwater

If you go outside during a heavy rainstorm you're likely to see water rushing down roads and into **storm drains** (runoff) and water forming small puddles in flat grassy areas and gradually soaking into the ground (infiltration). What determines the fate of a particular rain drop landing on the ground?

In general, heavier rainstorms, steeper slopes, and harder surfaces will cause more rainwater to runoff rather than soak in. The soil and geology can have a big impact. Which type of soil will allow rain to soak in faster – gravel or clay? Clay is made of small mineral grains that pack together very closely and allow water to move through it only slowly. Soils with larger grains, like sand and gravel, have larger spaces between grains that allow rain to infiltrate and groundwater to flow horizontally.

Nearly all of Michigan's bedrock is covered by loose sediments left behind by glaciers or the rise and fall of the Great Lakes. Much of the Lower Peninsula is covered with a thick layer of coarse material, such as sand and gravel, that was deposited by glaciers (Figure 4). Coarse sediments store groundwater and allow it to be pumped out relatively easily (Figure 5).[2] The Great Lakes deposited a thin layer of finer sediments around Saginaw Bay and the southeastern edge of Michigan (Figure 4). Water moves much more slowly through fine and medium grained sediments, so wells in this area can only withdraw water slowly, discouraging most large-scale groundwater uses (Figure 5).

Below the ground's surface, Michigan has abundant and valuable **groundwater** reserves that provide drinking water for nearly half of Michigan's residents.[3] Underground areas with groundwater that can be tapped and withdrawn for human use are called **aquifers**. In Michigan, aquifers can be found in deep bedrock layers or coarse glacial deposits such as those in the Au Sable watershed. Approximately 1.2 million homes in Michigan use private wells, which is more than any other state.[4] Many towns and cities, including Lansing, Battle Creek and Kalamazoo, pump out groundwater for their public water supply system. Water is required for nearly all manufacturing. Many industries locate in Michigan because of its high quality ground water resources, including beverage, food processing, pharmaceutical and battery companies. Clean groundwater and surface water are vital to Michigan's economy.

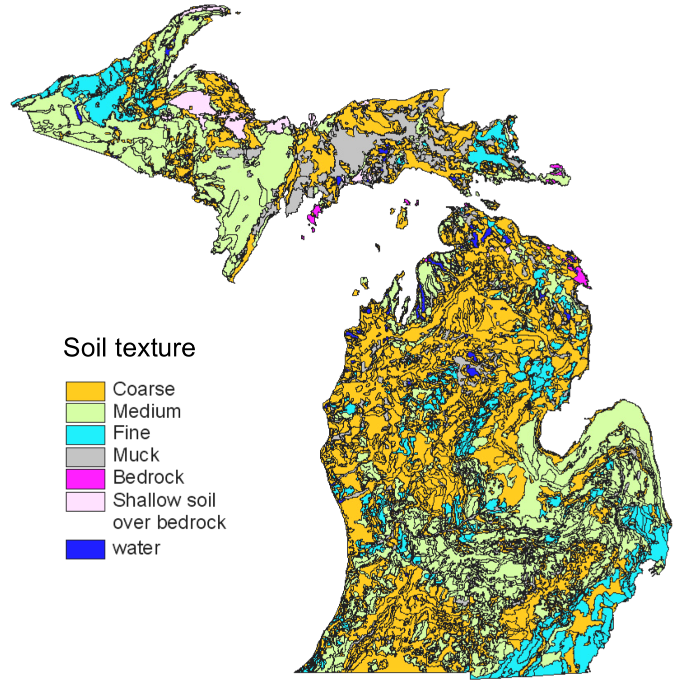

Figure 4. The texture of soils and sediments across Michigan.[9]

