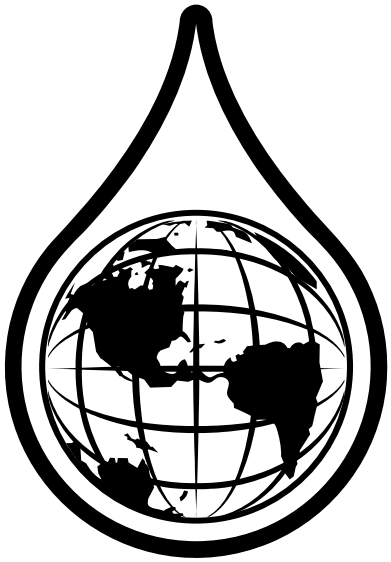
Water for



People and the Planet

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Water for People and the Planet is a high school curriculum unit developed to help students understand where our water comes from and where it goes. This inquiry unit focuses on the connections between groundwater and watershed systems. Lessons are designed for students in general-level science courses who typically have limited interest in learning science. Lessons are intended to help students connect big ideas in science to their own lives and see the relevance and importance of learning science. Included within the unit are connections to personal water use; a recent Mid-Michigan urban flooding event; an exploration of a groundwater pollution case in Battle Creek, Michigan, which contaminated the municipal groundwater supply; and investigations of water supplies and water treatment facilities.

This unit follows a general inquiry and application model. Lessons use a general approach that 1) establishes a problem/purpose, 2) develops a model and provides experiences using the model, 3) provides data for finding patterns, 4) allows students to develop explanations, 5) and applies learning to new situations. Student materials support student small group cooperation, conversations, and co-construction of understanding.

Teacher materials provide embedded assessment scaffolds to help teachers assess how well students are progressing towards the learning goals and suggestions for what to do next in helping students revise their initial ideas about important concepts. A pre-post test and a culminating authentic assessment activity are also included.

General Features of each Lesson

1. Teacher Resources
   - A. Learning goals – Provides the teacher with an overview of what students should know and be able to do after completing the lesson. Learning goals are divided into
     1. Knowledge statements – Connected to major standards documents (Benchmarks for Science Literacy and the National Science Education Standards) and local documents (Michigan Curriculum Framework, Lansing Pacing Guide)
     2. Objectives – Explain what students should be able to do using the knowledge in the knowledge statements.
     3. Assessments – Provide the context in which students use the knowledge and objectives within the unit.
   - B. Lesson Purpose – Explains the purpose of the lesson, how the lesson fits into the instructional approach and sequence, and provides an overview of the lesson activities.
   - C. Lesson Overview Table– Detailed table that provides a list of the main activities, their function, and a brief description of each activity.
   - D. Preconceptions Table – Identifies common student preconceptions related to the lesson, the goal conception for students when they complete the lesson, a list of activities that help address the listed preconceptions, and a note to the teacher on what to emphasize within the activities to address the preconception.
   - E. Materials Table – Lists the materials needed for each activity.
   - F. Activity Descriptions
     1. Estimated Time
     2. Function/Rationale – Explains how the activity fits into the activity sequence of the lesson.
     3. Directions – Provides step-by-step directions for the activity
     4. Group Suggestions – Provides tips or suggestions for guiding student small group activity.
     5. Embedded Assessments – Provides hints on what to look for in student work and talk to assess how well students are progressing towards achieving the learning goal. Also provides hints on how to proceed if students are not making expected progress.
   - G. Journal Questions – Each lesson begins with questions that the teacher can use at the beginning of each day of instruction to connect the day's activities to previous days of instruction. Teachers have flexibility in how they use journal questions as whole class discussion starters, embedded assessment, or small group conversation ideas.
   - H. RT Activities – Re-Teach Activities are provided as additional activities that teachers can include if students are not making expected progress towards the learning goals.
   - I. Overhead Masters – Can be photocopied onto overhead transparencies.
2. Student Resources – Student activity guides for each activity.

