



Water Quality Introduction

Living in the water-rich Great Lakes basin, many Michigan students take water for granted. The *MEECS Water Quality Unit* is designed to provide students with a solid foundation in understanding the critical importance of having adequate supplies of clean, available fresh water for the environment, Michigan's economy, and our quality of life. The unit provides a national and international perspective on water availability, an appreciation for Michigan's "dirty" water history, and an understanding of the challenges that Michigan faces in addressing water quality and quantity issues related to groundwater, streams and rivers, wetlands, inland lakes, and the Great Lakes. Not only can humans not survive a week without water, neither can an economy survive without sufficient supplies of clean water.

The *MEECS Water Quality Unit* contains nine core lessons and five extension lessons. All lessons are correlated to middle and high school benchmarks for science and social studies. The lessons and activities may be adapted for specific grades, as well as for non-formal education programs. In addition, six interactive online learning modules have been developed to support several lessons in the unit (http://techalive.mtu.edu/meec_index.htm). Both individual lesson assessments and a MEAP-like unit assessment are included. The embedded lesson assessments are either project-based or invite student reflection and discussion. Teachers also have the option of using a pre- and post-unit assessment. Use of a science journal throughout the unit is encouraged.

Topics addressed in the unit include the availability and distribution of water on Earth (Lesson 1); household water use and water used in the manufacture of goods and services in Michigan (Lesson 2); managing water quantity and movement within a watershed (Lesson 3); land uses and water pollution (Lesson 4); groundwater quality and potential contamination (Lesson 5); water quality standards and the history of water quality protection (Lesson 6); assessing the health of aquatic ecosystems with stream monitoring (Lesson 7); managing storm water runoff (Lesson 8); and bioaccumulation of contaminants in the Great Lakes (Lesson 9). Additional Great Lakes challenges that we face include invasive species, emerging contaminants, proposed out-of-basin export of Great Lakes water, over-pumping of groundwater, combined sewer overflows and storm water runoff, cleaning up Areas of Concern and Superfund sites, impacts of climate change on water levels and aquatic ecosystems, beach closures, loss of wetlands, and declining biodiversity. Students are encouraged to explore possible solutions to these challenges including pollution prevention strategies, using data to make management decisions, personal behavior and product choices, engaging in activities that inform their communities, and more. The role of government and environmental stewardship to protect water quality and quantity is woven into lessons throughout the unit.

The water management choices that Michigan residents make now and in the future will have significant environmental, economic, and social impacts for us as individuals, for our communities, the State of Michigan, and for our country. How can Michigan residents, businesses, and industry continue to meet their needs without compromising the ability of future generations to meet their water resource needs? In order to ensure a healthy, sustainable future, Michigan residents must have the knowledge and skills necessary to make informed data-based decisions about the water resource challenges facing us as residents of a Great Lakes state and as participants in a global economy.

The future of Michigan's environment, economy, and quality of life depends on the decisions made by *today's* youth as *tomorrow's* decision-makers. The *MEECS Water Quality Unit* will help Michigan students gain the knowledge and skills they need to become stewards of Michigan's water resources and to help keep this Great Lakes state GREAT!

