2019 5th Grade

Watershed Unit

CENTRAL MASSACHUSETTS REGIONAL STORMWATER COALITION

WPI

5th Grade Watershed Unit

Welcome to WPI's fifth grade Watershed Science Curriculum! This curriculum includes a series of lessons and hands-on activities that aim to engage the students while informing them on the water cycle, pollution's effects on stormwater, and methods to reduce these effects. The curriculum begins with a hands on activity that teaches the students on the lack of available freshwater in the world. Then, there is a lesson and poster activity on the water cycle and how stormwater runoff is incorporated into this process. Next, there is a fun lesson that illustrates how certain human activities can cause pollution which can harm the quality of water. This activity leads into a lesson which teaches the students on the difference between impervious and porous surfaces. The last lesson introduces several stormwater management practices which help reduce pollution's effects on water quality. The sixth section contains three hands-on activities which can be used as a final "lab" day or can be incorporated into earlier lessons as they are taught. We recommend starting with the first two lesson, while the rest can be taught individually or out of order.

This curriculum includes hands-on activities to ensure that the students are engaged and enjoying their learning experience. However, some reading, writing, and math skills were also incorporated. The lessons were made to hit on five of the Massachusetts and Next Generation Science Standards so that they comply with state regulations. The goal of this curriculum is to inform the students on water education and pollution's effects on stormwater. We hope that you enjoy this learning experience as much as the students!

	Chapter	Topic	Standards Met	Key Phrases	Goal of the Lesson
Lesson 1	The Water Cycle	The Importance of Freshwater	5-ESS2-2	Saltwater, Freshwater, Frozen Freshwater, Groundwater, Underground Wells, Desalination, Pollution	Show students the limited amount freshwater available for Earth's animals, plants, and 7.7 billion people. **Describe the importance of keeping limited freshwater pollutant free**
Lesson 2	The Water Cycle	Evaporation, Condensation, Precipitation, and Stormwater Runoff	5-ESS2-1	Water Cycle, Hydrosphere, Precipitaiton, Condensation, Evaporation, Stormwater Runoff, Geosphere, Atmosphere, Biosphere	Students will be able to know the differences between precipitation, condensation, and evaporation while also learning about the importance of runoff in the Water Cycle.
Lesson 3	Watershed	Pollution's Effect on Water	5-ESS2-1	Groundwater, Runoff, Watershed, Pollutant, Non-Point Source Pollution, Point Source Pollution	Students will identify different pollutants and understand how they negatively affect human life and water quality.
Lesson 4	Stormwater Runoff	Impervious Vs. Pervious Surfaces Through the Use of GIS / Google Maps	5-ESS3-1	Stormwater Runoff, Best Management Practice, Urban Environment, Rural Environment, Impervious Surfaces, Pervious Surfaces, Rain Barrel, Rain Garden, Green Roof	Students will understand and model the difference between pervious and impervious surfaces in an urban and rural environment.
Lesson 5	Stormwater Runoff	Best Management Practices (BMPs)	5-ESS3-1 5.3-5-ETS3-2	Stormwater Runoff, Best Management Practice, Urban Environment, Rural Environment, Impervious Surfaces, Pervious Surfaces, Rain Barrel, Rain Garden, Green Roof	Students will understand what best management practices are and how they can naturally filter water. Then, they will engineer a BMP model to incorporate into a scenario and use scientific writing to back their reasoning for their design.
Lesson 6	Watershed/ Stormwater Runoff	Lab Day: Enviroscape, Impervious Vs. Pervious Surfaces, Water filtration	5-ESS3-2	Hydrosphere, Precipitation, Condensation, Evaporation, Groundwater, Runoff, Geosphere, Atmosphere, Biosphere	Show students the limited amount freshwater available for Earth's 6.8 billion people, animals, and plants so they understand the importance of keeping our water bodies pollutant free.

Massachusetts 2016 Standards Addressed:

5-ESS2-1: Use a model to describe the cycling of water throughout a watershed through evaporation, precipitation, absorption, surface runoff, and condensation.

5-ESS2-2: Describe and graph the relative amounts of salt water in the ocean; freshwater in lakes, rivers, and groundwater; and fresh water frozen in glaciers and polar ice caps to provide evidence about the availability of fresh water in Earth's biosphere.

5-ESS3-1: Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.

5-ESS3-2 (MA): Test a simple system designed to filter particulates out of water and propose one change to the design to improve it.

5.3-5-ETS3-2 (MA): Use sketches or drawings to show how each part of a product or device relates to other parts in the product or device.

Grade 5 Unit Goals:

1. Students will be able to explain the process of the water cycle.

2. Students will be able to model the process in which pollutants reach bodies of water and how it impacts the water cycle / environment.

3. Students will be able to use maps and sketches to identify local watersheds and the bodies of water they flow to.

4. Students will be able to identify different materials and their effect on stormwater runoff.

5. Students will be able to identify different designs that help protect Earth's resources and the environment.

Lesson	Chapter	Topic	Unit Goal	MA Standard
1	The Water Cycle	The Importance of Freshwater	1	5-ESS2-2
2	The Water Cycle: with Strong Importance on Stormwater Runoff	Evaporation, Condensation, Precipitation, and Stormwater Runoff	1 and 2	5-ESS2-1
3	Watershed	Pollution's Effect on Water	2 and 4	5-ESS2-1
4	Stormwater Runoff	Impervious Vs. Porous Surfaces Through the Use of GIS / Google Maps	3	5-ESS3-1 5.3-5-ETS3-2
5	Stormwater Runoff	Best Management Practices (BMPs)	5	5-ESS3-1 5.3-5-ETS3-2
6	Watershed / Stormwater Runoff	Lab Day: Enviroscape, Impervious Vs. Porous Surfaces	2 and 4	5-ESS3-2