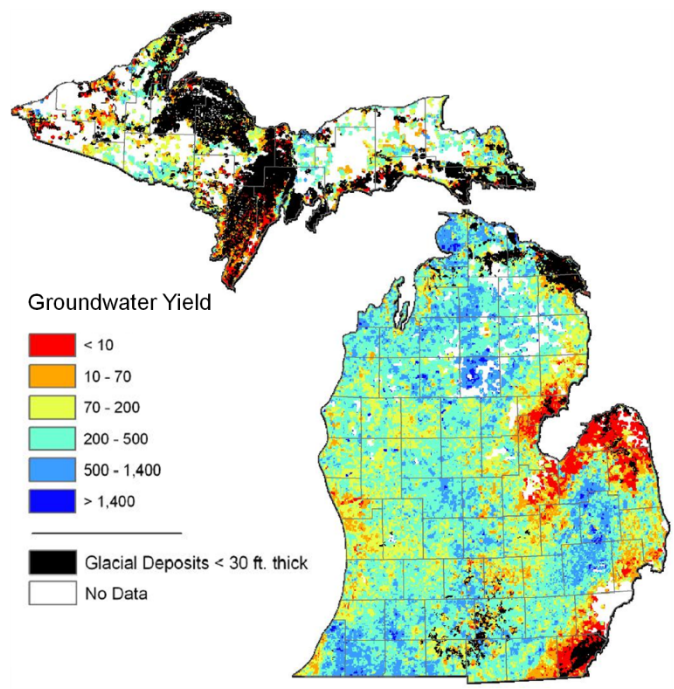

Figure 5. The estimated groundwater yield from glacial deposits in Michigan. The colors indicate how quickly groundwater could be pumped out. This rate is expressed in gallons per minute (gpm)[9]

Key Points

- Coarse sediments, like sand and gravel, allow rainwater to easily soak in, creating valuable groundwater reserves in some parts of Michigan.

Discussion Questions

- What type of soils are found in your watershed? Are there good aquifers in your area? Do you know any businesses, towns or homes that use groundwater?

What Makes a Good Trout Stream?

So what does geology have to do with rivers and fish? Look at Figure 6 – the good trout fishing streams are all clustered together in certain regions of Michigan. What's unique about these areas? The simple answer: coarse soils, limited development and lots of groundwater.

In watersheds with coarse, sandy soils, like the Kalamazoo or Au Sable watershed, most rainwater soaks into the ground and then that groundwater gradually feeds into streams throughout the year. Rivers that are fed primarily by groundwater rather than runoff tend to have steady, cold flows – even in the warmer regions of southwest Michigan. Cold water holds more oxygen and can better support sensitive insects and fish such as trout.

In areas with medium- or fine-textured soils like clay, rainwater can only soak into the ground slowly and less groundwater is available to sustain streams. For example, there is a lot of clay and relatively little groundwater around Saginaw Bay and the Thumb region. Without a steady supply of groundwater, streams can dry up in the summer.

How we develop the land in our watersheds also influences the quantity and quality of water available for wildlife and humans. Figure 7 shows land cover across Michigan. Extensive farming around Saginaw creates runoff that warms streams. You can see that most trout streams are found in forested areas of Michigan where trees shade and cool the streams.

Hardened or **impervious** surfaces, such as pavement and roof tops, prevent rainwater from soaking into the ground and replenishing groundwater reserves. Instead, rainwater washes across pavement and into drainage ditches and storm drains before eventually flowing into streams. As rainwater runs over pavement it warms-up and picks up sediment and other contaminants, like oil and heavy metals, changing the temperature, the clarity and the quality of streams that receive the run-off.

Runoff that follows a rainstorm is known as **stormwater** and needs to be actively managed by communities. A big pulse of stormwater runoff can lead to flooding, erosion of stream banks and deposition of sediments in lakes and harbors downstream. Many fish require rocks or pebbles to lay their eggs so sedimentation will degrade fish habitat.