Water Quality Overview

Essential Questions	Core Lesson
<p>1 Where is water found on Earth? How does water move on Earth? Is there enough water on Earth for everyone? Why are the Great Lakes unique?</p>	<p>1. Where Is All the Water in the World? – Students describe how water moves through the water cycle, where water is located on Earth, and how much fresh water is available for human use.</p>
<p>2 Why is clean, fresh, available water so important to humans? What are direct and indirect uses of water? How would having less water or more expensive water affect Michigan residents?</p>	<p>2. How We Use Water – Students identify the many ways we use water both directly for household activities, and indirectly in everything we consume. Students calculate their weekly water use and its cost compared to gasoline, and consider how water is an essential component of Michigan’s economy and environment.</p>
<p>3 What is a watershed? Why care about watersheds? How does water in your watershed reach the Great Lakes? Why does the amount of streamflow differ between Michigan streams and for different months of the year?</p>	<p>3. Do You Know Your Watershed? – Students define watershed and the parts of a river; compare watershed size and stream flow in Michigan; examine their watersheds’ relationship to the Great Lakes.</p>
<p>4 How does what we do on the land affect water quality? How does pollution get from one place to another? How can I learn about water pollution in my watershed?</p>	<p>4. How Do Land Uses Affect Water Quality? – Students build a simple watershed model to observe point & non-point pollution from different land uses; identify the types of pollution resulting from different land uses; give examples of best management practices to reduce pollution; and identify potential sources of water pollution in their watersheds.</p>
<p>5 How is groundwater connected to surface water? How does groundwater move? How can groundwater become polluted? Is there enough groundwater for all Michigan uses?</p>	<p>5. Why Care About Groundwater? – Students explore groundwater movement, how groundwater interacts with surface water, and groundwater uses in Michigan. Student build a model to see how groundwater can be pumped and recharged, and use Michigan data to explore how groundwater can be contaminated.</p>
<p>6 How do we know our water is safe to drink? What units are used to measure water pollution? Has our water always been clean? Who is responsible for protecting our drinking water?</p>	<p>6. Would You Drink This Water? – Students consider whether the ‘look’ and ‘smell’ of water is enough to indicate its quality; conduct a serial dilution to observe the tiny quantities that can be harmful to humans and aquatic organisms; and become familiar with who protects Michigan’s water quality.</p>
<p>7 What is stream monitoring, and how is it done? How do you know if a stream is healthy? What are bioindicators? What makes good habitat for fish?</p>	<p>7. How Healthy Is This Stream? – Students identify characteristics of healthy streams and use real Michigan data to evaluate four streams for the presence of pollution-sensitive bioindicator organisms, appropriate habitat, and good water quality in order to select the best stream for planting brook trout.</p>
<p>8 Where does storm water come from and where does it go? What are potential contaminants in runoff? How do people affect the quantity and quality of runoff? How can communities grow without impacting aquatic ecosystems? How is storm water runoff different in urban areas versus rural areas?</p>	<p>8. How Can We Stop Storm Water? – Identify pollutants in storm water; use aerial photos to compare changes in land use and runoff quantity; identify best management practices to reduce storm water impacts.</p>
<p>9 Are the Great Lakes really great? Can I eat fish from the Great Lakes? What types of contaminants are found in the Great Lakes? How can I help protect the Great Lakes?</p>	<p>9. Bioaccumulation and the Great Lakes Ecosystem – Student investigate the source and pathways for bioaccumulation of contaminants in Great Lakes food chains; identify locally contaminated rivers using the Michigan Family Fish Consumption Guide; and answer the question, “How can I help the Great Lakes?”</p>

Enhancements and Extensions

1. - Play *Incredible Journey* water cycle game from Project WET online www.projectwetusa.org/pdfs/incrediblejourney.pdf.
 - Research environmental issues of Lake Baikal online <http://www.bww.irk.ru/index.html>.
 - Explore the *World Lake Database* online <http://www.ilec.or.jp/database/database.html>.
 - Compare the relative volume and surface areas of the five Great Lakes.
 - Investigate the physical and chemical properties of water in the Project WET activity *Is There Water on Zork?* (on the MEECS Water Quality CD-ROM).
2. - Design and implement a home water conservation plan.
 - Compare U.S. water use to that of other countries <http://www.wateryear2003.org>.
 - Stack plastic gallon jugs to display the amount of water used for different activities.
 - Investigate the claim of a looming “Global Water Crisis.”
3. - Visit the Terraserver web site (<http://terraserver.com>) to view aerial photos of the local watershed.
 - Compare extension lesson *Investigating Stream Flow in Michigan’s Rivers* on the MEECS Water Quality CD-ROM.
 - Try the interactive web modules *The Watershed Concept* and *Aquatic Ecosystems: Wetlands* at http://techalive.mtu.edu/meec_index.htm.
 - Use a commercial stream table to demonstrate stream development under varying conditions.
 - Play *Raging River* to model the confluence of tributaries into the main river channel.
4. - Investigate water quality in your local river using Michigan Department of Environmental Quality web sites listing contaminated water bodies and contaminated sites.
 - Try the interactive web module *Water Quality: Pollutant Sources & Impacts* at http://techalive.mtu.edu/meec_index.htm.
 - *Take a Watershed Tour* of your local area to meet with water users and managers, and see a variety of land uses, using the extension lesson on the MEECS Water Quality CD-ROM.
 - Build erosion models to identify effective Best Management Practices.
 - Compete in the activity *Runoff Races* from *WOW! The Wonder of Wetlands* by Project WET.
 - Do *Sum of the Parts* activity from Project WET to explore the cumulative effects of streamside pollution (on the MEECS Water Quality CD-ROM).
5. - Investigate Groundwater Supply & Groundwater Contamination using the online web modules at http://techalive.mtu.edu/meec_index.htm.
 - Demonstrate groundwater movement and contamination using a groundwater model or enviroscape.
 - Debate: Should groundwater withdrawals in Michigan be regulated?
 - Have rural students download the well log for their home drinking water from <http://www.deq.state.mi.us/well-logs/>.
 - Visit a local well driller to see an actual well being drilled.
 - Install a shallow groundwater monitoring well at your school to monitor water table fluctuations.
 - Try some lessons from Septic Educational Program to Instill Conservation (SEPTIC) (on the MEECS Water Quality CD-ROM).
 - Conduct a porosity or permeability demonstration.
6. - Take student on a tour of your local wastewater treatment facility.
 - Investigate the safety of your community’s drinking water by checking your local *Water Quality Consumer Confidence Report*.
 - Investigate *Water and Wastewater Treatment* using the online web module http://techalive.mtu.edu/meec_index.htm.
7. - Do the online web module *Stream Monitoring* or *Aquatic Ecosystems: Rivers & Streams* at http://techalive.mtu.edu/meec_index.htm.
 - Have students “design a macroinvertebrate” to illustrate specific characteristics of different bioindicators.
 - *Develop A Watershed Assessment* of your local watershed using the extension lesson on the MEECS Water Quality CD-ROM.
8. - Do the activity *A-Maze-ing Water* from the Project WET Curriculum & Activity Guide.
 - Conduct a storm drain stenciling project in the local community.
 - Develop a rain garden for your school grounds.
 - Measure the water quality of storm water.
 - Design an experiment to compare the permeability of different soils.
 - Try *Measuring Watershed Runoff at Your School* using the extension lesson on the MEECS Water Quality CD-ROM.
9. - Try the “Smart Fish Calculator” to determine the amount of potentially contaminated fish that is safe for you to consume based on your body weight.
 - Show the *Life of the Lakes: The Great Lakes Fishery* video or DVD from Michigan Sea Grant.
 - *Investigate a Great Lakes Issue* using the extension lesson on the MEECS Water Quality CD-ROM.
 - Make a Great Lakes floor map using *Lake Effects Curriculum Guide*.
 - Do the online web module *Aquatic Ecosystems: The Great Lakes* to learn more about the Great Lakes food chain at http://techalive.mtu.edu/meec_index.htm.

