The Hydrosphere, Water, and How We Use it

A Curriculum Unit for Fifth Grade,
aligned with the *Next Generation Science Standards*
(April 2013 edition)

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July 2014

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Unit Development and Acknowledgements

The organizational approach used in this unit is the Biological Sciences Curriculum Study (BSCS) 5E Instructional Model, which includes five phases of instruction: Engage, Explore, Explain, Elaborate and Evaluate. The National Science Teachers Association (NSTA) employed this model for the units showcased in a recent publication, *Science for the Next Generation*.

Teachers will note that this unit includes two parts. The first part, *Earth's Water and How We Use It*, explores Earth's systems and then focuses on water and the hydrologic systems of the planet. We explore human uses of water and measure water use in the school. The second part, *Water Conservation Engineering Design Challenge*, is an engineering design project where students develop their own approach to conserving water in their classroom or school. The two unit sections may be taught independently

There is a wealth of additional online educational materials related to water conservation education. I have referenced those that I found to be most useful for elementary educators, and encourage the reader to explore these for background information and extensions. Web URLs are imbedded in each Lesson where the site is integral to the plan. Additional web resources are listed in the Additional Resources section at the end of the unit.

The Hitchcock Center for the Environment gratefully acknowledges support received from the New England Environmental Education Alliance, in cooperation with the Massachusetts Environmental Education Society, through their United States Environmental Protection Agency Environmental Education Sub-Grants Program.

The author wishes to thank his colleagues at the Hitchcock Center for the Environment for their encouragement, inspiration, and collaborative spirit.

Funded in part through a grant from the New England Environmental Education Alliance in cooperation with the Massachusetts Environmental Education Society. Although the information in this document has been funded in part by the U.S. Environmental Protection Agency under assistance agreement number 96157901 to the New England Environmental Education Alliance, it may not necessarily reflect the views of the Agency and no official endorsement should be inferred.

Unit Summary

The unit begins with students viewing several videos of natural disasters and reflecting, through class discussion and in writing, on the major Earth systems (geosphere, hydrosphere, atmosphere and biosphere) that are involved in the disasters and how the systems interact. The unit then focuses on the hydrosphere and how we use water. Students research Earth's water: quantities, sources, locations, salt and fresh, and liquid and frozen. They investigate how they themselves get water, both at home and in school. They inventory how much water their classroom (or school) is currently using. They research ways that different people and societies get their water and the impacts that these systems are having on the planet.

In the Engineering Design portion of the unit students undertake a major design challenge, working in groups to design water conservation approaches, either a device, system, or education or behavior modification program for their classroom. Student groups share their designs with their classmates, revise them based on feedback, implement their inventions in the school, and track subsequent water use and any changes resulting from their designs. The unit closes with an opportunity for students to reflect on their experiences in water conservation and share what they have learned with their wider community. Teachers may choose to teach the unit without the engineering design challenge.

Unit Objectives

After completing this unit, students will be able to

- describe the Earth's 4 major systems, the geosphere, hydrosphere, atmosphere and biosphere, and give examples of what can happen when they interact.
- explain and demonstrate graphically that there is a limited amount of water on the planet and that much of it is unavailable for use by humans and other living things.
- create and evaluate two dimensional models of water on Earth.
- research and synthesize information about water use and conservation.
- give examples of how human uses of water are impacting natural systems around the globe, and explain how some of these uses have significant negative consequences for life.
- describe how people are doing things to reduce negative inputs to Earth's hydrosphere system.
- use engineering design practices to invent ways to reduce water consumption in their immediate world.
- understand that the engineering design process is creative and iterative, and that they can be engineers.

Performance Expectations

Earth and Space Sciences

5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere and/or atmosphere interact.

5-ESS2-2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Engineering, Technology and Applications of Science

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Create and revise simple models that represent events, scientific principles, and/or design solutions **Using Mathematics and Computational Thinking** • Measure and graph a variety of physical properties, including area and volume • Analyze data mathematically and/or use data to compare alternative design solutions **Obtaining, Evaluating, and Communicating Information** • Obtain information from media to explain phenomena an/or solutions to a design problem **Asking Questions and Defining Problems** • Define a simple design problem that can be solved through the development of an object, tool, process, or system and that includes several criteria for success and several constraints on materials, time and/or cost **Constructing Explanations and Designing Solutions** • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem • Evaluate ideas based on their scientific accuracy	**ESS2.A Earth Materials and Systems** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. **ESS2.C The Roles of Water in Earth's Surface Processes** • Nearly all of Earth's available water is in the oceans. Most fresh water is in glaciers or underground; Only a tiny fraction is in streams, lakes, wetlands and the atmosphere. **ESS3.C Human Impacts on Earth Systems** • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. Individuals and communities are doing things to help protect Earth's resources and environment **ETS1.A Defining and Delimiting Engineering Problems** • Possible engineering design solutions are limited by available materials and other resources (constraints). The success of a designed solution is determined by how well it meets the specifications of the problem (criteria). Different solutions can be compared based on how well they meet the specified criteria and how well each takes the constraints into account. **ETS1.B Developing Possible Solutions** • Initial research on a problem helps us understand what is needed • Testing a solution involves investigating how well it performs under a range of likely conditions. • Communicating with peers about proposed solutions can lead to improved designs. **ETS1.C Optimizing the Design Solution** • Different designs are tested to determine which one best solves the problem • Tests are designed to identify difficulties or failure points in designs and to indicate where improvements are needed.	**Scale, Proportion and Quantity** • Standard units are used to measure and describe physical quantities such as weight and volume **Systems and System Models** • A system can be described in terms of its components and their interactions. **Influence of Science, Engineering, and Technology on Society and the Natural World** • People's needs and wants change over time as do their demands for new and improved technologies • Engineers improve existing technologies or develop new ones to increase their benefits, decrease risks, and meet societal requirements. **Science Addresses Questions about the Natural and Material World** • Science findings are limited to questions that can be answered with empirical evidence

Common Core Standards Connections

<u>English Language Arts</u>
RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research

SL.5.5 Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes

<u>Mathematics</u>
M.2 Reason abstractly and quantitatively

MP.4 Model with mathematics

5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation

Unit Overview and Brief Descriptions of Lessons

Part 1: Earth's Water and How We Use It

ENGAGE
LESSON 1: Earth's Major Systems - Students view videos of several different natural disasters and write about them with the goal of understanding the 4 major Earth systems.

EXPLORE and EXPLAIN
LESSON 2: Water Distribution on Earth - Students learn about Earth's hydrosphere: where is water located? How much is there? How much of it is potable for humans?

ELABORATE
LESSON 3: Global Water Access and Use - Students explore, through media images and stories, how we get our water and how we use it in different cultures around the world and play an active, outdoor game carrying water as a simulation of the labor some people expend carrying water for their own use.

LESSON 4: Where do we get our water? - Students explore where we get our water both at school and at home.

LESSON 5: How Much Water Do We Use? - Students predict and measure how much water they use in their school. They graph water use and calculate the water used per day and per person.

EVALUATE
LESSON 6: Part 1: Summative Assessment – Students write about what they learned

Part 2: Water Conservation Engineering Design Challenge

EXPLAIN
LESSON 7: Getting Started – How Much Water Do We Use Now in Our Classroom? – Students figure out ways to track water use in their classroom.

EXPLORE and ELABORATE
LESSON 8: The Challenge - Students are challenged to invent ways to conserve water in their classroom or school.

LESSON 9: Water Conservation Design Process – Students work in design groups to invent an approach that they think will conserve water in their classroom.

LESSON 10: Student Design Presentations, Feedback and Revisions - Students present their designs to the class, receive peer feedback, and revise their designs.

Lesson 11: (Optional): Choosing Our Water Conservation Strategy(ies) - Teacher, or students, choose the water conservation approach(es) to be implemented.

LESSON 12: Water Conservation Projects: Implementation and Inventories – Student groups implement their water conservation approaches and monitor their success.

EVALUATE
LESSON 13: Water Conservation Review and Reflection – Students reflect on and write about their experiences with the design process and analyze and graph the results of their work.

LESSON 1: Earth's Major Systems *(3 Periods)*

Period 1: Full Class Video Viewing and Discussion
With your class view videos of several different kinds of natural disasters. See web links below. Following each video discuss what students have seen. What caused these natural disasters? Encourage students to think in terms of what systems are involved in each? The goal is to have the students become aware of and think about the 4 major systems of the planet: geosphere, atmosphere, hydrosphere and biosphere. Provide information about the 4 spheres if you feel your students need that (see *Lesson 1: Earth's Systems Information* reproducible sheet). In the disaster scenarios what systems are interacting? Did the atmosphere draw water from the hydrosphere to cause the heavy rains? Did the high-speed winds (atmosphere) destroy portions of the biosphere? Did the earthquake (geosphere) set up movement in the ocean (hydrosphere) causing the tsunami waves?

Period 2: What is a System?
Being able to examine the world through the lens of how a system works is important. Almost anything on the planet can be a system. *Systems thinking* is more a perspective, a way of seeing, than a *thing*. Discuss systems and how to think about them with your students.

Background Information on Systems

What is a system?
A system is a set of interacting parts and processes that form an integrated whole.

A system has:
- Structure – parts that are related to each other
- Behavior – processes that transform inputs into outputs
- Interconnectivity – parts and processes are connected

Questions about Systems
- What are the parts of the system?
- What are the inputs and outputs?
- What does the whole system do that the individual parts cannot do?
- How does energy, matter, and/or information flow through the system?