Lesson 1: Amount of Freshwater in the World

Introduction

Chapter	The Water Cycle	Day 1	Grade Level: 5
Title of Topic	The Importance of Freshwater	Time: 40-50 minutes	
Desired Outcome from Lesson: Students will realize how limited clean, freshwater is and will understand why it is important to protect our bodies of water.			
Topic of Lesson: Earth's water is 97.5% salt water and only 2.5% freshwater. Of Earth's freshwater, only 1% is easily accessible from rivers, lakes, etc. This lesson will give students a visual representation of the lack of available freshwater.			
Goals of the Day: Show students the limited amount freshwater available for Earth's animals, plants, and 7.7 billion people. **Describe the importance of keeping limited freshwater pollutant free**			
Essential Vocabulary: ● *Saltwater*- Water (as of the ocean) that naturally contains a significant amount of salt. ● *Freshwater*- Bogs, ponds, lakes, rivers, streams, and any other bodies of water bodies that consist of water not containing salt. ● *Frozen Freshwater*- Freshwater that is not easily accessible due to being frozen in glaciers and ice caps. (Water locked up in ice and snow) ● *Groundwater*- Water that moves down into the ground (due to gravity) passing between particles of soil, sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water.			
Extended Vocabulary: ● *Underground wells*- A structure created in the ground by digging, driving, or drilling to access liquid, like water. ● *Desalination*- A process that takes away salt and mineral components from saltwater. ● *Pollution*- The presence of a substance or thing that has harmful or poisonous effects in the environment.			

Teacher Guideline

Overview:

- 97.5% of Earth's water is saltwater.
- 2.5% of Earth's water is freshwater.
  - Of that freshwater, about 69% is frozen
  - About 30% is groundwater
  - About 1% is other freshwater

Note to Educator:
This lesson is a hands-on activity and gives a visual representation to students on the lack of easily accessible freshwater.

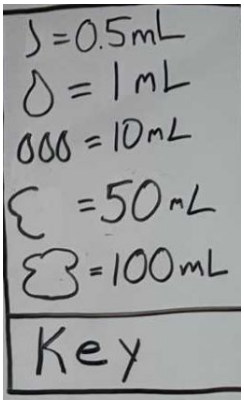
Materials:

- 2 liter bottle
- Four other containers that can hold water
  - One of them should be able to hold 2 liters of liquid
  - The other three can be less than 2 liters
- At least one graduated cylinder (in milliliters)
  - Or any liquid measuring tool that has milliliter increments
- Large board/paper (for bar graph)
- Water
- Salt (optional)
- A cover for one of the containers (optional)
- A freezer (optional)

Instructions:

1. Split up the class into 4 groups.
2. Fill the 2 liter bottle with water.
3. Explain to the class that this bottle represents all the water in the world.
4. Assign each group one category of water: Saltwater, Frozen Freshwater, Groundwater, and Other Freshwater (you can wait to tell the groups which category they are until after the exercise if wanted).
5. Give each group one container that can hold water.
    a. The salt water group needs the biggest container.
6. Give each group the 2 liter bottle and the graduated cylinder. Then, have them measure their respective amount of water out of the 2 liter bottle to put in their container. (have the salt water group go last)

    a. Frozen freshwater (glaciers and ice caps) = 34.5 mL
    b. Groundwater = 15 mL
    c. Other freshwater (bogs, ponds, lakes, rivers, streams, swamps, etc.) = 0.5 mL
    d. Salt water = the rest of the water (or 1950 mL)
7. Explain that the container with 0.5 mL of water is proportional to the amount of easily available freshwater in the world.
8. Then, create a graph on a large piece of paper or on the board.
9. Have the students label the x-axis for the four different categories of water.
10. Then create a key next to the graph which depicts:



    a. Half of a droplet= 0.5 mL
    b. One water droplet= 1 mL
    c. Three connected water droplets = 10 mL
    d. Half of a body of water= 50 mL
    e. A body of water = 100 mL

(See pictures of what the key [right] and final bar graph [below] should look like)

11. Call students from each group up to the board to complete the graph.

Extra Steps Part 1:

12. If wanted, add salt to the salt water container, put the cover over the groundwater container, and put the frozen freshwater in the freezer. Tell the students that the remaining open container is proportional to the amount of easily available freshwater in the world. They will see that it is impossible to share this water throughout the class.
13. Have the students then take time to discuss with their groups as to how they would ration the amount of freshwater between humans, animals, and plants. Each group should write down responses on a piece of paper.
14. After 5 minutes / end of student discussion, ask each group how they would ration freshwater and see what they think about the lack of fresh water in the world.
15. Possible option- give background about how much water they use in a day.