Michigan Curriculum Standards and Benchmarks

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| 1 | <ul style="list-style-type: none"> • Generate scientific questions about the world based on observation (SCI.I.1.MS.1). • Use maps of the Earth to locate water in its various forms and describe conditions under which they exist (SCI.V.2.MS.1). • Describe how surface water in Michigan reaches the ocean and returns (SCI.V.2.MS.2). • Explain how water exists below the Earth's surface and how it is replenished (SCI.V.2.MS.3). • Explain the behavior of water in the atmosphere (SCI.V.3.MS.3). • Locate, describe, and compare the ecosystems, resources, and human environment interactions of major regions (SS.II.2.MS.1). • Explain how elements of the physical geography (<i>water scarcity</i>), culture, and history of a region may be influencing current events (<i>conflicts over a limited essential resource</i>) (SS.II.5.MS.3). |
| 2 | <ul style="list-style-type: none"> • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Locate, describe, and compare the ecosystems, resources, and human environment interactions of major world regions (SS.II.2.MS.1). • Explain how elements of the physical geography (<i>water scarcity</i>), culture, and history of the region may be influencing current events (<i>conflicts over a limited essential resource</i>) (SS.II.5.MS.3). • Use economic reasoning when comparing price, quality, and features of goods and services (SS.IV.1.MS.1). • Compare various methods for production and distribution of goods and services (SS.IV.2.MS.2). • Interpret social science information about the natural environment and cultures of countries from a variety of primary and secondary sources (SS.V.1.MS.3). • Engage in activities intended to contribute to solving a national or international problem they have studied (SS.VII.1.MS.2). • Explain how processes like population growth, economic development, urbanization, resource use, international trade, global communication and environmental impact are affecting different world regions (SS.II.4.HS.3). |
| 3 | <ul style="list-style-type: none"> • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Describe and identify surface features using maps (SCI.V.1.MS.1). • Identify and describe regional watersheds (SCI.V.2.HS.1). • Explain how humans modify the environment and describe some of the possible consequences of those modifications (SS.II.2.MS.4). • Describe the consequences of human/environment interactions in several different types of environments (SS.II.2.MS.5). |
| 4 | <ul style="list-style-type: none"> • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Describe the origins of pollution in the hydrosphere (SCI.V.2.MS.4). • Explain the effects of agriculture and urban development on selected ecosystems (SCI.III.5.HS.6). • Analyze properties of common household and agricultural materials in terms of risk/benefit balance (SCI.IV.1.HS.1). • Describe how human activities affect the quality of water in the hydrosphere (SCI.V.2.HS.2). • Explain how humans modify the environment and describe some of the possible consequences of those modifications (SS.II.2.MS.4). |
| 5 | <ul style="list-style-type: none"> • Generate scientific questions about the world based on observation (SCI.I.1.MS.1). • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Explain how water exists below the Earth's surface and how it is replenished (SCI.V.2.MS.3). • Explain how humans modify the environment and describe some possible consequence of those modifications (SS.II.2.MS.4). • Describe the consequences of human/environment interactions in several different types of environments (SS.II.2.MS.5). |
| 6 | <ul style="list-style-type: none"> • Generate scientific questions about the world based on observation (SCI.I.1.MS.1). • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Describe health effects of polluted air (and water) (SCI.V.3.MS.4). • Select a contemporary condition and trace some of the major historical origins (SS.I.1.MS.3). • Explain how the rule of law protects individual rights and serves the common good (SS.III.1.MS.3). |
| 7 | <ul style="list-style-type: none"> • Generate scientific questions about the world based on observation (SCI.I.1.MS.1). • Design and conduct scientific investigations (SCI.I.1.MS.2). • Use tools and equipment appropriate to scientific investigations (SCI.I.1.MS.3). • Develop awareness and sensitivity to the natural world (SCI.II.1.MS.5). • Compare and classify organisms into major groups on the basis of their structure (SCI.III.2.MS.1). • Describe how human activities affect the quality of water in the hydrosphere (SCI.V.2.HS.2). • Explain how humans modify the environment and describe some possible consequences of those modifications (SS.II.2.MS.4). |
| 8 | <ul style="list-style-type: none"> • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Describe the origins of pollution in the hydrosphere (SCI.V.2.MS.4). • Explain the effects of agriculture and urban development on selected ecosystems (SCI.III.5.HS.6). • Describe how human activities affect the quality of water in the hydrosphere (SCI.V.2.HS.2). • Explain how humans modify the environment and describe some of the possible consequences of those modifications (SS.II.2.MS.4). |
| 9 | <ul style="list-style-type: none"> • Use sources of information in support of scientific investigations (SCI.I.1.MS.5). • Predict the effects of changes in one population in a food web on other populations (SCI.III.5.MS.3). • Describe ways in which humans alter the environment (SCI.III.5.MS.6). • Describe the origins of pollution in the hydrosphere (SCI.V.2.MS.4). • Describe responses of an ecosystem to events that cause it to change (SCI.III.5.HS.4). • Explain the impact of human activities on the atmosphere and explain ways that individuals and society can reduce pollution (SCI.V.3.HS.4). • Explain how humans modify the environment and describe some of the possible consequences of those modifications (SS.II.2.MS.4). |