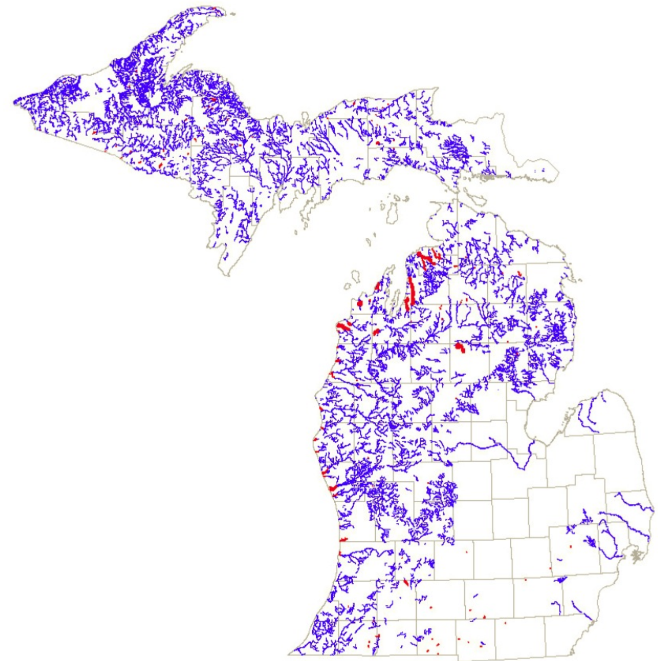

Figure 6. Trout streams and lakes in Michigan.[9]

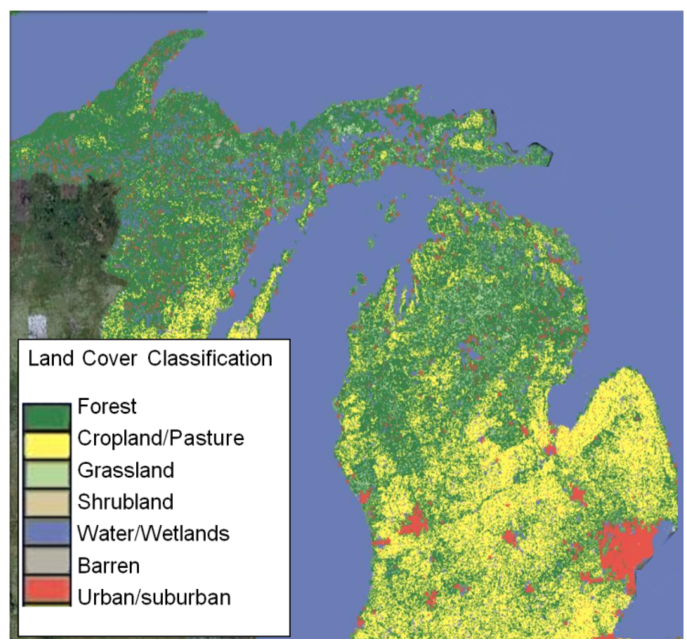

Figure 7. Land cover in Michigan. Land cover classes were identified based on satellite imagery. (National Land Cover Data 2001)

Key Points

- Groundwater can provide a steady supply of clean, cold water that creates excellent trout fishing.
- Clay soils and development can produce runoff which warms streams, making them less suitable for trout.

Discussion Questions

- Are there any good trout streams in your watershed? Why or why not?

The Unique Signature of a River

The annual pattern of water flow through a river - the high and low water periods – can be measured and graphed to help us better understand the river – like taking the pulse of the watershed (Figure 8).

The US Geological Survey routinely monitors water levels and **water quality** in streams across the United States. Hydrologists use a **stream gage** to measure the height of the stream at regular intervals throughout the day. The shape of the river channel and the height of the river are used to calculate the volume of water passing through the stream. The rate of water flow is called **stream flow** or **discharge** and is typically reported in cubic feet per second.

Figure 8 illustrates how the rate of water flowing through six rivers in Michigan changes over the course of a year. The peaks indicate times when the stream swelled and water was moving very quickly, such as after a rain storm. Look carefully at Figure 8. Although the graphs might initially seem chaotic, you will start to see that river flows in each region of Michigan look somewhat similar. Use the maps in this guide to ask:

- Which rivers have a similar water flow pattern? How are their watersheds similar in terms of precipitation, soils and development?
- Look at Clinton River and River Raisin. What might cause the sharp rises and falls in stream flow?
- Why is stream flow relatively steady in the northern parts of the Lower Peninsula?
- What causes the big rise in stream flow in the spring months in the Upper Peninsula?

Figure 9. Sections of the Clinton River flow through concrete banks. Water levels can be very high or low because the river receives a lot of urban runoff.