Extra Step Part 2

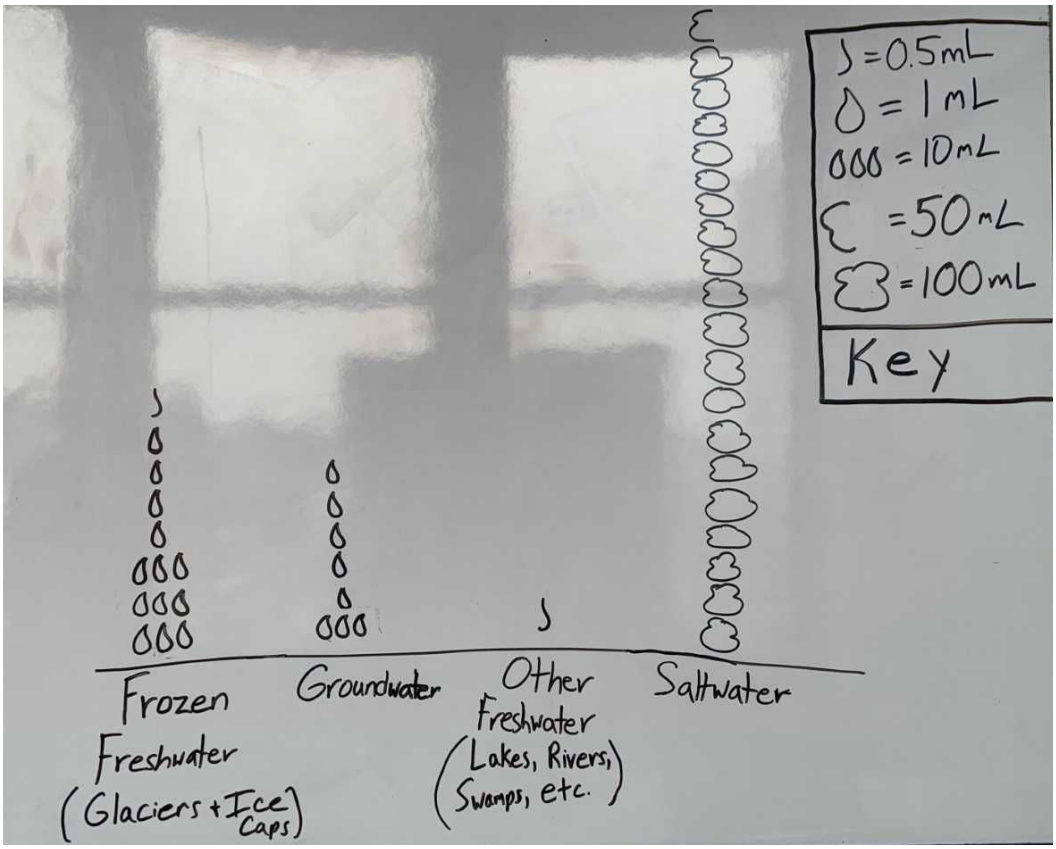
1. Add food coloring to the water to show pollution effects. Put an emphasis on the lack of freshwater and what fewer drops of food coloring to the "other freshwater" container does to the water. The scarcity of water should make for fewer droplets of food coloring to make the water darker than in the other containers.

Exit Ticket

1. Why is it important to keep pollutants out of our freshwater?

a. There is very limited available freshwater so we must keep it clean.

2. What are some ways that you and your family can conserve freshwater?
    a. Possible answers: Fix leaking faucets, take quicker showers, turn off the faucet when brushing your teeth, do not waste half full water bottles, etc.
3. Can you think of some ways that humans can make saltwater, groundwater, and frozen freshwater available for human use?
    a. Possible answers: underground wells, desalination methods, etc.



Example of the Graph Explained in Part 1

Information from: https://water.usgs.gov/edu/earthwherewater.html

Lesson 2: The Water Cycle Poster Contest

Introduction

Chapter	The Water Cycle	Day 2	Grade Level: 5
Title of Topic	Evaporation, Condensation, Precipitation, and Stormwater Runoff	Time: 40-50 minutes	

Desired Outcome from Lesson: Students will be able to explain the process of the Water Cycle.

Topic of Lesson: The water cycle is the process which water circulates between the Earth's oceans, atmosphere, and land. This cycle is made of stages such as precipitation, condensation, transpiration, and evaporation.

Goals of the Day: Students will be able to know the differences between precipitation, condensation, and evaporation while also learning about the importance of runoff in the Water Cycle.

Essential Vocabulary:

- *Water Cycle*- The natural sequence through which water passes into the atmosphere as water vapor, precipitates to Earth in a liquid or solid form, and ultimately returns to the atmosphere through evaporation.
- *Hydrosphere*- All the waters on the Earth's surface, such as lakes and seas, and sometimes including water over the Earth's surface, such as clouds.
- *Precipitation*- Rain, snow, sleet, or hail falling from the clouds.
- *Condensation*- Cooled water vapor (gas) that has turned into droplets of liquid. (Clouds are made up of water vapor, dust, and cool air.)
- *Evaporation*- The process in which liquid water becomes water vapor.
- *Stormwater Runoff*- Generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.

Extended Vocabulary:

- *Atmosphere*- The envelope of gases surrounding the Earth or another planet.
- *Biosphere*- The regions of the surface, atmosphere, and hydrosphere of the Earth (or analogous parts of other planets) occupied by living organisms.

Teacher Guideline

Overview:
This lesson plan connects stormwater to the water cycle. Usually, only "runoff" is mentioned when teaching the water cycle but we believe stormwater also should be incorporated.

Note to Educator:
This lesson plan is a complementary to the first lesson plan. This covers the Next Generation Science Standards and is also interactive activity.

Materials:
- Chalk Board
- Markers/Pens/Pencils
- 11x17 paper (or bigger)

Instructions:

Part 1:

1. Students split into groups, each group consisting of 3-5 students.
2. Initially, have the students take 5 minutes and write down all of the ways they use water. After some time has elapsed, have students raise their hand to compile the ideas on the board.
3. Have the students discuss with their groups if the water on Earth today is the same water dinosaurs used.
    - Answer: Yes, it is because water is a constant cycle.
4. Next, show the students this ~4 minute YouTube video called "The Water Cycle | Educational Video for Kids" which explains three stages of stormwater: https://www.youtube.com/watch?v=y5gFI3pMvoI
5. Then, show the students this ~2 minute YouTube video called "Stormwater Animation" on stormwater runoff: https://www.youtube.com/watch?v=DYGDY3GYYyI
6. Have a class discussion on how stormwater runoff relates to the three stages of the water cycle in the first video.