Use the accompanying *What is a System?* diagram to analyze a simple system with your class. Riding a bicycle could be a good choice. The second *What is a System*? diagram has been filled out using the example of riding a bicycle up a steep hill as the system. After students have filled out the chart for the bicycle have them fill out a blank chart using a system of their own choosing. Alternatively students could fill out the blank *What is a System?* diagram choosing one of the 4 Earth systems.

Period 3: Individual Write and Draw

Following the discussion of systems have students write about and draw a natural disaster of their choosing. Caution students to limit their consideration to natural disasters and to avoid human-made ones. Their writing will need to identify at least 2 of Earth's systems that are interacting and describe how they interact.

Resources:

On-line disaster video web sites:

Caution for Teachers
I have chosen these videos as appropriate for fifth graders, but please preview them yourself to be sure they are okay for your students. Natural disasters include graphic human impacts that may not be appropriate for your audience.

National Geographic footage of the 2011 earthquake and tsunami in Japan with good narration and some instructional imaging and geologic explanation, age appropriate http://www.youtube.com/watch?v=foxww-tMoNg (Length 3:35)

Footage of an earthquake in Christchurch, New Zealand showing cars vibrating and a building collapsing. http://www.youtube.com/watch?v=duoS7hwJlrU (Length 4:38)

Hurricane Sandy's Danger: Storm Surge – footage of the destructive power of the ocean during a hurricane, narration is slightly sensational but with a good message, sponsored by NOAA and the Smithsonian http://www.youtube.com/watch?v=AUveZWKyeyw (Length 2:36)

Footage of flash flooding in Toowoomba, Australia in 2011 with the rising waters sweeping away cars http://www.youtube.com/watch?v=kYUpkPTcqPY (Length 5:56)

Film of an avalance on Mt Cheget in Terskol in the republic of Kabardino-Balkaria in Russia http://www.youtube.com/watch?v=99j17GL3qlE (Length on 3:09)

Controlled avalanche at Stjernoy in Norway in April 2014 – shown engulfing a building although the outcome for the building is not shown. http://www.youtube.com/watch?v=dYx9wbCsl14 (Length 2:39)

Carload of young tornado chasers get awesome footage of a double tornado in Nebraska in June 2014; some foul language; no damage shown http://www.youtube.com/watch?v=RNq4WxuTUow (Length 8:37)

News coverage of the Moore tornado (EF5) in Newcastle, Oklahoma, May 20, 2013 as it formed and came into the city http://www.youtube.com/watch?v=0L-XExpb3pY (Length 10:37)

Resource Pages:

Lesson 1: Earth's Systems Information - explains the 4 systems: geosphere, hydrosphere, atmosphere, biosphere

What is a System? – 2 diagrams that provide a way to visualize a system. One diagram has been filled out using the act of riding a bicycle up a hill as the system. The other one is blank and can be filled out by students.

Next Generation Science Standards **Performance Expectations:** 5-ESS2-1 **Science and Engineering Practices:** Developing and Using Models; Obtaining, Evaluating, and Communicating Information **Disciplinary Core Ideas:** ESS2.A, ESS2.C **Crosscutting Concepts:** Systems and System Models

Lesson 1: Earth's Systems Information

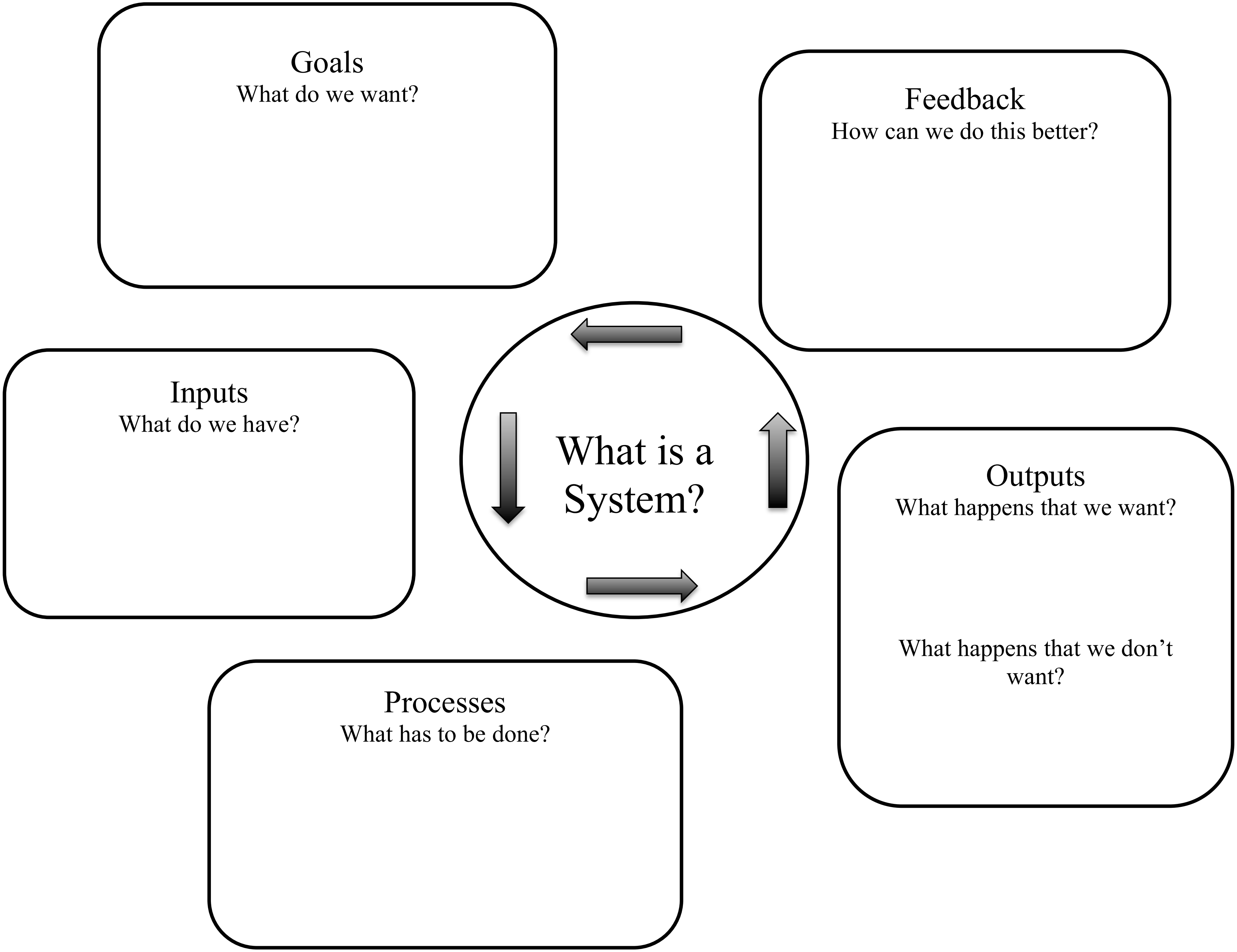
There are 4 major systems that influence how the planet Earth functions and supports life. Here are the 4 systems:

- Geosphere – solid parts of the Earth, including soil, solid and molten rock, sediments, sand, clay

- Hydrosphere – water on Earth including liquid water, ice and water vapor

- Atmosphere – air and gases

- Biosphere – living things, including humans plants and animals, fungi, bacteria


Goals
What do we want?
Feedback
How can we do this better?
Inputs
What do we have?
What is a System?
Outputs
What happens that we want?
What happens that we don't want?
Processes
What has to be done?

What is a System?

Goals
What do we want?

To ride our bicycle up a steep hill

Feedback
How can we do this better?

Gears help get up a hill without getting as tired. Get a bicycle with lower gears. Get a lighter bicycle.

Ride on smoother pavement.

Know how to change a flat tire.

Inputs
What do we have?

Pedals and Crank Shaft, Gears,
Chain, Wheels with Tires
Legs, Human Energy
Blacktop Road, Concrete Sidewalk

Outputs
What happens that we want?

We get to ride to the top of the hill faster than walking.

What happens that we don't want?

We get tired.

We could get a flat tire.

Processes
What has to be done?

Use our leg muscles to turn the pedals to move the wheels forward over the pavement to the top of the hill.

LESSON 2: Water Distribution on Earth *(4 Periods)*

Period 1: Full Class Brainstorm and Discussion
Start by giving students an opportunity to share what they already know about Earth's hydrosphere. Where is water located? How much is there? How much of it is potable for humans? Examine the globe and/or world maps to see locations of water in different forms.

Pre-Assessment: Individual Writing
After the discussion instruct students to make written predictions about water on the planet. Optional writing prompt: *Where do you predict water can be found on Earth? Where is most of Earth's water located? How much is salt and how much is fresh? How much is frozen and how much is liquid?*

Periods 2 & 3: Student Individual or Small Group Research and Work Time
After students have made their predictions provide resources (see handouts, and internet sites) for them to research the quantities of water on the planet and where the water is located – oceans, glaciers, freshwater lakes, atmosphere, groundwater…. Instruct the students to summarize their findings in the form of bar graphs. Allow students the freedom to set up their graphs as they think makes the best graphic sense. Discuss the possibilities for how the graphs could look and allow several students to share their ideas for how they want to portray the information they have discovered.

> *EXTENSION LESSON E1: Review the Water Cycle*
> Students should understand the water cycle and the fact that the amount of water on the planet is stable – there will never be more or less than there is today.

Period 4: Full Class Sharing and Discussion
Provide a time for students to share their graphs and for the class to discuss the information portrayed as well as any differences in the information that the students found.

Formative Assessment
Collect students' graphs to see how they have summarized their data.