A. Purpose – Explains the purpose of each activity to the students in a motivating and comprehensible manner.
B. Directions for Activities – Provide detailed directions for individual and small group activities.
C. Questions – Provide tasks and questions to guide student reasoning and thinking related to the learning goal.
D. Small Group Scaffolds – Tables and charts to help students develop the practices necessary to work together in small groups to accomplish group tasks. These scaffolds encourage individual accountability as well as opportunities for group synthesis of ideas. Students are also encouraged to reflect on their own participation in the group and set goals for their group achievement.

3. Assessments
   A. Embedded assessments are outlined in detail in the teacher resources pages for lessons 3, 4, & 5.
   B. A Pre-Post test is provided that addresses the main learning goals.
   C. The Salt Activity Assessment is an authentic assessment designed to provide students the opportunity to demonstrate both their understanding related to the learning goals and their ability to work as a small group to develop a solution to a surface and groundwater pollution problem.

Learning Goals

Big Idea #1: All life depends on water.
Driving Question: Why Is Water Important to You?

Learning Goal (Knowledge)	Objective (Doing)	Context (Assessment)
Humans rely on water for a variety of uses, including personal use (drinking, washing, waste disposal), food production, manufacturing, and recreation. (4BM6-8 #8 p. 69; NSES 9-12F3a, p. 198) People from different cultures use different amounts of water. (NSES 9-12F3b, p. 198). The Earth is three-fourths water, but only a very small portion is fresh and useable by humans. (4BM6-8 #8 p. 68-69).	O1a Recognize many of the ways that people use water in their everyday lives. (reflecting) O1b Recognize that people from different cultures use water differently (amounts and use). (reflecting) O2 - Recognize that the amount of useable freshwater on Earth is minimal and limited. (reflecting)	A1 Analyze how much water you use daily. A2 Compare your use to people from other cultures.

Big Idea #2: There is a limited supply of fresh water.
Driving Question: Where Does Water Come From & Where Does It Go?

Learning Goal (Knowledge)	Objective (Doing)	Context (Assessment)
The water falling on the land either runs-off into the surface watershed or infiltrates into the groundwater system. (BM4B6-8#7; NSESD5-8SES#6; MCF (EAW) V.3MS3, (EH)V.2MS2, (EH) V.2MS3) Watersheds and the ground water system are interconnected. (MCF(EH) V.2MS3) Watersheds: The watershed is defined as all of the land area, including the lakes, rivers, and wetlands that drains water into a particular body of water. (MEGOSE HS8, MCF(EH) V.2MS3) Groundwater: The groundwater system includes aquifers (rocks formations from which water can be withdrawn for use), springs, and the water table. Water moves underground through pore spaces and cracks	O3 Use an understanding of watersheds to explain how water moves through river systems. (using) O4 Apply an understanding of permeability to explain the movements of groundwater through confined and unconfined aquifers. (using) O5 Develop/build models that explain how water moves	A3 Given a map of Michigan, explain how a pollutant would affect different locations. A4 Given a stratigraphic cross-section of a groundwater system, explain how a pollutant will affect different aquifers and wells. A5 Build a model and explain the movement of water through a watershed and through a

in rocks and soil. (MCF(EH) V.2MS3) A variety of factors affect aquifer/groundwater system characteristics, including rock/sediment type, permeability, depth, and thickness. Aquifers can be either confined (bounded above by impermeable layers) or unconfined (unbounded). Engineered System: Both surface water and groundwater systems provide water for humans. Surface water can be pumped directly from rivers and lakes. Groundwater can be pumped from aquifers via wells. The water is treated, and piped to houses and businesses for use. Wastewater is cleaned and returned to the watershed. (LPG)	through a groundwater system and watershed (constructing). O6 Explain how water cycles through the natural and engineered systems (telling the story)	groundwater model. A5-6 Develop a drawing to explain where the water you use in your house comes from, how water gets to your house and where it goes when it leaves. A6 Explain how one community's wastewater (treated or untreated) could be the source of another community's drinking water.

Big Idea #3*:* Human actions can both negatively and positively affect the quality and quantity of the water supply.

Driving questions: What are some ways that humans pollute the water? What are some ways that humans and nature can clean-up water?