7. Now, let's do a scenario on the board. Have a student come up and draw a body of water. Start explaining that it is a warm summer day, and ask the class what is happening to the water? The student at the board can "Phone a Friend" if they do not know the answer.
8. Have another student come up and draw a cloud above the body of water, and have them answer how this happened. This can be a group collaboration to get to the answer.
9. Now have students explain what happens when a lot of condensation occurs and the water becomes "heavy". Have the next student explain and draw precipitation.
10. Finally, have a student come up to draw and explain how the stormwater returns to the body of water. Throughout this whole board exercise, make sure the students are writing the words "Evaporation, Condensation, Precipitation, and Stormwater Runoff" on the board so they can visualize what is occurring.

Part 2: (Possible homework if not enough time in class)

Next, pass out a blank piece of paper to every student (11x17 or bigger). Have the students make posters illustrating the stages of the water cycle. Be sure that they have a strong understanding of the four stages of the water cycle so they can incorporate it in their posters. The posters should include: evaporation, condensation, precipitation, and "stormwater" runoff. A possible grading rubric is below. The vocabulary list below can be handed out to students to help them with their poster.

Grading Rubric

4	3	2	1
Model is accurate and explains what is happening. Accurate descriptions of definitions are present.	Model is accurate, labeled and includes most of the major elements.	Model has some inaccuracies or is missing some major elements.	Model is inaccurate or is missing many major elements

Student Instructions

Water Cycle Poster

You will be creating a poster describing the water cycle. Create a drawing of the water cycle in pencil first and check with the teacher before moving forward. Once you have been checked off by the teacher, you can use colored pencils and markers to finish the poster and make it look colorful.

What to include:

____ Title (1pt)
____ Your Name (1pt)
____ Draw and label the Sun (1pt)
____ Draw, label and define Evaporation (2pt)
____ Draw, label and define Condensation (2pt)
____ Draw, label and define Precipitation (2pt)
____ Draw, label, and define Stormwater Runoff (Surface Runoff) (2pt)
____ Draw and label Collection/Accumulation (2pt)
____ Draw and label Transpiration (1pt)
____ Draw and label Groundwater (1pt)
____ Draw and label Aquifer (1pt)
____ Effort and Neatness (1pt)

16-17 points = 4	15 points = 3.5	13-14 = 3
11-12 points = 2.5	9-10 points = 2	0-8 points = 1

Vocabulary

Water Cycle: The natural sequence through which water passes into the atmosphere as water vapor, precipitates to Earth in liquid or solid form, and ultimately returns to the atmosphere through evaporation

Evaporation: The process in which liquid water becomes water vapor.

Condensation: Cooled water vapor (gas) that has turned into droplets of liquid. (Clouds are made up of water vapor, dust, and cool air.)

Precipitation: rain, sleet, snow, or hail falling from the clouds

Accumulation/Collection: the process in which water pools in large bodies (like oceans, seas, and lakes).

Stormwater Runoff: generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.

Transpiration: the process in which some water within plants evaporates into the atmosphere through its leaves.

Groundwater: Water that moves down into the ground (due to gravity) passing between particles of soil, sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water.

Aquifer: A collection of groundwater.

<u>Extra Vocabulary to Use if Wanted</u>

Water Vapor: Water in the form of a gas

Dew Point: the point at which water vapor turns back into a liquid

Humidity: the amount of water vapor in the air

Lesson 3: Pollution's Effects on Water

Introduction

Chapter	Watershed	Day 3	Grade Level: 5
Title of Topic	Pollution's Effect on Water	Time: 40-50 minutes	
Desired Outcome from Lesson: Students will be able to model the process in which pollutants reach bodies of water and how it impacts the water cycle/ environment.			
Topic of Lesson: There are many ways pollutants can enter bodies of water, the soil, and the air. Students will learn the dangers human life can cause the watershed and why it is important to minimize pollution.			
Goals of the Day: Students will identify different pollutants and understand how they negatively affect human life and water quality.			
Essential Vocabulary: ● *Groundwater*- Water that moves down into the ground (due to gravity) passing between particles of soil, sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water. ● *Stormwater Runoff*- Generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground. ● *Watershed*- An area or ridge of land that separates waters flowing to different rivers, basins, or seas. ● *Pollutant*- A substance that causes harm to the environment, especially water or the atmosphere.			
Extended Vocabulary: ● *Non-point source pollution*- Caused when rainfall or snowmelt, moving over and through the ground, picks up and carries natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters and ground waters. ● *Point source pollution*- Any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack.			

Teacher Guideline

Overview: Youth will describe and identify the link between land use activities within a watershed and water quality.

Note to Educator: Students will evaluate the quality of a "water sample" (a bag of skittles), graph their results, and form a hypothesis about the land use near the location their "sample" was collected.

Materials:

- Candy (skittles) or colored beads
- Plastic sandwich bags
- Graph paper
- Colored pencils or crayons
- Pollutant labels (provided)

Experimental Steps:

Teacher preparation

1. Divide the candy into the sandwich bags (you may want to manipulate the bags so that the assortment of candy represents a particular land use area by adding more of a certain type of pollutant, rather than relying on a random mix. See table at end of lesson.)

Pollutant labels:

Sediment	Pesticides	Fertilizers

Oil and Gas	Toxic Waste

2. Prepare one bag (30 pieces) per student or one bag per group of students. Each bag represents a water sample from a watershed.