Resources for distribution of water on Earth:

United States Geologic Survey site – scroll down for a detailed and complete table of where water is found on Earth http://ga.water.usgs.gov/edu/earthhowmuch.html

Fairfax County, Virginia Water Authority web page has a greatly simplified description of where water is found on Earth
http://www.fcwa.org/story_of_water/html/earth.htm

Wikipedia page with tons of information about where water is found on Earth, for advanced fifth graders http://en.wikipedia.org/wiki/Water_distribution_on_earth

How Stuff Works web page with a three paragraph description of where water is found on Earth – no charts or graphs http://science.howstuffworks.com/environmental/earth/geophysics/question157.htm

NASA site with interesting graphic representation of water available on Earth for human use http://pmm.nasa.gov/education/lesson-plans/freshwater-availability-classroom-activity

NASA Precipitation Education web site, scroll down for a very complete table of where water is found on the planet http://pmm.nasa.gov/education/articles/earth-observatory-water-cycle-overview

Next Generation Science Standards **Performance Expectations:** 5-ESS2-2 **Science and Engineering Practices:** Developing and Using Models; Using Mathematics and Computational Thinking; Obtaining, Evaluating and Communicating Information **Disciplinary Core Ideas:** ESS2.C **Crosscutting Concepts:** Scale, Proportion and Quantity, Science Addresses Questions about the Natural and Material World

LESSON 3: Global Water Access and Use *(2 Periods)*

Period 1: Full Class Book Reading
Now that we know the locations and amount of water on the planet lets see how we humans are using it. Together as a class, spend some time exploring, how water is accessed and used around the planet. Read *A Cool Drink of Water* (see reference below) to the class. If you have the capability, project the photos for the class to view because the photographs are what really bring the message to the reader. Where do we get our water? How do people in other cultures and parts of the world get their water? The idea is to start the students thinking about how we get our water both in our country and around the planet. One goal of this period is that students will begin to gain an awareness of how fortunate we are that most of us have good access to abundant, clean, healthy and relatively cheap water. This is an awareness that will develop further over the remainder of the unit.

Period 2: Full Class Active Outdoor Activity: The Village Well
This is an outdoor activity designed to simulate what it would be like to carry water for your and your family's use.
1. Choose a water spigot on the outside of your school building and designate it as the Village Well. This will be the source of water for the activity. If your school doesn't have a conveniently located outdoor spigot you will have to be creative and invent some kind of tub or reservoir to represent the village well. And arrange to fill it with water.
2. Divide students into teams of 3.
3. Explain to students that their task will be to carry enough water from the village well to their storage reservoir to meet the daily needs of everyone in their group. Each student will require 12 gallons of water per day. Have groups calculate how much water they will need to carry.
4. Assign each team a large tub, trashcan or other water tank to act as their group's water storage reservoir. These reservoirs should hold 36 gallons of water, should be scattered around the playing area, and all located equidistant from the village well.
5. Provide a variety of containers that student groups will use to carry water from the village well to their group's reservoir. These containers should hold between a half gallon and 2 gallons of water and should have a variety of shapes and sizes.
6. Allow the student groups time to examine the carrying containers. Instruct groups to discuss the variety of containers and choose one that they will use to carry water from the village well. Each group may choose only one container.
7. Before beginning be sure that all teams have free access to water from the Village Well. Their job is to transfer enough water to meet their group's needs from the Village Well to their storage reservoir in the shortest time. Emphasize that water is precious and groups must spill as little as possible. Consider adopting penalties for major spills.
8. At the agreed-upon starting signal groups begin to carry water to their group's storage reservoir. They need to provide enough water for all of their group members for one day. When a group thinks they have carried enough water for their team they sit down.
9. Record the order in which the teams sit down.
10. When all groups are sitting down then the volume of water in their storage reservoirs needs to be measured to be sure that they carried enough water.

11. Provide groups with measuring containers. Have them measure the amount of water in their reservoirs and calculate the number of gallons.
12. Each group must show their calculations to confirm how much water they have carried.
13. The winning team is the first team that carried an adequate volume of water to meet their team members' needs.

Warning to Teachers

This activity is tons of fun! And it does give a real, physicalized idea of what it would be like to carry water for your own use. However, students will get very wet! You may want to schedule this lesson at the end of the school day. And warn parents; and ask the students to bring in changes of clothes and shoes.

EXTENSION LESSON E2: More About Water Use Around the World

If your students seem very curious about other cultures and their water supplies there are some good videos that can give them more information. See Extension Lesson E2 at the end of this unit.

INTERESTING FACT – in cultures where people have to carry water for their own use, each person uses on average 12 gallons of water per day. In the US average water use per person per day is 60 gallons.

Home Project: Student Free Write

Have students respond to the writing prompt: *What did you learn today about how we humans get our water and how we use water?*

Resource for human access and use of water:

Student book of photographs – Barbara Kerley's *A Cool Drink of Water* is a beautiful National Geographic Society photographic essay of how people in different cultures get their water.

Next Generation Science Standards

Performance Expectations: 3-5-ETS1-1

Science and Engineering Practices: Using Mathematics and Computational Thinking; Obtaining, Evaluating, and Communicating Information; Asking Questions and Defining Problems

Disciplinary Core Ideas: ESS3.C, ETS1.A

Crosscutting Concepts: Scale, Proportion and Quantity; Influence of Science, Engineering, and Technology on Society and the Natural World

LESSON 4: Where do we get our water? *(2-3 Periods)*

Period 1: Full Class Sharing, Discussion, and Brainstorm
Begin with students sharing, from their homework from Lesson 3, what they learned about global water use. Then move into exploring how we use water ourselves. Students brainstorm about where the school gets its water and where each of them gets water at home. What do students already know about this? Create a brainstorm list of students' thoughts. As the brainstorm continues bring back the *What is a System?* diagram from Lesson 1 to encourage students to think in terms of systems. Where do we get our water? What are the inputs needed for the system to work? What are the desired outcomes? Are there any parts of the system that need improvement?

Period 2: Guest Speaker (Optional)
Invite a representative from your local water agency to come into class and explain the city/town's water system – sources, transportation, treatment, quantities, wells, reservoirs…

> *EXTENSION LESSON E3: Understanding Your Water System*
> Depending on the time available have students work in groups to create diagrams/maps of your city/town's water system.

Period 3 (brief): Full Class Discussion and Home Research Project
Where do students get their water from at home? Municipal water supply? Does anyone get their water from a different source? Private wells? What does their water cost, either municipal or private well? Instruct students to discuss with their parents how their family gets their water. Students should fill in as much of the accompanying chart (*Lesson 4: Home Water Questionnaire)* as they can about where their family gets their water. And also, if possible, how much water their family uses and how much they pay for it. Estimating well and electricity costs will be difficult for families with private wells, so they will have to approximate as best they can.

Resource Pages:
What is a System? Diagram from Lesson 1
Student Handout: *Lesson 4: Home Water Questionnaire*

> **Next Generation Science Standards**
> **Performance Expectations:** 5-ESS3-1, 3-5-ETS1-1
> **Science and Engineering Practices:** Developing and Using Models; Using Mathematics and Computational Thinking; Obtaining, Evaluating, and Communicating Information
> **Disciplinary Core Ideas:** ESS3.C, ETS1.A
> **Crosscutting Concepts:** Scale, Proportion and Quantity; Systems and System Models; Influence of Science, Engineering, and Technology on Society and the Natural World

Name:____

Lesson 4: Home Water Questionnaire

What can you find out about the water you use at home? See how many of these questions you can answer with your family's help.

1. Where does your home water come from?

2. If you get your water from a water utility or district where do they get their water?

3. Do they have reservoirs or wells?

4. Where are the reservoirs or wells located?

5. How much water do you use at home?

6. Do you pay for your water?

7. If so, how much does your water cost?

8. If you don't pay a water bill are there any costs in getting your water?

9. If yes, what are the costs?

LESSON 5: How Much Water Do We Use?
(*4 periods plus recording school water use)*

Period 1: Discussion
Discuss the results of students' home water inventories. After the discussion, explain that our next task is to figure out how much water we use here in school. Encourage students to discuss and predict how much water their school uses.

Period 2: Full Class Learning
Ask your school custodian to show you where the school's water meter is located if your school has one. If your school doesn't have a water meter discuss with your custodian if there is a way to measure how much water the school uses. Either have the custodian teach the students how to read the meter or teach them yourself. See accompanying Resource Pages - *Lesson 5: Teacher Background Information: How to Read Your Water Meter* and *Lesson 5: How to Read Your Water Meter.*

It is important that students understand how to read the water meter. During the unit the water meter will be read regularly and data recorded in a format and location visible to the whole class. All students need to understand how to read the meter correctly. Choose student groups to record water meter readings each day during the water inventory period. Set a clear time span (of one week?) and carry out the inventory. Record daily water use each day for the week. (See *Lesson 5: Sample School Water Use Recording Chart)*

Period 3: Student Small Group Work
Student groups prepare graphs of the school water use data.
Instruct students to calculate the average water use by the whole school per day from their readings of the school's water meter. Also have them calculate how much water each person in the school uses per day. They will have to determine the school's population.

Period 4: Full Class Discussion and Free Write
Discuss the student graphs of their school water use. How much water does the class/school use per day? Per week? How much per person? Now let's compare the water that we use with other people. See Lesson 5 Resource Pages - *Lesson 5: Water Use Per Capita (per person) in the United States* and *Lesson 5: International Water Use Per Capita (per person)*

Per Capita Water Use
Share the accompanying charts of water use per person (per capita) with students. How do their calculations compare with other Americans? With those from other countries? Remember that their home water use is not included, right?