River Raisin and Clinton River (Figure 8a and 8b)

The streams in southeast Michigan show the impacts of urbanization and agriculture.[5,6] The impervious surfaces of developed areas and the relatively fine soils cause some rainwater to run off the land surface rather than infiltrating into the soil. Many of the farms within the River Raisin watershed have drain tiles and straight drainage ditches which move water off the fields and into streams quickly. As a result, streams in this region are very "flashy" with high peaks in stream flow after a storm and lows during dry months. Watershed restoration efforts focus on widening the buffers around streams, restoring wetlands, and better managing water levels in dammed lakes in order to stabilize flows down stream.

Figure 10. The Au Sable River watershed has extensive forests, sandy soils and great trout fishing.

Au Sable and Manistee River (Figures 8c and 8d)

The northern half of Michigan's Lower Peninsula is covered with deep, coarse glacial deposits, which readily store groundwater after rainstorms (Figure 5). As a result, most of the water in streams comes from groundwater, creating steady year-round flows, cold water conditions and world-class trout fishing.[7,8] Although the rivers experience some human impacts, including logging, dams and wetland loss, these watersheds are predominantly forested and the rivers support a diverse fish community (Figure 7). Restoration efforts focus on minimizing erosion along stream banks and road crossings and enhancing fish passage by removing or modifying dams.