Learning Goal (Knowledge)	**Objective (Doing)**	**Context (Assessment)**
While groundwater and surface water can be of either high or low quality, human actions can either pollute or enhance the quality of the water supply (4BM6-8 #8 p. 69; NSES 9-12F4ap. 198). Natural processes can pollute water, and nature has some ways of cleaning up pollution (NSES 9-12F4b, c p. 198). Many of these processes are active in wetlands. Human-caused pollution can easily overwhelm wetland processes. Humans have developed some ways to clean-up some pollution; some of these techniques are similar to natural clean-up processes. Human drinking water and wastewater treatment plants utilize processes that are similar to clean-up processes that occur in wetlands (LPG). However, most human techniques for cleaning up pollution are difficult and expensive. Prevention of human-caused pollution is the most effective way to protect water resources.	O7 Build/develop a model to investigate different sources for and methods for cleaning up groundwater pollution. (constructing) O8 Evaluate land use scenarios for potential groundwater and surface water pollution sources and impacts. (reflecting) O9a Compare the processes that take place in drinking water and wastewater treatment plant with natural water clean-up processes (using). O9b Explain why water treatment plants are necessary. (using)	A7 Present a model and describe the source of pollution and clean-up method used. A8a Given photos/maps of a given land use situation, identify the potential pollution sources and their impacts. A8b Given several land use proposals for a specific location, explain the impacts of the proposed action on runoff and infiltration. A9 Develop a concept map/mind map of a wastewater treatment plant and explain how the plant uses clean-up processes for similar to natural processes.

Big Idea #4: Humans must use scientific knowledge to make responsible and accountable decisions about water use in order to maintain a quality water supply for people and the planet.
Driving question: Once it is gone, is it really gone?

Learning Goal (Knowledge)	Objective (Doing)	Context (Assessment)
Renewable/Nonrenewable: Depending on the type and rate of use, water can either be a renewable, re-useable, or nonrenewable resource. (NSES 9-12F42 p. 198; LPG) Humans need to take action to protect the water supply. Decisions about the water supply should consider • Data & evidence • Cost/benefits • Bias & perspective	O10 Analyze water use situations to distinguish ways in which water is renewable, re-useable, and non-renewable (using).	A10 Given different water use situations, explain whether the water is renewable, non-renewable, or re-useable.

BM = Benchmarks for Science Literacy
NSES = National Science Education Standards
MCF = Michigan Curriculum Framework
LPG = Lansing Pacing Guide

Overarching Practices
1 Use model based reasoning to compare and contrast a model of phenomenon to real situations.
2 Make sound interpretations of data and experiences.
3 Compare and contrast issues relating to water supply in other parts of the state/world with local and regional water supply issues.
4 Read nonfiction text for information and understanding.
5 Develop shared understanding through small and large group discussions.

Unit Overview

Lesson #: Lesson Title	Description/Purpose	Activity Sequence	Approximate Time	Day#	Total Days
1: Water is a Finite Resource	This lesson introduces the unit, and establishes the purpose for studying about water resources	1.1 Daily Journals	10 minutes each day	1	1.5
		1.2 Calculate your personal water use	20-30 minutes		
		1.3 Compare your water use with other cultures	20-30 minutes		
		1.4 The Earth's water	20 minutes	2	
		1.5 Putting it all together	15 minutes		
2: The Engineered System	This lesson provides the context for all future lessons. It establishes the big picture of the surface water system, the groundwater system, and their connections to where we get our water and where it goes.	2.1 Daily Journals	10 minutes each day		1.5
		2.2 Why do we care where water comes from?	10 minutes		
		2.3 The Water Works	15 minutes	3	
		2.4 Where does it come from and where does it go?	15 minutes		

		2.5 (optional) Other systems	10-15 minutes		
		2.6 Closing Questions	5 - 10 minutes		