Formative Assessment: Individual Free Write
Instruct students to write in response to prompts such as: *Our school uses water for many purposes. How much water do we use for different jobs? How much water do we use? How much do we need? Does water get wasted in our school? How does this compare to water use in other countries?*

> *EXTENSION LESSON E4: Home Research Project*
> Using water at school is only one of the places where we use water. How much water do we each use if we think about what we do at home and other places. Try tracking your own individual total water use.

Resource Pages

Lesson 5: Sample School Water Use Recording Chart
Lesson 5: Teacher Background Information: How to Read Your Water Meter
Lesson 5: How to Read Your Water Meter
Lesson 5: Water Use Per Capita (per person) in the United States
Lesson 5: International Water Use Per Capita (per person)

> **Next Generation Science Standards**
> **Performance Expectations:** 3-5-ETS1-1
> **Science and Engineering Practices:** Developing and Using Models; Using Mathematics and Computational Thinking; Obtaining, Evaluating, and Communicating Information; Asking Questions and Defining Problems
> **Disciplinary Core Ideas:** ESS3.C, ETS1.A
> **Crosscutting Concepts:** Scale, Proportion and Quantity; Systems and System Models; Influence of Science, Engineering, and Technology on Society and the Natural World

Name:____

Lesson 5: Sample School Water Use Recording Chart

For our project we need to have a careful record of daily water use for our classroom or school. Fill out the chart below when you read the water meter for your school.

Date	Time	Meter Reading	Daily Water Use
			XXXXXXXXXXXXXXXXXXXXXXX

Lesson 5: Teacher Background Information: How to Read Your Water Meter

If you receive a monthly water bill for your individual residence, then your water usage is monitored by a water meter. A water meter is a simple device located on the main water supply for a property that tracks the volume of water that flows through the main into your home. This amount of water is recorded by your municipality in order to calculate your bill, but you can also read it yourself to help understand your own water usage. Learning how to read a water meter can provide important information about reducing your bills and water usage.

1. **Locate your water meter**. If you live in a single-family home, your meter box will likely be located in the front of your property near the street. The meter could be housed in a concrete box marked "water." If you live in an apartment or condominium, the water meters for your property will likely be located in a single room, often a utility room in the basement or ground level. If your water bill is included in the cost of your rent or home-owner's association dues, then your entire building is metered from a single meter.

2. **Remove the cover of the meter box if applicable**. If your water meter is housed in a concrete box, the cover should have several small holes in the top of it. Place a screwdriver in one of the holes and pry the cover off just enough to get your fingers under the edge. Carefully lift the cover off and set it aside.

3. **Lift the protective cap on the meter**. Many water meters will have a heavy metal cap over the dial to protect it from damage. Lift this cap on its hinge to expose the dial.

4. **Determine the current reading on the water meter**. On the face of the water meter, you will see a large dial and a series of numbers. The numbers represent the volume of water used by your household since the last time the meter was reset. The units for this measurement will be specified on the dial face; common units are gallons, liters, cubic

feet, and cubic meters. The dial itself rotates slowly with water consumption, and so isn't as useful for taking a reading.

5. **Determine the amount of water your household uses over a period of time**. To track your water usage, begin by writing down the reading on the meter. Wait a specified period of time (a full day or full week, for example), and then write down the new reading. Subtract the first reading from the second to determine how much water you used during that time period. If you are trying to reconcile your own readings with the figures on your water bill, remember that your municipality won't always take readings at the same time each month.

6. **Calculate the cost of your water usage**. If you want to calculate the cost of the water you use, you'll need to determine how the water is billed. Look at your water bill to determine the billing unit; this is usually bigger than the metered unit, and is commonly expressed as 100 gallons, 100 liters, or 100 cubic feet. The unit rate will be printed on your bill, which is the price paid per billing unit consumed. Convert your total water consumption into the billing unit, and then multiply by the billing rate to determine the cost of the water.

Taken from WikiHow http://www.wikihow.com/Read-a-Water-Meter

Lesson 5: How to Read Your Water Meter

A **water meter** measures the amount of water coming into your home. Your water meter may be located in your basement or outside in a pit or hole. A **meter reader** reads the water meter on a regular basis. The utility sends you a bill for the amount of water you use. The bill covers the costs of treating and distributing the water and paying the people who work to get clean water to your house. Sometimes a utility must buy water. All of these costs must be covered by users' water bills.

Water is a bargain. The average price of water in the United States is about $1.50 for 1,000 gallons. At that price, a gallon of water costs less than one penny. **How does that compare with other drinks?**

Here are images of two kinds of water meters used in North America.

The first water meter is read like a clock with six dials. Each dial gives the number for a different mathematical place in the total reading. The second water meter is read like a digital clock.

Water meters can measure in gallons, cubic feet, or cubic meters. The meters shown here are measuring in gallons.

Let's say the two water meter readings above are for the Smith family. The first water meter shows last month's reading. The second water meter shows the reading for this month.

How much water did the Smith family use in the last month? Show your math.

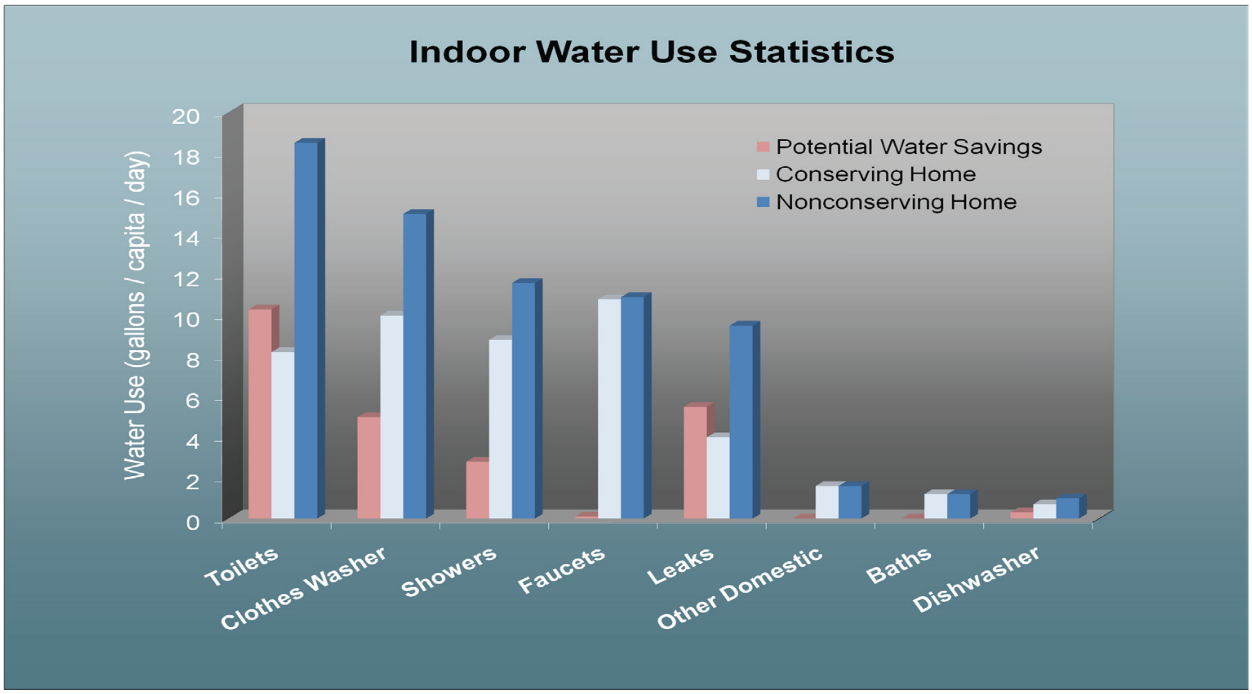
ANSWER

Subtract the first reading (7,654 gallons) from the second reading (10,664 gallons).

In one month they used 3,010 gallons of water.

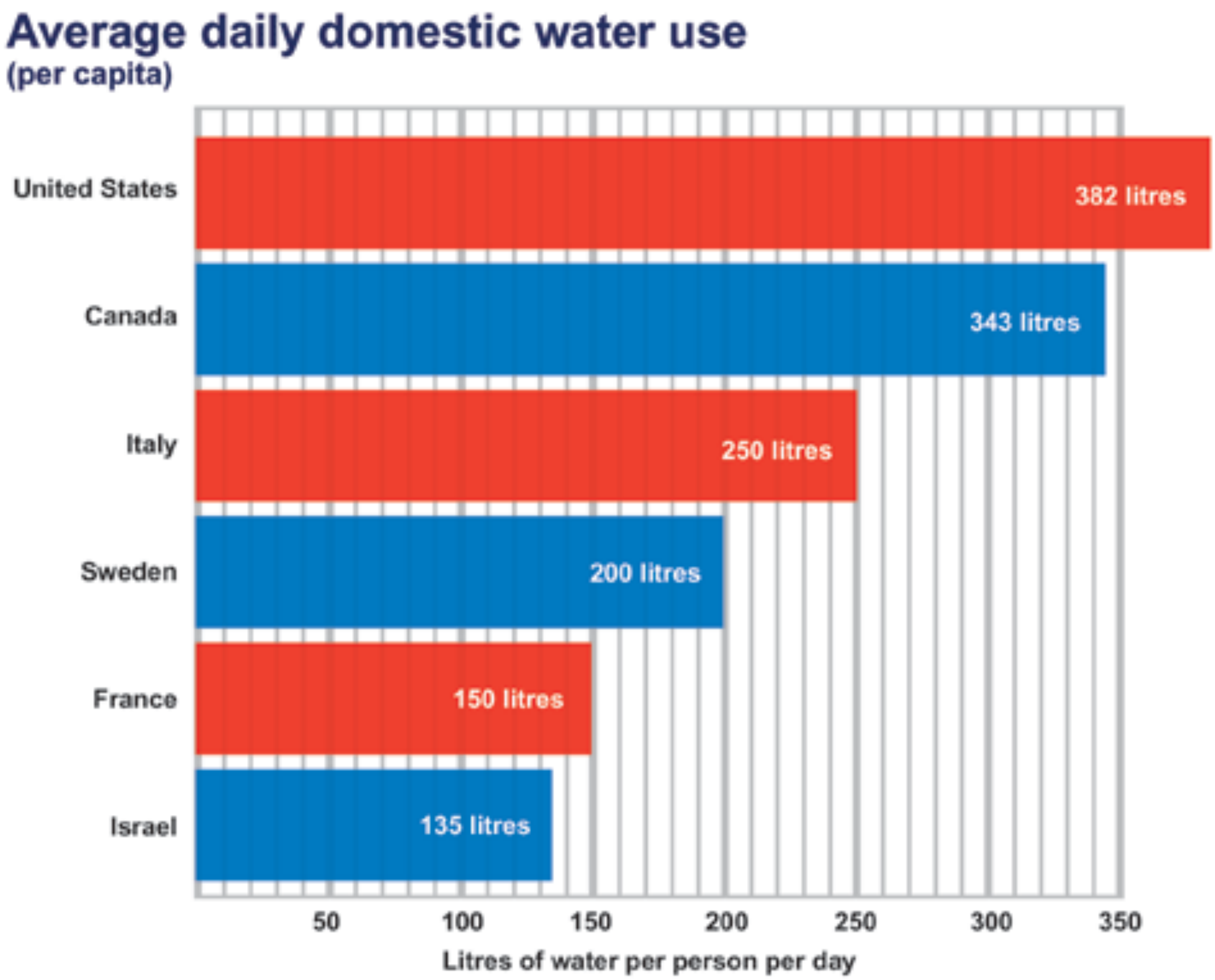
Lesson 5: Water Use Per Capita (per person) in the United States