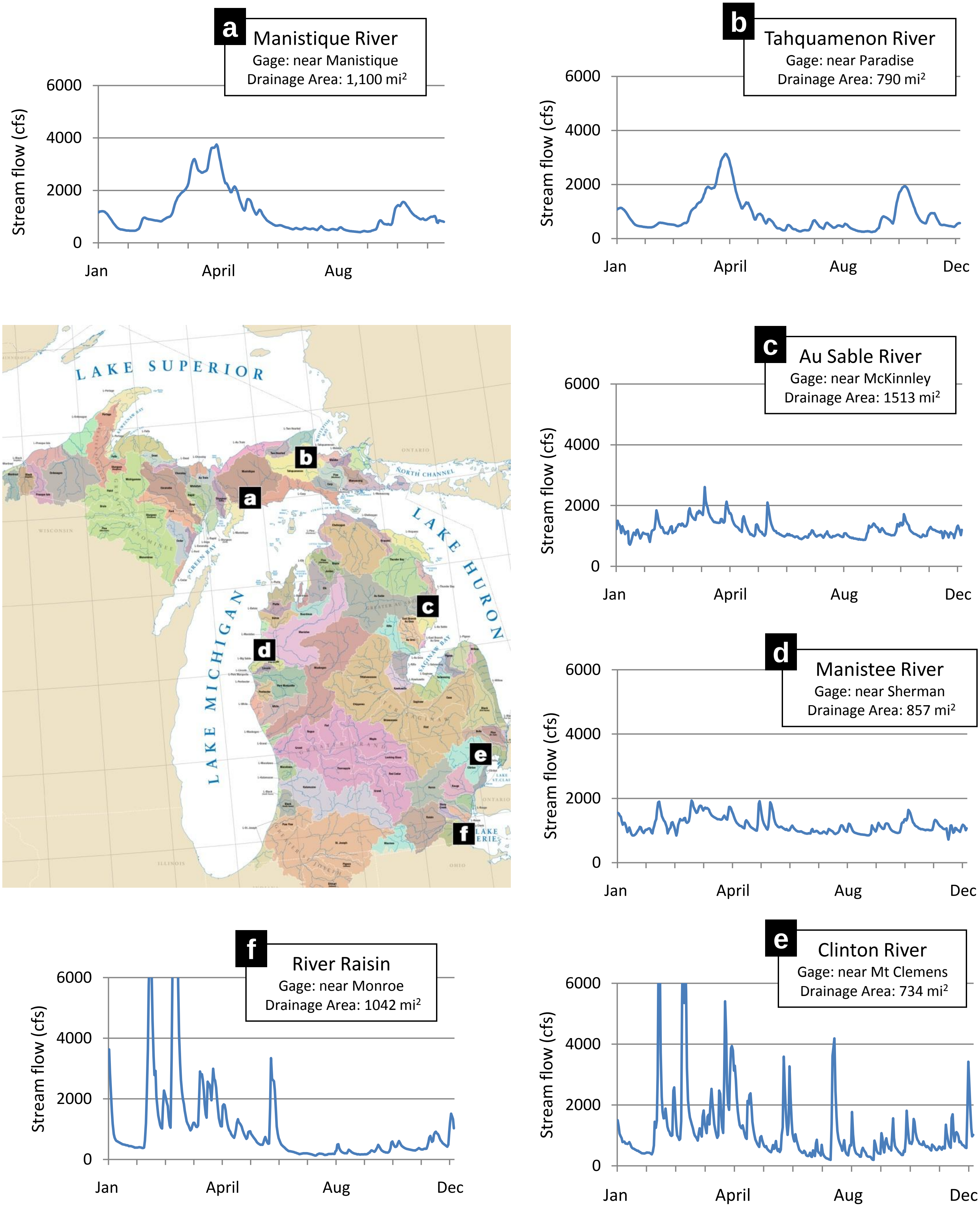

Figure 8. Changes in daily mean stream flow over the course of a year in select rivers around Michigan. Each graph shows the rate at which water flows through the river in cubic feet per second (cfs). (All data from USGS 2009 Annual Water Data Report.)

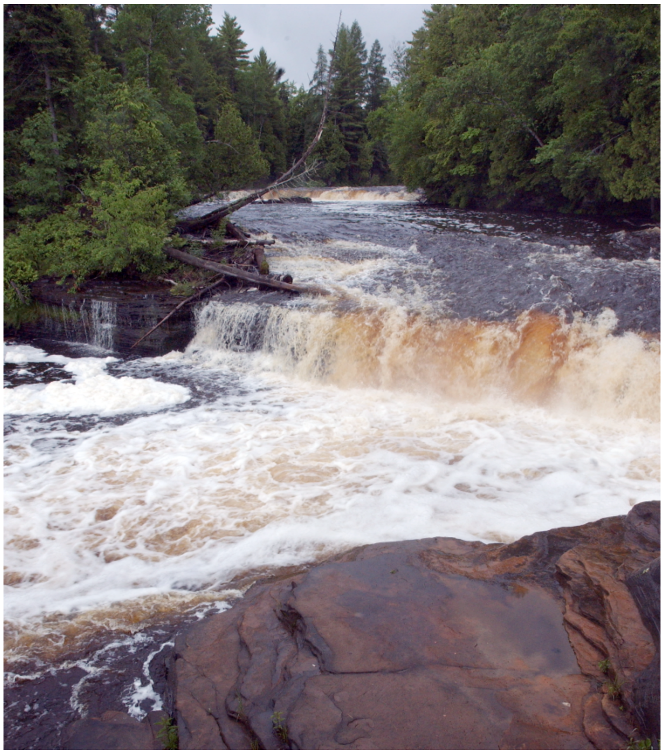

Figure 11. Swamps along the Tahquamemon River leach tannins into the water giving it a brown tint.

Manistique and Tahquamemon Rivers (Fig. 8e and 8f)
The eastern part of Michigan's Upper Peninsula receives heavy snowfall and spring snowmelt swells the streams. [9,10] Cool summers limit evaporation and high rainfall provides run-off to streams year round. Nearly half the land area is covered with wetlands, which store rainwater and slowly release it into streams, sustaining river flow in the summer. Hemlock, cedar and spruce swamps leach amber-colored tannins into the streams, and waterfalls add bubbly foam to the brown water. Along the Manistique River, 54 dams create shallow, lake-like impoundments that impede fish passage and warm the river. Most of this area is publicly owned and undeveloped, so dams are one of the few human impacts in these watersheds.

Watershed Planning and Stewardship

To protect a particular stream or lake we must consider the watershed that feeds it and influences the quality of its water. As water flows downhill within a watershed it can pick up sediments, nutrients, pathogens and contaminants and carry these into our waterways. We have seen that the watershed will influence the temperature and the flow of water through a river, determining which species of fish and wildlife are able to flourish.

Climate change in the Great Lakes region is likely to make severe rain storms more frequent *and* lengthen periods of drought.[11] Heavy rains saturate soils, slowing **infiltration** and increasing run-off. Communities will need to find ways to reduce flooding and erosion after storms *and* store water for use during dry periods.