Lesson #: Lesson Title	**Description/Purpose**	**Activity Sequence**	**Approximate Time**	**Day#**	**Total Days**
3: Groundwater	This lessons looks specifically at the groundwater system	3.1 Journals	10 Minutes each day	4	5
		3.2 What does water look like underground	10 Minutes		
		3.3 Permeability	10-15 Minutes		
		3.4 Aquifers – What are they?	5 Minutes		
		3.4RT – Soak some rocks	15 Minutes on each of 2 days		
		3.5 Building groundwater models	30 Minutes	5	
		3.6 Exploring the groundwater model	15-30 Minutes		
		3.7 Where would you put a well?	20 Minutes	6	
		3.8 What does it look like under Lansing? Well log cross-section	50 Minutes	6&7	
		3.9 Follow a Water Molecule	20-30 Minutes	8	
		3.9RT Tracing Water Paths in groundwater Models	15 Minutes		
		3.10 Surface water or ground water?	15-20 Minutes		
		3.11 Finish T-Chart	10 Minutes		

Lesson #: Lesson Title	Description/Purpose	Activity Sequence	Approximate Time	Day#	Total Days
4: Watersheds	This lesson looks specifically at the surface water system (watersheds) and introduces pollution in watersheds	4.1 Journals	10 Minutes each day	9	5
		4.2 May 2004 Flood	10-20 Minutes		
		4.3 Discussion of watersheds	10 Minutes		
		4.4 Make your own island	45 Minutes	9 & 10	
		4.5 RT Michigan Relief Map	10 Minutes		
		4.5 Make a Map of Your Island	20 Minutes	11	
		4.5 RT Island/Map Match-Up	20 Minutes		
		4.6 Michigan Watersheds	20-30 Minutes		
		4.7 Causes and Resolutions of Pollution Problems	10 Minutes	12	
		4.8 The flood at Cottonwood Flats	50-60 Minutes		
		4.9 The case of Shaker Heights	20 Minutes	12 & 13	
		4.9RT Concrete/Sand Demo	10 Minutes		
5: Groundwater Pollution	This lesson returns to the groundwater system. Students examine pollution in groundwater systems and the connection between groundwater and surface water systems.	5.1 Journals	10 Minutes each day	14	4.5 to 5
		5.2 Contaminate groundwater models	20-30 Minutes		
		5.3 Methods of clean-up	10 Minutes		
		5.4 Clean-up groundwater models	20-30 Minutes	15	
		5.5 Presentations	30 Minutes		
		5.6 Introduction to Verona Wells	20 Minutes	15 & 16	
		5.7 Verona Wells: Mapping the Problem	30 Minutes	16 & 17	
		5.8 Verona Wells Clean-up	20 Minutes		

Lesson #: Lesson Title	Description/Purpose	Activity Sequence	Approximate Time	Day#	Total Days
6: Water Treatment	This lesson looks at what we do with our water and how we clean it up.	6.1 Journals	10 Minutes each day	18	2.5 to 3
		6.2 What is in the water? Small Groups	10-15 Minutes		
		6.3 What is in the water? Large Group	10-15 Minutes		
		6.4 How does nature clean up water? (wetlands video)	15 - 20 Minutes		
		6.5 How do people clean-up water?	10 Minutes	19	
		6.6 Order the test tubes	10 Minutes		
		6.7 Treating Waste Water	45 minutes (30 minutes , Overnight, 15 minutes`		
		6.8 Bacteria & BOD	15 Minutes embedded in 6.7		
		6.9 Drinking water treatment	15-20 Minutes	20	
		6.10 Waste Water Treatment & Wetlands	20 Minutes		
7: Renewable & Re-useable	This lessons examines water as a finite but renewable and a re-useable resource	7.1 Journals	10 Minutes each day	20	2
		7.2 Defining Terms	10-20 Minutes		
		7.3 Renewable, re-useable and water	20 Minutes		
		7.4 Putting it together: Role Play	30 Minutes	22	
		7.5 At the Theater – Watch the Role Play	20 Minutes		
End of Unit Assessment: The Salt Problem	This problem synthesizes surface water, groundwater, pollution, and the engineered system	Students read maps and cross-sections to answer questions about a pollution case.	60 Minutes	23	1