Water Quality Master Materials List

Lesson 1. Where Is All the Water in the World?	
<p>Reproducible Materials <i>per class</i></p> <ul style="list-style-type: none"> • <i>Water Cycle</i> with no labels (transparency master) • <i>Water Cycle</i> with arrows and locations correctly labeled (transparency master) • <i>Where Is Water on Earth?</i> (transparency master/answer key) • <i>How Much of Earth's Water Is Available for Human Use?</i> (transparency master) • <i>Great Lakes Physical Features and Population</i> (transparency master) <p><i>per small group</i></p> <ul style="list-style-type: none"> • <i>Water Cycle</i> with no arrows or labels (student activity) • <i>Where Is Water on Earth?</i> (student activity) 	<p>Materials in MEECS kit <i>per class</i></p> <ul style="list-style-type: none"> • MEECS Water Quality CD-ROM (<i>Is There Water on Zork activity from Project WET</i>) • 1-2 inflatable globes <p>To be supplied by teacher <i>per class</i></p> <ul style="list-style-type: none"> • map of United States • 3 100-ml graduated cylinders • container of water (10-ml/student) • cup of salt water (optional, for one student to taste) • blue food coloring • 1 green and 1 blue paper plate (optional) • 5 clear plastic 12-oz. cups <p><i>per small group</i></p> <ul style="list-style-type: none"> • 1 clear plastic 2-L (2000 ml) bottle filled with (blue) water • 5 clear plastic 12 oz. cups • permanent marker • 1 water dropper • paper towels • 1 green and 1 blue paper plate (optional) • 100-ml graduated cylinder • calculator • scissors (optional)
Lesson 2. How We Use Water	
<p>Reproducible Materials <i>per class</i></p> <ul style="list-style-type: none"> • <i>What Is Your Household Water Use?</i> (transparency master) • <i>Calculate Your Household Water Use</i> (transparency master) • <i>Percent Water Use in the Home by Activity</i> (transparency master) • <i>Comparing Water Prices and Use in the United States and Other Countries</i> (transparency master) • <i>How Is Water Used to Make a Hamburger?</i> (transparency master) • <i>How Is Water Used in the Paper-Making Process?</i> (transparency master) • <i>Indirect Water Use</i> (transparency master) • <i>Made in Michigan Wood Products</i> (transparency master) • <i>Grown in Michigan Products</i> (transparency master) • <i>Total Water Withdrawals by Source in Michigan, 2004</i> (transparency master) • <i>Total Water Withdrawals by Sector in Michigan, 2004</i> (transparency master) • <i>Water Concept Map</i> (answer key) <p><i>per student</i></p> <ul style="list-style-type: none"> • <i>Calculate Your Household Water Use</i> (student activity) • <i>Water Concept Map</i> (student assessment) 	<p>Materials in MEECS kit <i>per class</i></p> <ul style="list-style-type: none"> • MEECS Water Quality CD-ROM <p><i>per small group</i></p> <p>To be supplied by teacher <i>per class</i></p> <ul style="list-style-type: none"> • self-adhesive notes (optional) <p><i>per student</i></p> <ul style="list-style-type: none"> • calculator