Fortunately, there are many ways that we can protect water quality and make our watersheds resilient to extreme storms. Preserving and expanding naturally vegetated areas along streams, known as **riparian** buffers, can slow down and filter some of the run-off from towns and farms (Figure 2). Adding green space throughout a community can create areas for rain water to naturally infiltrate and replenish groundwater reserves. Homes and businesses can use rain barrels and create rain gardens, ponds and wetlands to catch and store **stormwater** run-off, reducing flooding downstream. All of these techniques are known as low impact development or green infrastructure.

Figure 12. A rain garden that captures water from the roof of an elementary school in Ann Arbor, Mich.

Increasingly, states and communities are trying to manage watersheds as a single unit. The idea is that in order to protect a particular lake or river, we need to consider *all* the land area that drains to that water body. Most, but not all, **water quality** problems result from an issue within the watershed, so a map of the watershed boundaries can help identify potential sources of polluted run-off. By working together, individuals within the watershed can design a coordinated watershed management plan that monitors threats and protects water quality and aquatic habitats in an integrated, cost-effective way.

In Michigan, the goal is for all water bodies to meet the water quality standards for all **designated uses** (Table 1). If a water body does not meet the criteria for one of the designated uses, it is considered impaired. For example, if water samples regularly contained a certain density of *E. coli* bacteria, leading to beach closures and swimming restrictions, the waterbody is impaired. Other designated uses may be considered threatened if the danger is uncertain. For example, suspected leaks from underground storage tanks could threaten the public water supply.

Designated Use	General Definition
Agriculture	Water supply for cropland irrigation and livestock watering
Industrial Water Supply	Water utilized in industrial processes
Public Water Supply	Public drinking water source
Navigation	Waters can be used for shipping, travel and transport
Coldwater Fishery	Supports reproduction of coldwater fish
Warmwater Fishery	Supports reproduction of warmwater fish
Other Indigenous Aquatic Life and Wildlife	Supports reproduction of indigenous animals, plants, and insects
Partial Body Contact	Water quality standards are maintained for water skiing, canoeing, and wading
Total Body Contact	Water quality standards are maintained for swimming between May 1 and October 31

Table 1. Definitions of Designated Uses. Citation: R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99.

Key Points

- Most water quality problems result from an issue within the watershed.
- Natural plantings along river corridors and other techniques can improve water quality by encouraging rain to soak in and minimizing runoff.

Discussion Questions

- What water quality issues exist in your watershed? Does the river ever look muddy? Does it flood frequently? What could your community do to protect the river?

Get Involved!

Community members and schools can help protect their watershed by monitoring potential threats and changes in stream flow. Residents and business owners can take steps to reduce run-off from their property and eliminate sources of pollution. In Michigan, almost everything that gets into a **storm drain**, creek, or drainage ditch could eventually flow into the Great Lakes. Everyone can play a role in protecting clean water:

- Pick up and throw away pet waste. Animal and human waste contains bacteria and **pathogens** that make water dangerous for swimming.
- Do not pour oil or chemicals into the grass or storm drains. Keep boats clean and avoid dripping fuel.
- Avoid using fertilizers and pesticides in your yard. Nutrients in runoff can contribute to algal blooms.
- Protect trees along creeks and lakes for shade. Replace lawns with deep-rooted plants to encourage rainwater to soak into the ground.
- Conserve water by using plants that don't need a lot of water. Avoid watering in the middle of the day when water will evaporate.
- Volunteer with a watershed organization and help monitor, clean-up and restore waterways.

Effectively managing a watershed requires cooperation, understanding and persistence, but the rewards of clean water and inviting streams are worth the hard work!

Figure 13. Stabilizing the shore of a lake in southern Michigan using natural materials and shrubs.

Inquiry and Stewardship in the Classroom

The Michigan Watershed Map, the illustrations in this guide and other online resources can be used to encourage further exploration. For example:

- Give students copies of the stream flow data shown in Figure 8. What might cause the differences? Encourage students to use the Michigan Watersheds Map and the other maps in this guide to develop their own explanations.
- Use the map of groundwater yields (Figure 5). If you were trying to build a new Coca Cola plant, where could you find reliable groundwater to make Coke? What impacts might this plant have on nearby streams? Why?
- Look at the map of trout habitat (Figure 6). Why are trout abundant in some watersheds but not others? Look at the other maps of Michigan, what do the watersheds with trout have in common?
- What information would you need to develop a management plan for your watershed?
- If your local lake is looking green, how could you identify the source of the problem? How could a watershed map help you?