A national residential indoor water use study completed in 2000 compared water use in non-conserving and conserving homes (U.S. General Accounting Office, 2000; Vickers, 2001). The national study revealed that indoor water use in a conserving home averaged 45.2 gallons per capita per day, while use in a non-conserving home is 69.3 gallons per capita per day. The distribution of and differences in water uses in a conserving versus non-conserving home are shown in the graph below. Taken from http://des.nh.gov/organization/divisions/water/dwgb/wrpp/documents/primer_chapter7.pdf



Lesson 5: International Water Use Per Capita (per person)

From an Environment Canada site
http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F25C70EC-1



Lesson 6: Unit Part 1 - Summative Assessment

Period 1: Individual Open Response Writing
Think about our study of water and Earth. And the ways in which people use water. What did you learn from our study?

1. In what ways is water part of the 4 major Earth systems?

2. Where is water found on the planet and in what different forms?

3. How do humans get and use water around the planet?

4. How much water do we use here in our school? And how does this compare to others' use of water?

Part 2: Water Conservation Engineering Design Challenge

Lesson 7: Getting Started – How Much Water Do We Use Now in Our Classroom? (*4 Periods plus on-going water use monitoring*)

Period 1: Full Class Discussion - figuring out current water use in the classroom
Now we know how much water is being used in our school. What about the water that we use ourselves, in our classroom and in other ways? Encourage students to predict how much water they use. How would we figure this out? What are the different ways we use water? (See *Lesson 7: Classroom Water Uses Chart*) Drinking, washing, using the toilet… When do we use water in the classroom? Outside the classroom? How would we keep track? Divide students up into working groups. Instruct groups to invent ways to inventory water uses by the students in their classroom. What ideas do they have? How would they track the water used? Have groups draw and write their ideas.

Period 2: Full Class Sharing and Discussion
Convene all the working groups back together. Have groups share their ideas with the full class. The class as a whole will choose the best ideas from the working groups and create a Classroom Water Use Inventory. Assign each working group one of the categories of water use. Each group will define and finalize how they will measure water use for their activity. Groups will need to include details on how they plan to measure water used in each of the various activities and a simple reliable way of tracking uses. As the water use unit continues students will take responsibility for measuring water use and tracking their findings. (Depending on your situation consider expanding the inventory to more of the school, including other classrooms, teacher's room, lunchroom...

Period 3: Student Small Group Water Inventories
Once the inventory procedures are agreed upon and established set a clear time span (of one week?) and carry out the inventory classroom-wide (or school-wide). Record daily water use each day for the week.

Ongoing: classroom water use monitoring and data recording
Record water use for a defined period (one week?) on a chart in the classroom.

Period 4: What Did We Find Out?
At the end of the week examine your data. What did you discover? How much water was used? Were there any problems with the data? With the methods for gathering information? What could make the data gathering even better? What is the per capita water use for the students in your class? What thoughts do students have about the idea of a single per capita number for water use? You may choose to have students graph the class's water use in any or all of the several forms discussed above.

Note to Teachers

One approach to determine how much water is used in a sink or a drinking fountain is to run the water into a container and time how long the faucet is on. Then measure the amount of water that accumulates in the container and calculate how much water runs out of the tap per second. Then whenever the tap is turned on, time how long it is turned on and then calculate the volume of water that came out. A great math integration!

Resource Pages

Lesson 7: Classroom Water Uses Chart

Lesson 7: Classroom Water Uses Chart

Water use	How many times per day?	How much water used each time?	Totals
Washing Hands			
Drinking water			
Flushing Toilet			
Flushing Urinal			
Others?			

Lesson 8: The Challenge (*3 Periods*)

Period 1: Water Conservation Design Challenge
Water is a limited resource. And it can be expensive. What can we do to reduce our own water use? Explain to the class that the remainder of this unit is an exercise in designing solutions to a specific human problem or challenge. Engineers, inventors and others use the engineering design process when they are trying to solve a problem. The process is creative and can be fun – like inventing something. Who has invented something before?

The accompanying diagram (*Lesson 8: Steps in the Engineering Design Process*) presents one approach to the steps in the design process. Go over the process with the class and discuss any questions they have. The iterative nature of the process is not natural and comfortable for most students. They will need support coming up with a variety of possible solutions and then evaluating the different ones. They will usually want to jump right to the first idea they think of. The challenge is for students to work in their small groups to come up with their idea of the best way of conserving water in their classroom. They can invent a gismo, install existing devices, create an educational campaign or a behavior change campaign, or try something else. It needs to be real and do-able given the time and resources available to the class.

Note to Teachers
Water conservation, while important, may not be the highest environmental concern in areas with plentiful rainfall and developed infrastructure. If this challenge doesn't grab you or your students, feel free to revise the challenge and find another that is more relevant. Puddles on the playground, roof runoff into storm sewers, soil erosion, or any number of other concerns may be more appropriate for your teaching setting. You can follow the process outlined in these lessons or consult other engineering design curricula. The Boston Museum of Science's *Engineering is Elementary* is an excellent series of curriculum units on engineering design for grades 1-5, 3-5, and 6-8. More information is at http://www.eie.org/ *Teach Engineering: Resources for K-12* is a web site loaded with activities and curriculum ideas. http://www.teachengineering.org/

Note to Teachers
Necessary Water Use and Wasting Water - Students could get carried away in their desire to reduce water use. So they stop washing their hands or decide to drink less water. Discuss this with students ahead of time so that they know that all needed uses of water are not to be restricted in any way. They will be focusing on situations where water is WASTED.

Period 2: Full Class Discussion and Creating a Rubric of Constraints and Criteria
Now before students divide up into design teams the entire class needs to decide and agree on the CONSTRAINTS and the CRITERIA that the inventions need to meet. This is like creating a rubric for a school project or setting goals for the inventions ahead of time. Being clear on these will help the class determine the success of their designs at the end of the project. Together the class generates the CONSTRAINTS and CRITERIA for the water

conservation designs. During the design process post these in a prominent place in the classroom.

Possible CRITERIA

- needs to reduce water consumption
- needs to have measurable results
- needs to describe in detail how the amount of water saved will be measured
- needs to be simple enough so that anyone in class can understand and do
- others?

Possible CONSTRAINTS

- needs to keep cost below $______
- needs to not be hazardous or dangerous to anyone
- cannot restrict anyone's access to necessary water use
- others?