Lesson 3. Do You Know YOUR Watershed?

Reproducible Materials

per class

- *Diagram of a Watershed* (transparency master)
- *Overview of a Stream* (transparency master)
- *Stream Channel Profile* (transparency master)
- *Michigan Water World* (answer key)
- *Great Lakes Watershed and Political Boundaries* (transparency master)
- *Stream Hydrograph* (transparency master)
- *Stream Hydrograph Data* (transparency master)

per small group

- *Michigan's Water World* (student activity)
- *Watershed Labels* (printed on overhead transparency)
- *Watershed Labels* (transparency master)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (*Developing a Watershed Management Plan*, Extension Lesson *Investigating Stream Flow in Michigan Rivers*, list of USGS Stream Gaging and Precipitation Stations)
- *Michigan Water World* poster

per small group

- *Michigan's Water World* poster – teacher should laminate these before using
- Michigan highway map

To be supplied by the teacher

per class

- spray bottle filled with blue water or rain shaker cups
- 5' x 5' sheet of white plastic (shower curtain or tablecloth) or tarp
- 5-10 sheets of newspaper
- large tub or children's swimming pool (optional)

per small group

- 5-10 sheets of newspaper wadded up individually (or boxes or rocks)
- aluminum turkey roasting pan, paint pan, dish tub, or other container (approximately 2' x 2' x 6")
- foil
- spray bottle filled with blue-colored water or rain cups

Lesson 4. How Do Land Uses Affect Water Quality?

Reproducible materials

per class

- *Point and Nonpoint Source* photos on MEECS Water Quality CD-ROM
- *Water Quality and Possible Pollutants* (answer key/transparency master)
- *Land Uses and Water Quality* PowerPoint
- *Land Uses and Water Quality* (answer key)
- *Land Use Labels* (transparency master)
- *Line Drawings of Four Land Uses* (answer key/transparency master)
- *Plan for New Development* (answer key rubric)

per small group

- *5-6 Land Use Labels*
- *Line Drawings of Four Land Uses* (student activity)
- *Plan for New Development* (student activity)

per student

- *Water Quality and Possible Pollutants* (student activity)
- *Land Uses and Water Quality* (student activity)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (Powerpoint: *Land Uses & Water Quality*, Extension Lesson *Taking A Watershed Tour*, list of Michigan Dept of Environmental Quality regional offices, *Guidebook of Best Management Practices for Michigan Watersheds* (MDEQ, 1998))

per small group

- Michigan Sea Grant poster *Where Land Meets Water* or the MEECS *Michigan Land, Air, and Water* poster – teacher should laminate these before using

To be supplied by the teacher

per class

- computer projector
- pollutants (label each container)
 - fertilizer = green powdered drink mix
 - herbicide/pesticide = red powdered drink mix
 - sediment from soil erosion = cocoa powder or potting soil
 - road salt = table salt
 - litter = torn paper
 - industrial wastes = colored water (point source) in a squeeze bottle
 - used motor oil = maple/chocolate syrup or molasses
 - small houses, cars and trucks, trees, etc.

per small group

- watershed models (from Lesson 3)
- small houses, trees, vehicles, and other items to represent land uses in the watershed
- spray bottle filled with blue-colored water or rain cups
- paper towels

Lesson 5. Why Care About Groundwater?