Watershed Data and Resources

A number of organizations provide access to watershed data that could be used to support authentic investigations in the classroom. Students could graph daily stream flow to answer a variety of questions. For instance: When is streamflow highest? How has streamflow changed over the last 20 years? Which rivers are really flashy- with sharp rises and drops? Which rivers have similar stream flow patterns?

U.S. Geological Survey (USGS) Water Data

The USGS provides both real-time and historical data about streamflow and water quality.

- The *Annual Water Data Reports* provide a summary of all the data from a particular site as a PDF report, including monthly and annual statistics. http://wdr.water.usgs.gov/adrgmap/index.html
- Interactive "mappers" allow students to locate **stream gaging sites** and download data. http://wdr.water.usgs.gov/nwisgmap/
- Michigan Stream Data: http://waterdata.usgs.gov/mi/nwis/rt

Michigan Groundwater Mapping Project

These sites provide a variety of tutorials about Michigan's geology and hydrology, a series of full-color maps, as well as a very accessible online map viewer that could be used as a computer lab activity.

- Interactive mapping: http://gwmap.rsgis.msu.edu/start.htm
- Downloadable maps: http://www.egr.msu.edu/igw/GWIM%20Figure%20Webpage/index.htm

Surf Your Watershed

This site, developed by the U.S. Environmental Protection Agency, provides information about all U.S. watersheds, including known impairments and watershed groups in the area. You can also look up your watershed's official **hydrologic unit code** (8-digit HUCs), which will help you find additional data specific to your watershed.
http://cfpub.epa.gov/surf/locate/index.cfm

Michigan Geographic Data Library

This map repository provides Geographic Information System (GIS) data, interactive mapping tools and maps with a wide range of information, including population, cities, natural resources and environmental hazards.
http://www.mcgi.state.mi.us/mgdl/

Michigan Environmental Education Curriculum

This site includes a series of online visuals and tutorials about water, watersheds and environmental issues.
http://techalive.mtu.edu/meec_index.htm

Teaching with Great Lakes Data

This new website provides water-related data sets, teaching suggestions and ready-to-go lessons about weather, hydrology and dead zones. The activities develop higher-level thinking and science process skills.
www.greatlakeslessons.com

Fisheries Learning on the Web

This online curriculum includes lessons about water quality, watersheds, fisheries and food webs.
www.projectflow.us

Water on the Go

The Cranbrook Science Center offers free programs about Great Lakes watersheds at school sites.
http://science.cranbrook.edu/

Related Curriculum Standards and Great Lakes Literacy Principles

State of Michigan - Grade Level Content Expectations (5th-7th grade)

Earth Science

Soils
E.SE.06.11 Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.
E.SE.06.12 Explain how waves, wind, water, and glacier movement, shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.

Human Consequences
E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.
E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Water Cycle
E.ES.07.81 Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff, ground water, and absorption occur within the cycle.
E.ES.07.82 Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.

Science Process

Inquiry process (IP)
S.IP.05-07.16 Identify patterns in data.

Inquiry, analysis and communications (IA)
S.IA.05-07.11 Analyze information from data tables and graphs to answer scientific questions.
S.IA.05-07.13 Communicate and defend findings of observations and investigations using evidence.

Reflection and Social Implications (RS)
S.RS.05-07.17 Describe the effect humans and other organisms have on the balance in the natural world.

Great Lakes Literacy - Essential Principles and Fundamental Concepts

•1d - The Great Lakes, their respective watersheds and waterways, and the ocean are all connected. Within the Great Lakes system, water flows from the upper lakes (Lake Superior, Lake Michigan, and Lake Huron) through Lake St. Clair into Lake Erie, over Niagara Falls and into Lake Ontario before flowing through the St. Lawrence River into the ocean. Rivers and streams transport nutrients, dissolved gases, salts and minerals, sediments, and pollutants from watersheds into the Great Lakes.

•6c - The Great Lakes are affected directly by the decisions and actions of people throughout its watershed, which includes parts of the states of Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin, the Canadian provinces of Ontario and Quebec, and tribal lands.