Period 3: Full Class Modeling

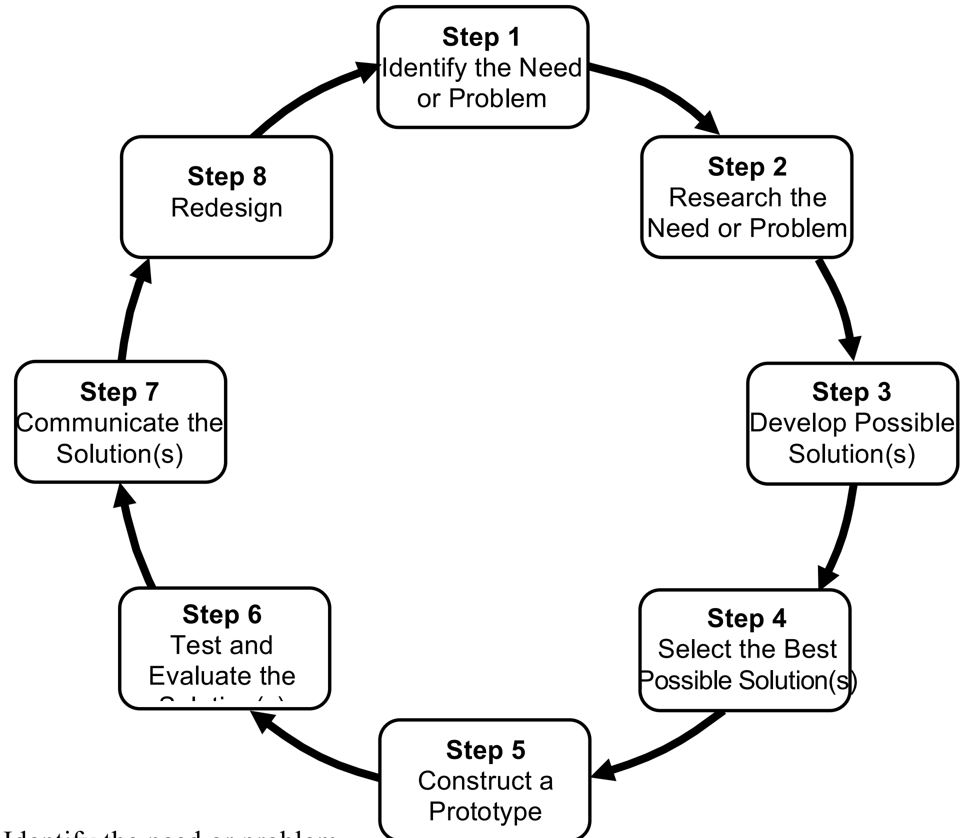
The complexity of this process and the probable lack of experience with it for most fifth graders will probably necessitate a demonstration of the process with the full class. Using solicitation of student ideas and discussion, develop a proposed solution to the challenge. Diagram alternatives for the class and describe how each would work. It is important to model the generation of several ideas and choosing the 'best' one. Use the rubric developed above to reflect on the alternatives and choose one to develop further.

Note to Teachers

The design challenge is presented here as limited to only your classroom. Obviously there would be a much larger impact, and probably a more measurable one, if you expanded the project to other classrooms or the whole school. This is a big undertaking with implications for your school culture. Would other teachers get on board? Would your principal be supportive? Custodian? Lunchroom staff? Figuring out how far to extend this project bears thought and planning. Is this something you are ready to take on?

Next Generation Science Standards
Performance Expectations: 3-5-ETS1-1, 3-5-ETS1-2
Science and Engineering Practices: Developing and Using Models; Using Mathematics and Computational Thinking; Asking Questions and Defining Problems; Constructing Explanations and Designing Solutions
Disciplinary Core Ideas: ESS3.C, ETS1.A, ETS1.B
Crosscutting Concepts: Systems and System Models; Influence of Science, Engineering, and Technology on Society and the Natural World

Lesson 8: Steps in the Engineering Design Process
(Taken from the Massachusetts Science and Technology/Engineering Curriculum Frameworks, 2006)



1. Identify the need or problem
2. Research the need or problem
    - Examine the current state of the issue and current solutions
    - Explore other options via the Internet, library, interviews, etc.
3. Develop possible solution(s)
    - Brainstorm possible solution(s)
    - Draw on mathematics and science
    - Articulate the possible solution(s) in two and three dimensions
    - Refine the possible solution(s)
4. Select the best possible solution(s)
    - Determine which solution(s) best meet(s) the original need or solve(s) the original problem
5. Construct a prototype
    - Model the selected solution(s) in two and three dimensions
6. Test and evaluate the solution(s)
    - Does it work?
    - Does it meet the original design constraints?
7. Communicate the solution(s)
    - Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the initial need or the problem
    - Discuss societal impact and tradeoffs of the solution(s)
8. Redesign
    - Overhaul the solution(s) based on information gathered during the tests and presentation

Lesson 9: Water Conservation Design Process (3-*4 Periods*)

Periods 1-3?: Student Group Independent Work Time
Student groups work together to come up with an approach to water conservation that they think could work in their classroom. Interrupt their group process to hold specific, teacher-directed opportunities to review the classroom generated CONSTRAINTS and CRITERIA (see *Lesson 9: Sample Rubric for Self-Assessment of Water Conservation Strategy*). Circulate between groups during their work time to hear where they are in their process, what they are thinking and to steer them in good directions if needed.

Period 4: Design Approach Additional Requirements
At the end of the work time groups need to come up with a design for a water conservation strategy that includes:

- a name for their approach
- a detailed, written description of all the elements of the approach – what it is and how it works
- diagrams and drawings to support the written description
- specifications for any devices and equipment needed
- a detailed description of exactly how they are going to make daily measurements of changes in water use

EXTENSION LESSON E6: Marketing Their Inventions
If you would like to support their creativity, as students develop their water conservation approaches, you can add some marketing and promotion to the process of inventing. Groups can invent a logo and slogan for their design.

Next Generation Science Standards
Performance Expectations: 3-5-ETS1-2
Science and Engineering Practices: Developing and Using Models; Asking Questions and Defining Problems; Constructing Explanations and Designing Solutions
Disciplinary Core Ideas: ESS3.C, ETS1.A, ETS1.B, ETS1.C
Crosscutting Concepts: Systems and System Models, Influence of Science, Engineering, and Technology on Society and the Natural World

Resource Pages
Lesson 9: Sample Rubric for Self-Assessment of Water Conservation Strategy).

Name:____

Lesson 9: Sample Rubric for Self-Assessment of Water Conservation Strategy

Your water conservation approach needs to address the constraints and criteria that we agreed on in class and include the part of the design. Check off the yes/no boxes.

Criteria	Yes	No
Does your project reduce water use in our classroom/school?		
Can you measure the amount of water saved by your invention?		
Constraints		
Does your project cost under $5.00 in equipment or other costs?		
Is your project something that you can create or install or make?		
Is your project something kids in this class/school can do?		
Could anyone get hurt by your project?		
Check List – does your group have:		
A name for your invention		
A written description of how your invention works		
Full list of all devices and equipment needed		
Diagrams and drawings that help explain your invention		
Careful step-by-step description of how you are going to measure water saved by your invention		

How much water do you predict that your invention will save?

How did you figure out this amount? Show your math.

Lesson 10: Student Design Presentations, Feedback and Revisions *(2-3 Periods)*

Period 1: Student Group Presentations
Student groups share their water conservation design ideas with their classmates for feedback and suggestions. You can use the attached rubric for Lesson 10 for students to document their evaluation of other groups' designs. Give specific and clear guidelines for how to provide constructive feedback. If feedback strays from the guidelines below remind all of the structure. If necessary, give presenting groups suggestions about how to record the feedback they receive so that they will remember the suggestions from their classmates.

> NOTE TO TEACHERS - good peer feedback will help others learn and will give them ideas about improving their work. All suggestions should be:
> - constructive,
> - specific, and
> - considerate of others' feelings.

Periods 2-3: Student Group Independent Work Time
Following the presentations, student groups return to their design teams to review and revise their designs based on peer feedback.

Formative Assessment
Student group designs are submitted as a formative assessment for the unit.

> **Next Generation Science Standards**
> **Performance Expectations:** 3-5-ETS1-2, 3-5-ETS1-3
> **Science and Engineering Practices:** Developing and Using Models; Asking Questions and Defining Problems; Constructing Explanations and Designing Solutions
> **Disciplinary Core Ideas:** ESS3.C, ETS1.A, ETS1.B, ETS1.C
> **Crosscutting Concepts:** Systems and System Models; Influence of Science, Engineering, and Technology on Society and the Natural World

Lesson 11 (Optional): Choosing Our Water Conservation Strategy(ies)

Teacher evaluation
After evaluating the written student group designs, their practicality and possibility of implementation, decide whether you want to have all the groups implement their own different design ideas or whether you want to choose one of the groups' ideas and implement only one with the whole class. If you decide to implement only one group's design, you can either choose the 'winning' idea yourself or create a process for students to select the best idea (see below).

OR

Process for class choice
If you want a more involved and motivational(?) process with your students, organize a conference where the groups present their final revised ideas to the class and the students rate the ideas according to a rubric that reflects the constraints and criteria identified in Lesson 8. See *Lesson 11: Sample Water Conservation Design Assessment Rubric*. The student idea with the highest scores would be the one that is implemented. If you decide to go this route be sure you are prepared to accept the judgment of the class.

Resource Pages

Lesson 11: Sample Water Conservation Design Assessment Rubric

Name:____

Lesson 11: Sample Water Conservation Design Assessment Rubric

As you listen to the other student group presentations about their inventions you will give them scores on their ideas. Use this table to record your scores.

Criteria	Score (1-10)
How well do you think their invention will reduce water use in our classroom?	
How well do you think their system of measuring the amount of water saved by their invention will work?	
Constraints	
Does their project cost under $5.00 in equipment or other costs?	
Is their project something that they would create or install or make?	
Is their project something kids in this class could do?	
Is their design complete and well thought out?	
Do you think anyone could get hurt by their project?	

Lesson 12: Water Conservation Projects: Implementation and Inventories *(2 Periods plus time to monitor water use changes)*

Periods 1-2: Project Implementation and Installation
Whether you choose one project or the student groups work with their own individual projects, it will be the students who actually implement the water conservation strategy or strategies. Give groups time and support to gather necessary materials. And time to install and implement their inventions and conservation strategies.

On-going Monitoring of Water Use
Groups carefully inventory every day and record water use as a result of their water conservation strategies.

(Trouble-shooting)
If designs do not work out as intended that is the time to support students to trouble shoot their inventions and support them to "go back to the drawing board" and revise and reinvent. This is a point where many students might be tempted to give up on their idea. This is a critical point for the teacher to step in and help them see it not as a failure but as an opportunity for further creative thought and design. Students with poorly developed skills in creative problem-solving will need support for positive outcomes. If a group is having difficulty moving forward consider having that group share their challenge with the entire class to see if the whole class can assist them with problem-solving.