Reproducible materials

per class

- *Groundwater: Michigan's Hidden Resource* PowerPoint presentation (on MEECS Water Quality CD-ROM) or make transparency masters
- *What Do You Know About Michigan's Hidden Resource?* (answer key)
- *Porosity and Permeability of Earth Materials* (transparency master)
- map of Michigan's 83 Counties (transparency master)
- Michigan Groundwater Contamination maps (transparency masters) OR on MEECS Water Quality CD-ROM:
 - Part 201 Sites of Environmental Contamination
 - Contaminated Landfills
 - Abandoned Landfills and Dumps
 - Part 213 Leaking Underground Storage Tanks
 - Oil and Gas Extraction Contamination Sites
 - Superfund Sites in Michigan
 - Pesticide and Herbicide Contamination Sites
 - Nitrate Contamination in Drinking Water Wells
 - Volatile Organic Compounds (VOCs)
- *Michigan Groundwater Use in 2004* (transparency master)

per student

- *What Do You Know About Michigan's Hidden Resource?* (student activity)
- *Where Is Groundwater?* (student activity)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (Powerpoints: *What Do You Know About Michigan's Hidden Resource? Beginner version*, Groundwater Contamination Maps for Michigan Counties; *What Do You Know About Michigan's Hidden Resource? Advanced version*, SEPTIC Curriculum)

To be supplied by the teacher

per class

- self-adhesive notes
- computer projector
- overhead projector
- pollutants with plastic spoons
 - fertilizer = green drink powder
 - nitrates = blue drink powder
 - pesticide = red drink powder
 - industrial/hazardous wastes = orange drink powder
 - used motor oil or leaking underground storage tanks = maple/chocolate syrup or molasses
 - landfill leachate = yellow drink powder

per student

- Non-edible Groundwater Model
 - 4-8 oz. water (1 c.)
 - 8-oz. clear plastic cup
 - 3-oz. cup
 - 1 straw OR dropper
 - 2" x 2" screen
 - 4 oz. gravel (1/2 c.)

OR

- Edible Groundwater Model
 - 4-8 oz. milk
 - 8-oz. clear plastic cup
 - 3-oz. cup
 - 1 plastic spoon
 - 1 straw
 - 1/4 cup each of 3 kinds of (unsweetened) cereal:
 - clay (Grape Nuts)
 - sand (Kix, Sugar Pops)
 - gravel (Chex)

Note: If you make the edible groundwater model, inquire about possible food allergies (peanuts, lactose intolerance, etc.).

Lesson 6. Would You Drink This Water?

Reproducible materials

per class

- *Timeline of Important Events in Water History* with dates (transparency master/answer key)
- *Timeline of Important Events in Water History* with no dates (transparency master)
- *Maximum Contaminant Levels in Drinking Water* (transparency master)
- Serial Dilution (answer key)
- *Who Cares About Water Quality? Why Do They Care?* (transparency master)
- *Water on Tap Questions* (answer key)
- *Lesson 6 Overview* PowerPoint (optional, on MEECS Water Quality CD-ROM)

per small group

- Serial Dilution (student activity)

per student

- *Water History Timeline* no dates (student activity—see Advanced Preparation)
- copy of *Water on Tap* by EPA (on MEECS Water Quality CD-ROM or see Additional Resources)
- *Water on Tap Questions* (student assessment)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (Powerpoint: Lesson 6 Overview, *Water on Tap* (EPA) *Understanding Water Sample Results* (MEHA), City of Houghton Water Quality Consumer Confidence Report, *Nitrate in Drinking Water*, Project WET Curriculum & Activity Guide: *Poison Pump* activity)

To be supplied by the teacher

per class

- bar or meter stick
- red food coloring
- 3 cups of water (add sand and vinegar)

per small group

- 4-oz. cup labeled *well water*
- 4-oz. cup labeled *rinse water*
- 1 clear, plastic *Chemplate*[®] or white ice cube tray with cups numbered from 1-9
- white sheet of paper to place under *Chemplates*[®]
- 2 water droppers
- paper towel
- calculator

Lesson 7. How Healthy Is This Stream?

Reproducible materials

per class

- *Comparison of Two Streams* (on MEECS Water Quality CD-ROM)
- *Designing A Stream Monitoring Investigation* 15-minute PowerPoint (on MEECS Water Quality CD-ROM)
- *Designing A Stream Investigation* (answer key)
- *Aquatic Food Chain in a Stream* (transparency master)
- *Where Should the Brook Trout Be Planted? Stream Assessment Data Table* (answer key)
- *Hart Middle School Students: First Responders to Erosion Mishap* (answer key)
- sample *Stream Health* concept map
- *Biological Assessment Data Form* (transparency master)
- *Stream Habitat Assessment Form* (transparency master)
- *Habitat Assessment* PowerPoint (on MEECS Water Quality CD-ROM) (optional)
- *Macroinvertebrate Identification* PowerPoint (on MEECS Water Quality CD-ROM) (optional)
- *Hart Middle School Students: First Responders to Erosion Mishap* photos (on MEECS Water Quality CD-ROM)