In Class:

3. Ask students what a pollutant is. Tell them that each color of skittles represents a different kind of pollutant.
   PURPLE = Sediment, RED = Pesticides, GREEN = Fertilizers,
   YELLOW = Oil and Gas, ORANGE = Toxic Waste
   Discuss each of these pollutants with the students. Ask the students where the pollutants come from, and the positive and negative impacts they have.
4. Distribute the graph paper to each student or group. Tell the students that they will be drawing a bar graph to show the number of pollutants found in their "water sample." Have the students label the x-axis with the pollutant types and the y-axis with the amount of pollutants.
5. Give each group a "water sample." Tell the students to separate and count the number of each pollutant and graph them on the paper. Remind the students that they cannot eat the skittles until they are finished with their graph!
6. Ask the students to try and determine what activities are occurring in their watershed according to the "water sample." For example, a water sample from an area with a lot of agricultural use may have more sediment, fertilizer, and pesticides.
7. Discuss how each water sample is different. While some samples might contain an abundance of one type of pollution, almost all types of pollutants can be found in every sample (even if they are small amounts). Discuss strategies to reduce pollution. How can the students do this on a large scale (in their community) or small scale (in their own home)?

In the Community:

- Talk to friends and neighbors about what they have learned.
- Pick up trash in your neighborhood.
- Recycled littered plastics and papers.

In home:

- Encourage parents to fix leaky cars.
- Talk to parents about using less fertilizers and pesticides.
- Recycle items at home.
- Do not dump oil, gas, or other pollutants in the storm drains.

Suggested Combinations of Skittles for Different Land Uses:

Land Use	Purple	Red	Green	Yellow	Orange
Agriculture	8	5	5	2	0
Golf Course	5	5	8	2	0
Factory/Industrial	5	2	5	5	10
Construction	10	0	0	5	0
Neighborhood	2	5	8	5	0

Lesson 4: Different Types of Surfaces; GIS Mapping

Introduction

Chapter	Stormwater Runoff	Day 4	Grade Level: 5
Title of Topic	Urban Vs. Rural Runoff	Time: 40-50 Minutes	

Desired Outcome from Lesson: Students will be able to identify different surfaces and their effect on stormwater runoff.

Topic of Lesson: Using your school's landscape, students will understand how stormwater acts differently when it comes in contact with porous and impervious surfaces. They will begin to visualize how polluting our environment can pollute our stormwater.

Goals of the Day: Students will understand and model the difference between porous and impervious surfaces in an urban and rural environment.

Essential Vocabulary:

- *Impervious Surfaces*- Surfaces, such as asphalt, roofs, and sidewalks, where water cannot readily absorb into the ground.
- *Porous Surfaces*- Surfaces where water can readily absorb into the ground.
- *Stormwater Runoff*- Generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.
- *Catch basin*- A reservoir or well into which surface water may drain off.
- *Urban Environment*- A human settlement with high population density and infrastructure of built environment such as cities, towns, or suburbs.
- *Rural Environment*- Open land that has few homes or other buildings, and not very many people.

Extended Vocabulary:

- *Discharge Point*- The point where stormwater which has been collected in catch basins is released into our bodies of water or into our environment
- *Storm Drain Network*- The network of underground pipes which stormwater travels from the catch basin to the discharge point

Teacher Guideline

Overview: This lesson is for students to understand the difference between porous and impervious surface by relating it to the surroundings of their schools. The use of Google Maps will be helpful during this lesson as students will have a better understanding of the aerial view.

Note to Educator: This lesson plan relates the surroundings of your perspective school in order to gain the interest from students. The aerial view that you see below is a Google Earth screenshot of Sherwood Middle School in Shrewsbury, MA. You can access a screenshot of your school on Google Earth if necessary. Although this specific lesson plan has topographic maps, storm drain network and catch basin locations of Sherwood Middle School, we encourage teachers to reach out to their local DEP or Town Engineer to have maps made for your specific school. Town Engineers would love for this to happen and teachers should take advantage of this community tool that they have in front of them. Most of the time, Town Engineers would be willing to come into your classroom and teach about their expertise.

Materials:

- Google Earth Screenshot print outs
- Markers/Pencils/Highlighters
- Topography Maps/Catch Basin Map

Instructions:

Part 1

1) Start off this class by giving definitions of porous and impervious surfaces
    a) Ask around the classroom to see if any students can give you examples- if not provide them with examples. (Roads, roofs, sidewalks etc..)
2) Next, show this YouTube "Dr. Drain the Rain Brain Stormwater 101 Video" which further explains the difference between impervious and porous surfaces: https://www.youtube.com/watch?v=4XXMKaLgX6Y
3) Once they have an understanding of what the difference is, hand out the Google Earth Satellite maps of your surrounding school and have them highlight the different surfaces (impervious or porous) surrounding the school. (An example is attached below)

a) Have them pick two different colors for impervious and porous.

4) After they have completed this, project the same blank copy of the map on the board (better with a smart board) and have each student come up and fill in/highlight one of the surfaces until the map is complete.
    a) This is a chance to provide the students with the correct answers so they can fix their own drawings.
5) Next, explain what happens on impervious surfaces.
    a) No water infiltration
    b) Stormwater pollution from human interaction
        i) Oils, garbage, animal waste, fertilizers, pesticides.
    c) All of these bacteria are discharged into lakes and streams that they play in during the summer.
6) End the lesson with an Exit Ticket: 2 questions with 2-4 sentence answers.
    a) What are two definitions that you learned from today's exercise?
    b) What can you do to help make stormwater cleaner?

Part 2

1) If there is another day that you have available, reach out to your local Town Engineer to come in and take the students on a field trip outside of your school.
    a) You can get ahold of them through your local stormwater coalition and/or DEP.
2) If the Town Engineer is unable to visit your classroom, you can do an outdoor lesson by yourself.
    a) You can reach out to the DEP of your town and ask for maps of your surrounding areas.
    b) These maps are as follows.
        i) Topographic maps, Storm Drain Network and Catch Basin Locations with Discharge Points.