Regular Reading of School Water Meter
Students must take responsibility for carefully reading the school's water meter each day, when the water conservation strategies are in place, and recording the data in an agreed upon location using a chart as in lesson 5. So in case their individual strategies for measuring water conservation don't work there will be an overall measure of the effectiveness of their projects.

Extent of Implementation and On-going Monitoring Phase
It is anticipated that this phase of the unit may take at least a week, and maybe longer, to carry out the water conservation approaches and measure the results. Once the designs are in place, the water use monitoring could possibly be done outside of formal class time. It will be important to gather data for the same amount of time after the water conservation strategies are in place as the students gathered data on water use before the inventions were implemented (see Lesson 7)

Next Generation Science Standards
Performance Expectations: 3-5-ETS1-2, 3-5-ETS1-3
Science and Engineering Practices: Developing and Using Models; Using Mathematics and Computational Thinking; Asking Questions and Defining Problems; Constructing Explanations and Designing Solutions
Disciplinary Core Ideas: ESS3.C, ETS1.A, ETS1.B, ETS1.C
Crosscutting Concepts: Systems and System Models, Influence of Science, Engineering, and Technology on Society and the Natural World

Lesson 13: Water Conservation Review and Reflection (*4-6 Periods*)

Periods 1-2: Student Group Preparation and Presentations
Provide time for student groups to prepare presentations about their experiences. They will be expected to report on their inventions and talk about what worked, how much water they saved, what didn't work as they had expected, and how their approaches could be improved if they had more time to work on their design.

> NOTE TO TEACHER – in large schools one classroom's campaign might not make much of a difference in the overall use of water for the school. This realization can lead to a discussion of the need for action on larger scales by more people.

Period 3: Individual Free Write
Students work individually to write their reflections on the entire project. How did the water conservation design(s) work? What could be improved? Think about your group's design. What did you like about it and what do you think could be better? Direct students to share any reflections on their process of water conservation. See *Lesson 13: Project Reflections* page if needed.

Periods 4-6: School Water Use Graph
Have student groups prepare charts of daily water meter readings, both prior to and after installing the water conservation approaches. Their chart should show each day and the quantity of water used by the school.
Students will then work individually, using the data gathered from reading the school's water meter, to create a graph. Explain to students that they are to prepare a point graph using *x* and *y* axes and horizontal and vertical scales that the students choose. The graph will indicate daily water use for the school, both before and after their projects, and any trends that resulted from their work. See *Lesson 13: Sample School Water Use Graph*. Instruct them to include with their graph a written analysis of any trends it indicates and explanations for the trends.

Summative Unit Assessment
Student groups submit their written reflections on their water conservation designs along with their graphs and written analysis of water use results as the unit's summative assessment.

Resource Pages

Lesson 13: Project Reflections
Lesson 13: Sample School Water Use Graph

Next Generation Science Standards
Performance Expectations: 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3
Science and Engineering Practices: Developing and Using Models; Using Mathematics and Computational Thinking; Obtaining, Evaluating, and Communicating Information; Asking Questions and Defining Problems; Constructing Explanations and Designing Solutions
Disciplinary Core Ideas: ESS3.C, ETS1.A, ETS1.B, ETS1.C
Crosscutting Concepts: Systems and System Models; Influence of Science, Engineering, and Technology on Society and the Natural World

Name:____

Lesson 13: Project Reflections

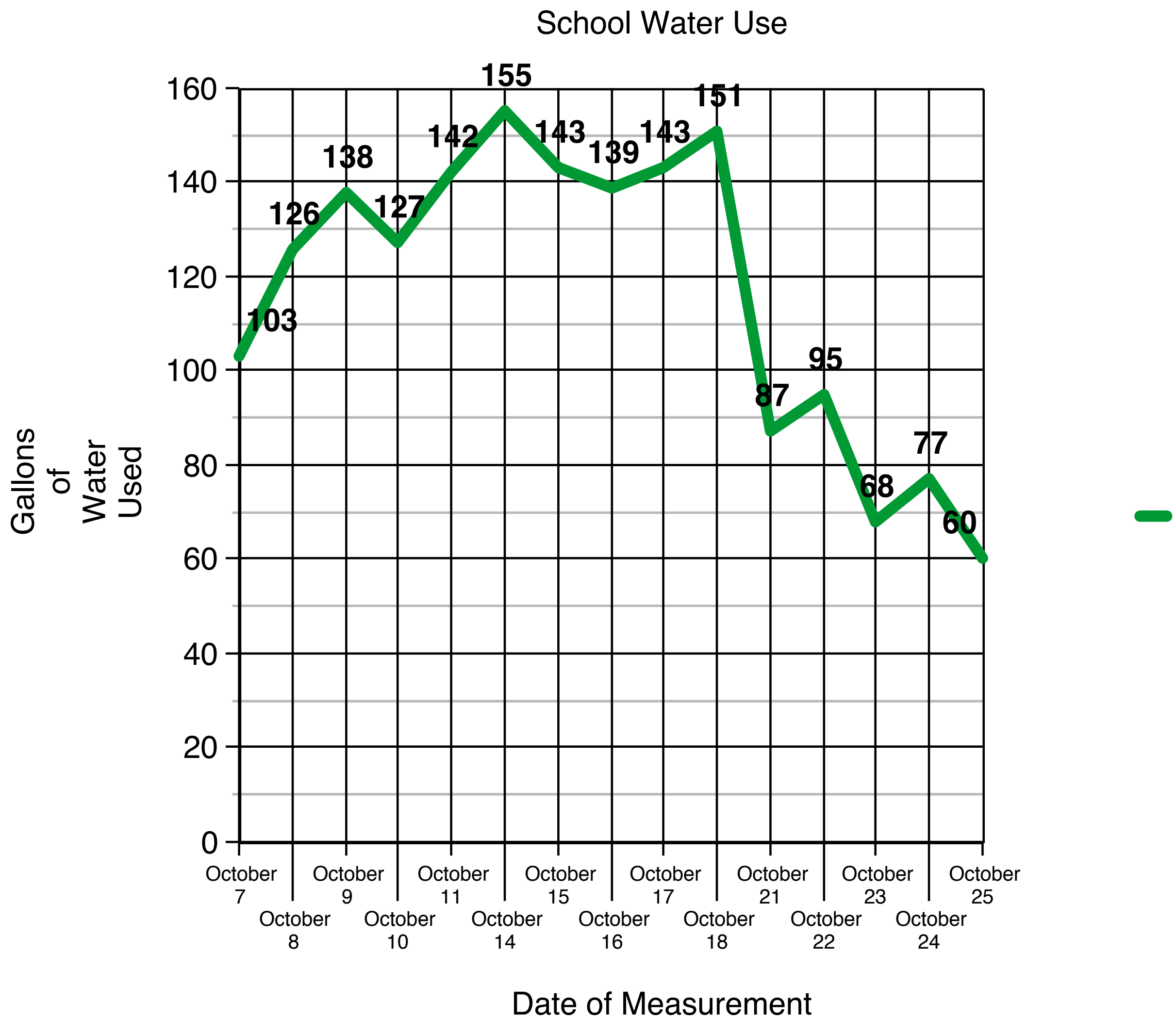
Write about your water conservation invention. Write about what worked and what didn't work?

How did you feel about working with your group? What could have helped your group work even better together?

If you were going to do this project again what would you do?

What were the 2 major things you learned from our class's water conservation project?

Lesson 13: Sample School Water Use Graph



Additional Resources

<u>Print – Teacher's Guides and Information</u>

Banko, W, M Grant, M Jabot, A McCormack, & T O'Brien. 2013. *Science for the Next Generation: Preparing for the New Standards*. NSTA Press, Arlington, VA. ISBN 978-1-936959-26-6. A good introduction to the NGSS with some great sample unit plans and much more.

Gartrell, JE, J Crowder & JC Callister. 1989. *Earth: The Water Planet*. NSTA, Washington, DC. ISBN 0-87355-083-8. An older book but from a very reputable source, full of some great activities on water resources: Groundwater, Erosion, the Water Cycle, Water in the World, & Physical Properties of Water

NGSS Lead States. 2013. *Next Generation Science Standards For States, By States*. The National Academies Press, Washington, D.C. ISBN 978-0-309-27227-8. The 2013 national version NGSS laid out in two volumes in complete form with charts and appendices; has performance expectations arranged by Disciplinary Core Idea and by Topic.

Watercourse, The & Council for Environmental Education. 1995*. Project Wet: Curriculum and Activity Guide.* Project WET, Bozeman, MT. ISBN 978-1888631807 Full of 64 fun, engaging, hands-on water activities; activities directed toward specified age groups K-12.

Watercourse, The & International Project WET. 2000. *Conserve Water Educators' Guide: Water Conservation Activities & Case Studies.* US Department of the Interior: Bureau of Reclamation. ISBN 978-1888631043. Middle and high school level teacher's guide with overview of water conservation issues, hydrology and lots of background information. Includes case studies that encourage students to view real life situations from different perspectives.

<u>Print – Student Literature</u>

Kerley, B. 2006. *A Cool Drink of Water*. National Geographic Children's Books, Washington, DC. ISBN 978-0792254898 Illustrates that people around the world are unified by our common need for water by combining striking National Geographic photographs with a poetic text.

Overbeck, C. 1995. *Water, Water Everywhere*. Sierra Club Books for Children, San Francisco, CA. ISBN 978-0871563835 A Reading Rainbow Book written for grades 3-4 celebrating one of Earth's most precious resources; addresses the water cycle and explores why people of all nations must conserve our planet's water supply.