per small group

- Page with color photo of each river: Clinton River, Coles Creek, Gilkey Creek, and Au Sable River (on MEECS Water Quality CD-ROM)

per student

- Background Information/Student Reading
- *Designing a Stream Investigation* (student activity)
- *Where Should the Brook Trout Be Planted* Student Packet containing:
 - *Where Should the Brook Trout Be Planted?* instructions
 - Stream Assessment Data Table
 - Data page for each stream: Au Sable River, Clinton River, Coles Creek, Gilkey Creek
 - Stream Ecology: Temp/pH/DO
 - Biological Assessment Data Form
 - Stream Habitat Assessment Form
- *Who Is Protecting Michigan's Rivers and Streams?* (student activity)
- *Hart Middle School Students: First Responders to Erosion Mishap* (student assessment)
- *Stream Health* concept map (student activity)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (*Comparison of Two Streams*, Powerpoints: *Designing a Stream Investigation*, *Macroinvertebrate Identification*, *Habitat Assessment*; Michigan Frog & Toad Calling Survey; Michigan Frog & Toad Deformity Survey; Extension Lesson *Developing A Watershed Assessment*; Stream Monitoring Field Forms – biological assessment, water chemistry, physical channel measurements, habitat assessment, stream comparison forms; Project WET Curriculum & Activity Guide: *Sum of the Parts* activity; page with color photo of four rivers, Hart Middle School Stoney Creek photos)

To be supplied by the teacher

per class

- balance (optional)
- 1 gram weight per student (optional)
- computer projector
- samples of live or preserved benthic macroinvertebrates (optional)
- *Aquatic Invertebrates & Water Quality* video (optional)

Lesson 8. How Can We Stop Storm Water?

Reproducible materials

per class

- *Storm Water* PowerPoint presentation OR *After the Storm* video (22 minutes)
- *Storm Water Study Guide* (answer key)
- *Storm Water Runoff and Infiltration* (transparency master)
- *Comparing Aerial Photos* (answer key)

per small group

- 2 aerial photos of the Huron Creek Watershed for 1975 and 1997 (on MEECS Water Quality CD-ROM) OR 2 aerial photos of your watershed for two different years (optional)
- *Comparing Aerial Photos* (student activity)

per student

- Background Information and/or *Potential Impacts of Storm Water on Aquatic Ecosystems* (student resource)
- *Storm Water Study Guide* (student activity)
- Brochure Assignment (student assessment)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (Powerpoint: *Run-Away Storm Water*; Huron Creek aerial photos for 1975 and 1997; Extension Lesson: *Measuring Watershed Runoff at Your School*)
- Huron Creek Watershed aerial photos for 1975 and 1997
- *After the Storm* video

To be supplied by the teacher

per class

- toy car
- pet leash
- snow shovel
- small houses from Monopoly®
- fast food bag
- plastic turf or golf ball
- paint brush
- car “soft cloth”
- packet of seeds
- toy bulldozer
- toilet paper
- computer projector

per small group

- paper and colored pencils OR computers

Lesson 9. Bioaccumulation and the Great Lakes Ecosystem

Reproducible materials

per class

- *A Lake Trout Food Web in the Upper Great Lakes* (transparency master)
- *Bioaccumulation of Contaminants in the Great Lakes Food Chain* (transparency master)
- *Bioaccumulation in the Great Lakes* PowerPoint (on MEECS Water Quality CD-ROM)
- *Toxic Tag* (transparency master)
- *Contamination in the Great Lakes* (answer key)
- *Great Lakes Watershed and Political Boundaries* (transparency master from Lesson 3)
- *Maximum Contaminant Level in Drinking Water* (transparency master from Lesson 6)

per small group

- Optional student resources (see Advanced Preparation)

per student

- *Contaminants of Concern in Fish of the Great Lakes* (student resource)
- *Contamination in the Great Lakes* (student activity)

Materials in MEECS kit

per class

- MEECS Water Quality CD-ROM (Powerpoints: *Bioaccumulation of Toxins in the Great Lakes*, *Emerging Contaminants in the Great Lakes* by Dr. Peter Adriaens; Extension Lesson *Investigate a Great Lakes Issue*; *Understanding Lake Data* by UW Extension; *Our Great Lakes Report*; *Michigan Family Fish Consumption Guide 2004*)
- *Life of the Lakes* posters from Michigan Sea Grant

per small group

- Michigan highway map
- *Michigan Water World* poster – teacher should laminate these before using