3) In the maps provided, you will see that catch basins are highlighted along with discharge points.
4) Take your class out and explain that when it rains, water is drained into these catch basins and picks up any human pollution that happens between the rainfall and the catch basin.
5) Explain that it then travels throughout these Storm Drain Networks and all of the pollution is discharged into rivers and lakes that they swim in during the summer.
    a) Walk the storm drain network with the students if possible.
6) This is an interactive opportunity to take your students outside on a sunny day and have them interact with the outdoors.


Oak St
Gale Ave
Sherwood Ave
Sherwood Ave

Lesson 5: Best Stormwater Management Practices

Introduction

Chapter	Stormwater Runoff	Day 5	Grade Level: 5
Title of Topic	Best Management Practices (BMPs)	Time: 40-50 minutes	

Desired Outcome from Lesson: Students will be able to identify different practices and designs that help protect Earth's resources and the environment.

Topic of Lesson: Students will learn how runoff can be reduced through best management practices while using a model, sketch, drawing, or other representation of a BMP to solve a stormwater runoff problem in an urban setting.

Goals of the Day: Students will understand what Best Management Practices are and how they can naturally filter water. Then, they will engineer a BMP model to incorporate into a scenario and use scientific writing to back their reasoning for their design.

Essential Vocabulary:

- *Stormwater Runoff*- Generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.
- *Best Management Practice*- A type of water pollution control.
- *Urban Environment*- A human settlement with high population density and condensed houses/buildings such as cities, towns, or suburbs.
- *Rural Environment*- Open land that has few homes or other buildings, and not very many people.
- *Impervious Surfaces*- Surfaces, such as asphalt, roofs, and sidewalks, where water cannot easily absorb into the ground.
- *Porous Surfaces*- Surfaces where water can easily absorb into the ground.

Extended Vocabulary:

- *Rain Barrel*- A water tank used to collect and store rainwater runoff, typically from rooftops via pipes.
- *Rain Garden*- A planted depression or a hole that allows rainwater runoff from impervious urban surfaces the opportunity to be absorbed.

Teacher Guideline

Overview:
This lesson plan is for students to learn how stormwater runoff pollution can be reduced through the best stormwater management practices. It will also force them to interpret a scenario and come up with what they think would be the best management practice for that scenario.

Note to Educator:
This lesson plan covers the Next Generation Science Standards and also is interactive. This lesson lets the students think like engineers as they have to design their own best management practice for two different scenarios.

Materials:
- Printed handouts (provided)

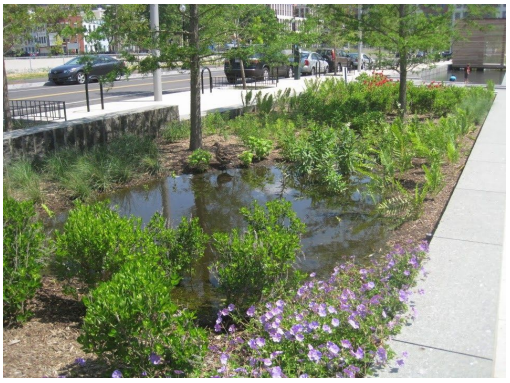
Instructions:

Part 1

1. Play video 1 (Rain Gutter)
    a. https://www.youtube.com/watch?v=EbzLT7dR_1A
2. Now play video 2 (Rain Barrel)
    a. a. https://www.youtube.com/watch?v=QJdKECi1cAg
3. Ask the students what they see is happening at the end of each video
4. Explain to the students that what they see is a rain barrel, a barrel used to collect and store rainwater runoff, typically from rooftops via pipes.
5. Explain that a rain barrel is an example of a best management practice, a type of water or pollution control. The rain barrel is an example of pollution control because it collects pollutants from gutters on roofs and can be used as irrigation that naturally gets filtered in the ground. It also prevents water from turning into runoff and further flowing across impervious surfaces.

Part 2

1. Ask the students if they can describe what best management practices are.
    a. A BMP is a type of water pollution control
2. Ask if they can think of examples of best management practices
3. Once they cannot think of any more examples, show them the pictures below of examples of the best management practices.
    a. Ask students what they think the picture is
    b. Then tell/show them the definition

	Bioswale- landscape elements designed to concentrate or remove debris and pollution out of stormwater runoff water. A bioswale is most commonly found in neighborhoods as it collects pollutants running down impervious surfaces.
	Rain Garden- is a garden of native shrubs, perennials, and flowers planted in a small depression, which is generally formed on a natural slope. It is designed to temporarily hold and soak in rain water runoff that flows from roofs, driveways, patios or lawns. These are most effective in cities, but can also work in other environments.

	Rain Barrel- is a water tank used to collect and store rainwater runoff, typically from rooftops via pipes. A rain barrel works best at the bottom of a house's gutter in a typical neighborhood. These catch the rain that runs off the roof of your house!
	Permeable Pavers- pavement that is cut into squares and has breaks between them so that water can filter through. These can be most commonly found in neighborhoods or cities that have a lot of impervious surfaces.
	Signage- Making people aware of where pollutants flow too. These are usually found in cities with a lot of impervious surfaces are, but can work in other environments.
	Aggregate Strip-a material or structure formed from loosely compacting rocks. The rocks are able to slow down the flow of stormwater because water is able to leak into and through the loosely packed rocks. This type of BMP works in most environments but is especially effective in rural environments.