Strauss, R. 2007. *One Well: The Story of Water on Earth*. Kids Can Press, Tonawanda, NY ISBN 978-1553379643 Almost 70% of the planet is covered with water which is how Earth supports life; all water is connected and it can cause little and big changes; empowers young people to conserve and protect Earth's water; part of CitizenKid book series designed to inspire young people to be better global citizens.

Wick, W. 1997. *A Drop of Water: A Book of Science and Wonder*. Scholastic Press, New York, NY ISBN 978-0590221979 Wick's photographs (he photographs for Scholastic's *I Spy* series) teach about the physical properties and the beauty of water; also includes simple kid-friendly experiments.

On-line Teacher Resources

The Next Generation Science Standards are in final form on the web. Individual state's are in the process of adopting them. Here's where to find them
http://www.nextgenscience.org/next-generation-science-standards

The Franklin Institute from Philadelphia's Community Science Action Guide's water conservation on-line curriculum; full of on-line links and some good activities
http://www.fi.edu/guide/schutte/water_overview.html

Seametrics water education web page with many links to other lesson plans and information
http://www.seametrics.com/water-lesson-plans

On-line Student Resources

University of Michigan's Global Change: Human Appropriation of the World's Fresh Water Supply – for advanced students
http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html

7 ½ minute video on YouTube exploring where water comes from created by students in Davis, California
http://www.youtube.com/watch?v=EBg10t9Y2Dk

EXTENSION LESSON E1: Review the Water Cycle

Students should understand the water cycle and the fact that the amount of water on the planet is stable – there will never be more or less on the planet than there is today; although it does get redistributed constantly. Review the water cycle and discuss with the students that the water we drink today is the same water the dinosaurs drank…and the ancient Egyptians. This sets the stage for understanding our current use and conservation of water.

It is also a good opportunity for students to use systems thinking to conceptualize water on Earth. It is a closed system in terms of no additional inputs of water. Refer to the systems thinking diagram from Lesson 1 to remind students how to think in this way.

Here are some good internet sites that give more information about how water cycles on the planet:

This site has a great diagram of the water cycle and includes more of the processes and locations for water than usual diagrams. There is also a several paragraph description of the cycle with links to more information about specific aspects.
http://ga.water.usgs.gov/edu/watercyclehi.html

Here is a very cool animation of the water cycle from YouTube, including labels; quite advanced   http://www.youtube.com/watch?v=iohKd5FWZOE

EXTENSION LESSON E2: More About Water Use Around the World

Resources for human access and use of water:

This is a complex web site with advanced math and many charts, but it does have some interesting information and even just the first couple of bullet points are good and appropriate for 5th grade.
http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html

Here is a video about where water comes from, and how we use it, created by students in Davis, California. It is very accessible and would appeal to 5th graders
http://www.youtube.com/watch?v=EBg10t9Y2Dk (Length 7:32)

EXTENSION LESSONS E3: Understanding Your Water System

Student Small Group Activity
Divide students into working groups. Have them create diagrams/maps of your city/town's water system. Base their drawings on what the guest speaker presents to them. Their diagrams may include reservoirs, wells, treatment plants, water storage tanks, aqueducts and pipelines and water mains, and individual water service lines as well as water meters.

Possible Field Trips
Organize visits to wells, reservoirs, treatment plants or other portions of your district's water system. This will complete their understanding of where their own water comes from. Your local water district is usually very supportive and cooperative in helping to arrange field trips. Sewage Treatment Plants are also fascinating field trip sites. They are smelly and one local plant in our area cancelled all elementary school visits because of the complaints about smell!

EXTENSION LESSON E4: Home Research Project

Using water at school is only one of the places where we use water. How much water do we each use at home and other places?

Below is a chart that shows how much water an average person uses per day. Do you think you are an average water user?

Here is a very cool web site from the United States Geological Survey that allows you to identify water-using activities you might do on a day when you are home all day. You input your activities and it calculates a total of how much water you used. This number is expressed as gallons of water used per person per day.
http://ga.water.usgs.gov/edu/sq3.html

And here is another more advanced Water Consumption Calculator where you can input activities for your household and then compare to others in the US. It is very cool!
http://www.csgnetwork.com/waterusagecalc.html

After students have tried one or both of these calculators try having them track their daily or weekly home water use using a Water Journal. They would keep it with them at home and at school and jot down each time they do something that uses water. It could be set up as a table something like this:

Date	Time	Activity	How Long	Gallons Used

They will need some support figuring out how to determine the number of gallons each activity uses. Figuring this out will carry over to some of the other lessons in the unit.

EXTENSION LESSON E4: FACT SHEET

How much water does the average person use at home per day?

Estimates vary, but each person uses about 80-100 gallons of water per day. Are you surprised that the largest use of household water is flushing the toilet, and after that, taking showers and baths? That is why, in these days of water conservation, we are starting to see toilets and shower heads that use less water than before.

Many local governments now have laws that specify that water faucets, toilets, and showers only allow a certain amount of water flow per minute. Water agencies in some areas offer rebates if you install a water-efficient toilet. For your kitchen and bathroom faucets, if you look closely at the head of a faucet, you might see something like "1.0 gpm", which means that the faucet head will allow water to flow at a maximum of 1.0 gallons per minute.

Typical water use at home

Bath	A full tub is about 36 gallons.
Shower	2 gallons per minute. Old shower heads use as much as 5 gallons per minute.
Teeth brushing	<1 gallon, especially if water is turned off while brushing. Newer bath faucets allow a flow of about 1 gallon per minute, whereas older models allow over 2 gallons.
Hands/face washing	1 gallon
Face/leg shaving	1 gallon
Dishwasher	4 to 10 gallons/load, depending of efficiency of dishwasher
Dishwashing by hand:	20 gallons. Newer kitchen faucets allow a flow of about 2.2 gallons per minute, whereas older faucets allow more.
Clothes washer	25 gallons/load for newer washers. Older models use about 40 gallons per load.
Toilet flush	3 gallons. Most new toilets use 1.6 gallons per flush, but many older toilets used about 4 gallons.
Glasses of water drunk	8 oz. per glass (did you remember to drink your 8 glasses of water today?)
Outdoor watering	5 to 10 gallons per minute

Taken from the United States Geologic Survey's Water Science School
http://ga.water.usgs.gov/edu/qa-home-percapita.html

EXTENSION LESSON E5: Water Conservation Heroes

Full Class Viewing and Discussion
View one or two internet resources and/or videos as a class to learn how people around the planet are conserving water. What is being done in different areas around the planet?

Individual Student Research Reports
Instruct students to work with a partner to research people, companies, or governments and what they are doing to help conserve water around the planet. Student pairs will study one Water Conservation Hero and prepare a report to share with the class.

Full Class Sharing and Awards
Water Conservation Prize - Students report their Water Conservation Hero to the full class. Presentations should include illustrations and case studies and stories if applicable. Students in the class will allocate points to each Water Conservation Hero based on the scale in the accompanying rubric handout (*Extension Lesson E5: Water Conservation Hero Rubric*). And prizes can be awarded for the best water conserver!

Resources: Water Conservation Hero sample web sites:

A TED Talk by Ludwick Marishane, a young man from South Africa, explaining how and why he invented a waterless way of bathing and the advantages it offers http://www.ted.com/talks/ludwick_marishane_a_bath_without_water.html (Length 5:13)

UMASS Amherst Campus Sustainability Initiative installed Low Flow Water Fixtures on toilets, urinals and faucets
http://www.ted.com/talks/ludwick_marishane_a_bath_without_water.html

Matt Damon and Gary White founded Water.org to raise funds for initiatives that provide clean water for those in developing countries http://water.org/about/

http://www.epa.gov/watersense/our_water/learn_more.html#tabs-6 - the EPA's web site on water conservation

http://www.wateruseitwisely.com/100-ways-to-conserve/ - site of a campaign in Arizona to help municipalities and other organizations conserve water

http://wateruseitwisely.com/kids/index.php

http://eartheasy.com/live_water_saving.htm - an on-line store for water conservation devices and also includes some good information about conserving water

http://naturesvoice-ourchoice.org/conservation-devices/72.html http://www.unwater.org/water-cooperation-2013/en/ - web site of the United Nations' World Water Day which was March 22 in 2013.

http://www.saveourh2o.org/ - Save Our Water is a California campaign to encourage people from that state to reduce their use of water

The story of International Power in Australia and how the corporation has achieved water conservation on a large scale
http://www.youtube.com/watch?v=yKY7fgqLKvM (Length 2:36)

Student Handout: Extension Lesson E5: Water Conservation Hero Rubric

Next Generation Science Standards
Performance Expectations: 5-ESS3-1. 3-5-ETS1-1
Science and Engineering Practices: Obtaining, Evaluating, and Communicating Information; Asking Questions and defining Problems; Constructing Explanations and Designing Solutions
Disciplinary Core Ideas: ESS3.C, ETS1.A, ETS1.B
Crosscutting Concepts: Influence of Science Engineering, and Technology on Society and the Natural World

Name:____

Extension Lesson E5: Water Conservation Hero Rubric

Your job is to rate student group presentations about their Water Conservation heroes. Use the chart below to rate the different presentations.

Names of Students in group		Score 1-10
Name of Water Conservation Hero		XXXXXX
How did their hero save water?		
How did their hero help people?		
How did their hero make the Earth a better place?		
How did their hero help plants or animals?		
How did their hero help make water cleaner?		

EXTENSION LESSON E6: Marketing Their Inventions

Logos and Slogans
When students are designing their approach to water conservation an added dimension to the process could be to include some additional graphics and marketing work for the groups. Instruct student groups to invent a logo for their invention and a slogan to help market their idea so that people will WANT to use/adopt it. They could also think about how to market their idea in print and on line. They'll know more about current approaches to marketing, especially to their peers, than we will!