•6d - Local and national laws, regulations, and resource management affect what is put into and taken out of the Great Lakes. Shoreline development and industrial or commercial activities lead to point and non-point source pollution. Humans have altered the biology of the lakes and the viability of species through harvesting, species introduction, and nutrient loading.

Glossary of Watershed Terms

Aquifer: A geological formation or structure that stores and/or transmits water, such as to wells and springs. The term is usually applied to underground areas where enough groundwater is accessible to be pumped out and used economically.

Baseflow: The amount of water that continues flowing through a stream even during dry periods. Baseflow is composed largely of groundwater that feeds into streams throughout the year. In general, rivers with a large watershed and abundant groundwater have higher baseflows.

Catchment: Another name for a watershed.

Designated Use: Recognized uses of water established by state and federal water quality programs (Table 1).

Discharge: The volume of water that passes a given location within a given period of time. Usually expressed in cubic feet per second.

Drainage Basin: Another name for a watershed.

Evaporation: The process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces and snow fields.

Erosion: Detachment and movement of rocks and soil particles by gravity, wind or water.

Groundwater: The sub-surface water supply in the saturated zone below the water table.

Headwaters: The upper reaches of a watershed where rivers originate.

Hydrologic Unit Code (HUC): A nested system for classifying all of the drainage basins in the U.S. Drainage basins have been divided and sub-divided at four different levels and each assigned a unique hydrologic unit code (HUC) consisting of eight digits based on the four levels. The smallest of the four levels, called cataloging units or 8-digit HUCs are often referred to as watersheds. There are 65 cataloging units within Michigan. The Michigan Watershed Map shows smaller watershed divisions than the standard hydrologic cataloging units.

Hydrology: The study of how water is naturally distributed and circulated around the earth.

Impervious: A surface through which little or no water filters through. Impervious areas include paved parking lots and roof tops.

Infiltration: The penetration of water through the ground surface and into soil and rocks below.

Non-point Source Pollution*:* Pollution caused when rain, snowmelt, or wind carries pollutants off the land and into waterbodies.

Nutrient: A chemical that plants and animals need for normal growth, such as nitrogen or phosphorus.

Pathogen: Usually refers to a microorganism that causes disease, such as certain viruses, fungi or bacteria.

Precipitation*:* Water falling from the atmosphere onto earth as rain, snow, hail, sleet, dew or frost.

Riparian: Areas bordering rivers, lakes and other waterways.

Runoff: That portion of the precipitation or irrigation water that travels over the land surface, rather than soaking in, and ends up in streams or water bodies.

Sediment: This term is usually applied to material, like soil, sand, and minerals, suspended in water or recently transported and deposited by water.

Stream Gage: A site on a stream, lake, reservoir or other body of water where observations and hydrologic data are obtained. The USGS measures stream discharge at gaging stations.

Streamflow: The water discharge, or the rate of water movement through a natural channel.

Surface Water: All water on the Earth's surface, including water in streams, rivers, lakes or reservoirs.

Stormwater Runoff: The runoff that results when rainwater or snowmelt flows over land or impervious surfaces and does not percolate into the ground.

Storm Drain: An underground pipe or an open ditch that carries surface runoff, street wash, and snowmelt from the land. Water often enters drains through a slotted opening on the street.

Transpiration: The loss of water vapor from plants, such as through leaf pores.

Tributary: A river or stream that flows into a river, lake or ocean.

Water Quality: The biological, chemical and physical characteristics of water, usually in respect to its suitability for a particular purpose, such as drinking or swimming.

Watershed: The land area that drains surface water to a particular river, stream or body of water. The boundaries can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds include many smaller watersheds.

Sources: USGS Water Science Glossary. Available at: http://ga.water.usgs.gov/edu/dictionary.html
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The Michigan Watersheds Map was developed by Michigan Sea Grant in collaboration with the U.S. Geological Survey. The map illustrates the boundaries and main rivers of 63 major watersheds in Michigan. The map is a fantastic resource for learning more about Michigan's water resources and visualizing the connections between streams, rivers and the Great Lakes.

To obtain additional copies of the Michigan Watersheds Map – or its companion, the Great Lakes Basin Map (coming soon) – visit the Michigan Sea Grant bookstore, www.miseagrant.com

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