Part 3

1. Pass out each provided handout to the students
2. Have half the class work on scenario one and have the other work on scenario two (Pass out each handout).
3. Lead a discussion on each scenario that gives the students ideas of which BMP to design.
4. Next, in the first blank rectangle, have the students engineer (Draw) the whole scenario including their BMP with labels of parts.
5. Then, in the second blank rectangle, have the students use the Claim-Evidence-Reasoning thought process to discuss whether they agree or disagree with Town Engineer Smith.
    a. For the Farm
        i. The Town Engineer, Mr. Smith, believes the aggregate strip is the best management practice for the farm. Do you agree?
            1. Claim - Evidence - Reasoning
                a. The claim should be 1 sentence.
                b. Evidence should be 2 sentences.
                c. Reasoning should be 3+ sentences.
    b. For the neighborhood
        i. The Town Engineer, Mr. Smith, believes the rain barrel would be the best management practice for the neighborhood. Do you agree?
            1. Claim - Evidence - Reasoning
                a. The claim should be 1 sentence.
                b. Evidence should be 2 sentences.
                c. Reasoning should be 3+ sentences.

Name: _____

Lesson 5: Engineering a Best Management Practice

1. Farmer Joe owns a farm at the very top of a hill overlooking a town. This farm includes many animals, chemically treated plants, and loose soil. There was a large rainstorm last week and the stormwater runoff carried fertilizer, chemicals, animal droppings, and soil to a river nearby. Farmer Joe calls you, the Town Engineer, for help to prevent polluting the storm water runoff in future storms.

2. Lawyer Laura just bought a new house in a nice neighborhood in Worcester, MA. When it rains, the stormwater flows from the roof of her house to the gutters. The gutters pour onto her driveway which flows into the streets. People in the neighborhood walk their dogs without picking up after them, drop food wrappers, and do not clean up oil spills from their cars. There was a large rainstorm last week and pollutants were carried by the stormwater runoff down storm drains that discharge directly into Indian Lake in Worcester. Lawyer Laura calls you, the Town Engineer, for help to prevent polluting the storm water runoff in the future.

Engineer the **BEST** Management Practice model to incorporate into a scenario. Sketch your design in the box below.

Town Engineer Smith believes that the aggregate strip would be the **BEST** Management Practice for Joe and the rain barrel would be the BMP for Laura. Use Claim Evidence Reasoning to explain if you agree or disagree with Mr. Smith for the situation you chose.

Claim:
Evidence:
Reasoning:

Lesson 6 Part 1: Enviroscape Demonstration

Introduction

Chapter	Watershed / Stormwater Runoff	Day 6	Grade Level: 5
Title of Topic	Mapping How Water Flows / Enviroscape Presentation	Time: 40-50 minutes	

Desired Outcome from Lesson: Students will be able to use maps and sketches to identify local watersheds and the bodies of water they flow to.

Topic of Lesson: As it precipitates, water flows downhill into bodies of water. Students will learn the importance of understanding and identifying your watershed and where your water comes from.

Goals of the Day: Students will be able to explain and map how bodies of water connect to larger bodies of water in their watershed.

Essential Vocabulary:

- *Groundwater*- Water that moves down into the ground (due to gravity) passing between particles of soil, sand, gravel, or rock until it reaches a depth where the ground is filled, or saturated, with water.
- *Stormwater Runoff*- Generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground.
- *Watershed*- An area or ridge of land that separates waters flowing to different rivers, basins, or seas.
- *Pollutant*- A substance that causes harm to the environment, especially water or the atmosphere.
- *Non-point source pollution*- Caused when rainfall or snowmelt, moving over and through the ground, picks up and carries natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters and ground waters.
- *Point source pollution*- Any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack.

Teacher Guideline

Overview: Youth will describe and identify how water flows over impervious surfaces and takes pollutants to local bodies of water.

Note to Educator: If looking to purchase an Enviroscape table, contact your local DPW official or regional stormwater coalition. Enviroscape tables can also be borrowed for free from local watershed groups or DEP locations. Students will be able to visualize and investigate how stormwater runoff travels on impervious surfaces.

Materials:

- Enviroscape
- Baking Soda
- Food coloring
- Cocoa powder
- Water and spray bottle
- Cups

Instructions:

Teacher preparation

1. Setup enviroscape by placing animals, houses and trucks on the landscape.
2. Fill spray bottle with water.
3. The baking soda, food coloring, cocoa powder, etc. represents the different pollutants.
    a. Ex: food coloring= pesticides/herbicides, cocoa powder= animal waste
4. Place pollutants in different cups and label each pollutant.

In class

1. Describe the enviroscape to the students.
2. Place pollutants in different areas on the landscape and describe them to the kids.
3. Pose the question, “What do you think will happen when it rains?”
4. Let kids work in groups to come up with answers.
5. Use the spray bottle and spray the landscape.

6. Ask what they see. “Why is the water flowing on the streets? Why isn’t it being absorbed?”
7. Explain to the students the difference between porous and impervious surfaces.
8. Ask the students where the water flows to.
9. Ask them if they can come up with examples of each:
    a. Porous: grass, dirt
    b. Impervious: streets, roads (any pavement)
10. Continue spraying until pollutants end up in the river.
11. Ask the students if they can explain why this happened
    a. Answer: stormwater runoff, water flows over impervious surfaces picking up pollutants on the roads, flowing down storm drains and entering local bodies of water.

Lesson 6 Part 2: Impervious vs. Porous Surfaces

Teacher Guideline

Overview: Urban and Rural environments have different effects on stormwater runoff. One main factor being increased impervious surfaces in urban environments.

Note to Educator: As a facilitator, force the students to derive the essential questions by asking triggering questions.