To be supplied by the teacher

per class

- computer projector
- small squares of paper or poker chips to represent toxic chemicals: at least five food squares per student, mark 1/3 of food squares with an X to designate toxic chemicals
- *Michigan Family Fish Consumption Guide 2004*

per small group

- washable markers or dot stickers (4 colors: orange, purple, brown, green)

per student

- small plastic bag
- student journals or notebooks

Michigan Content Standards and Benchmarks Correlations for Water Quality Unit

X - Addresses/Supports

	1. Where Is All the Water in the World?	2. How We Use Water	3. Do You Know YOUR Watershed?	4. How Do Land Uses Affect Water Quality?	5. Why Care About Groundwater?	6. Would You Drink This Water?	7. How Healthy Is This Stream?	8. How Can We Stop Storm Water?	9. Bioaccumulation and the Great Lakes Ecosystem
Science	Middle School								
	I.1.MS.1 Generate scientific questions about the world based on observation.	X			X	X	X		
	I.1.MS.2 Design and conduct scientific investigations.						X		
	I.1.MS.3 Use tools and equipment appropriate to scientific investigations.						X		
	I.1.MS.5 Use sources of information in support of scientific investigations.						X		X
	II.1.MS.5 Develop an awareness of and sensitivity to the natural world.						X		
	III.2.MS.1 Compare and classify organisms into major groups on the basis of their structure.						X		
	III.5.MS.3 Predict effects of changes in one population in a food web on other populations.								X
	III.5.MS.6 Describe ways in which humans alter the environment.		X	X	X	X	X	X	X
	V.1.MS.1 Describe and identify surface features using maps.			X					
	V.2.MS.1 Use maps of the Earth to locate water in its various forms and describe conditions under which they exist.	X							
	V.2.MS.2 Describe how surface water in Michigan reaches the ocean and returns.	X							
	V.2.MS.3 Explain how water exists below the Earth's surface and how it is replenished.	X				X			
	V.2.MS.4 Describe the origins of pollution in the hydrosphere.				X	X		X	X
	V.3.MS.3 Explain the behavior of water in the atmosphere.	X							
	V.3.MS.4 Describe health effects of polluted air (and water).						X		
	High School								
III.5.HS.4 Describe responses of an ecosystem to events that cause it to change.								X	
III.5.HS.6 Explain the effects of agriculture and urban development on selected ecosystems.				X				X	
IV.1.HS.1 Analyze properties of common household and agricultural material in terms of risk/benefit balance				X					
V.2.HS.1 Identify and describe regional watersheds.			X						
V.2.HS.2 Describe how human activities affect the quality of water in the hydrosphere.				X			X		
V.3.HS.4 Explain the impact of human activities on the atmosphere and explain ways that individual and society can reduce pollution								X	
Middle School									
I.1.MS.3 Select a contemporary condition and trace some of the major historical origins.						X			
II.2.MS.1 Locate, describe, and compare the ecosystems, resources, and human environment interaction of major regions.	X	X							
II.2.MS.4 Explain how humans modify the environment and describe some of the possible consequences of those modifications.			X	X	X		X	X	X
II.2.MS.5 Describe the consequences of human/environment interactions in several different types of environments.			X		X				
II.5.MS.3 Explain how elements of the physical geography, culture, and history of a region may be influencing current events.	X	X							
III.1.MS.3 Explain how the rule of law protects individual rights and serves the common good.						X			
IV.1.MS.1 Use economic reasoning when comparing price, quality, and features of goods and services.		X							
IV.2.MS.2 Compare various methods for production and distribution of goods and services.		X							
V.1.MS.3 Interpret social science information about the natural environment and cultures of countries from a variety of primary and secondary sources.		X							
VII.1.MS.2 Engage in activities intended to contribute to solving a national or international problem they have studied.		X							
High School									
II.4.HS.3 Explain how processes like population growth, economic development, urbanization, resource use, international trade, global communication and environmental impact are affecting different world regions.		X							

Social Studies

The *Water Quality Unit* addresses the following “Big Ideas” or “Enduring Understandings:” Upon completion of the unit, students will understand that:

1. (Awareness) Good quality water and an adequate supply of water are essential to Michigan’s communities and to our quality of life.
2. (Connections) All Michigan residents live in a watershed that is part of the Great Lakes watershed, a unique global resource of unprecedented importance to Michigan, the United States and the world.
3. (Concern) Our activities have past, present, and future impacts on Michigan’s water resources.
4. (Knowledge) Water quality standards have been established to protect the many uses of Michigan’s water.
5. (Knowledge) We can assess the health and water quality of Michigan’s streams, rivers, lakes, and groundwater by collecting and analyzing appropriate data.
6. (Knowledge) We need to know where our drinking water comes from and where our wastewater goes.
7. (Decision-making) We need data to make decisions about protecting and restoring Michigan’s water resources.
8. (Stewardship and sustainability) It is up to every citizen to be a steward of Michigan’s water resources.