Materials:

- 2 Paint Pans per Group
- Markers
- 2 8oz. Cups of Water
- Sponges (or Green Felt)

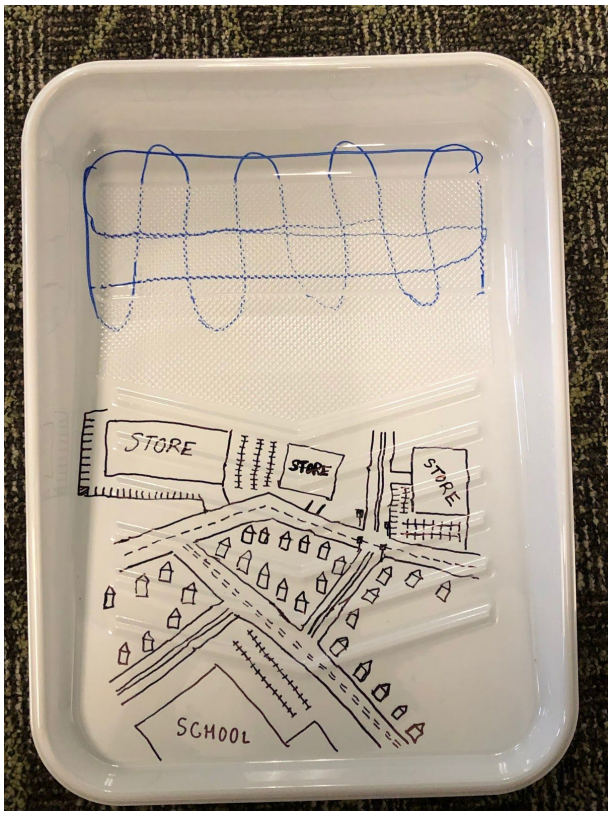
Instructions:

Teacher preparation

1. First break the students into groups of 3-5.
2. Show ***Dr. Drain the Rain Brain Stormwater 101 Video.*** (If not shown with 1st lesson)
    a. This video is easily found on youtube.com by searching "Dr. Drain the Rain Brain Stormwater 101".
3. Have two clear paint pans to demonstrate the difference between impervious and porous surfaces (This can also be done in groups of 4).
4. Have the students draw an urban community in one of the paint pans with the bottom of the paint pain representing a body of water.
    a. This will represent impervious surfaces.
5. Have the students fill their other paint pan with green sponges (or green felt). This is made to represent the forest.
6. Now have a student come to the front of the class and pour 8 oz. of water on the top side of each pan.

a. Ask a driving question of in which environment the water reached the bottom of the pan first. Why? (Explain to the students that these two pans represent different environments, one being a rural environment and one being an urban environment.)

7. Show the students two photos on the worksheet and pass out the worksheet, one being an urban setting, another being a rural setting:
    a. Have the students investigate with their group and discuss the differences of what will happen when it rains.
    b. Have the groups identify various things that create an increase/decrease in stormwater runoff in each environment.
    c. Have the student's think of items stormwater runoff could pick up along its way to a storm drain in an urban environment.



LESSON 6		
What will happen when it rains?		
Where does all the stormwater go?		
List pollutants that rainwater could pickup?		

LESSON 6 ANSWER KEY		
What will happen when it rains?	• **Water will flow from roads, sidewalks, roofs into storm drains.**	• **Water will infiltrate the ground through absorption. Some water will flow on top of the grass into puddles or small ponds.**
Where does all the stormwater go?	• **The stormwater goes into the storm drains and flows through pipes into a local body of water.**	• **Stormwater will absorb back into the water table or flow naturally into bodies of water.**
List pollutants that rainwater could pickup?	• **Water Bottles, leaves, trash, salt and sand, oil and gas.**	• **Fertilizers, paint, animal waste.**

Lesson 6 Part 3: Water Filtration

Teacher Guideline

Overview: Students are asked to design methods to filter water using ordinary materials. They will also learn about the importance of water and its role in our everyday lives.

Note to Educator: This lesson plan will draw an Engineering Connection as the students will be designing their own filtration. This will open the eyes of the students and show them how polluted water is unhealthy to drink, swim in, and use.

Materials:

- 1 liter of water (Prepared in advance)
- 3 test tubes prepared with the water standards A, B, and C.
- Cotton balls
- Gauze squares
- Netting
- Tissue
- Paper towels
- Coffee filters
- Gravel
- Sand
- 3 test tubes per student group
- Graduated Cylinder
- Worksheet

Instructions:

Teacher preparation

1. Gather materials and print copies of worksheet.
2. Make the liter of water dirty with mulch/dirt.
3. Filter out tubes A, B, and C.
    a. A is filtered through grass and a strainer, B is filtered through a coffee filter and a strainer, and C is filtered through 2 coffee filters with a paper towel and a strainer.
    b. These all should be different colors. The students will use these as a guide to base their filtered water off of.

In class

1. Create an Engineering Opportunity: Tell the students that they are an Engineering Firm and they have to solve a problem in their town from a drought that has occured. Show them the three test tubes prepared and how: C is almost ready for human use, B is almost ready for animal use, and A is almost ready for plant use. They will recieve money for the amount of filtered water they supply.
2. Have the students fill out the worksheet provided to make sure they understand the purpose and to start thinking like an Engineer.
    a. Think of three different filtration methods.
3. Provide students with the materials and let them decide on what materials they want to use to filter their water.
    a. Provide them with a budget and make unit prices for each material.
    b. Make the budget low so they can think about how to maximize their materials.
4. Have students draw schematics of their filtration process to think like an Engineer. Once this is completed provide them with 25mL of dirty water.
    a. They have to come up with a filtration process to match the first shown tubes. (A, B, and C).
5. Once this is complete, they will compare their filtered water results to the ones provided and then answer the last question on the worksheet.

Name:_____ Date:_____ Class:_____

Water Filter Worksheet

1) After looking at the three samples, write down what materials you want to use for samples A, B, and C.

2) What are your limits when designing your water filter?

3) After creating your samples, how would you change your design if you had to do it again?