EARTHECHO INTERNATIONAL

Install a Rain Barrel In Your Community

with

BARRELS BY THE BAY

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Classroom Standards

Next Generation Science Standards

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

ESS3.A : Natural Resources:

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

- **ETS1.A: Defining and Delimiting Engineering Problems**
  The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

- **ETS1.B: Developing Possible Solutions**
  There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

Classroom Standards

Common Core English Language Arts Standards

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text

RI.6.1;RI.7.1;RI.8.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text

RI.5.4 Determine the meaning of general academic and domain-specific words and phrases

RI.6.4;RI.7.4;RI.8.4 Determine the meaning of words and phrases as they are used in a text.

RI5.7 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.6.7 Integrate information presented in different media or formats (for example visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

RI5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

W5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic

W6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate

W7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation

W8.7 Conduct short research projects to answer a question, (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration

W5.9; W6.9; W7.9; W8.9 Draw evidence from informational texts to support analysis, reflection and research

SL5.2 Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SL6.2 Interpret information presented in diverse media and formats, (eg. visually, quantitatively and orally) and explain how it contributes to a topic, a text, or issue under study

L5.1; L6.1; L7.1; L8.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

L5.2; L6.2; L7.2; L8.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing

L5.3; L6.3; L7.3; L8.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening

L5.6; L6.6; L7.6; L8.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases

How to Install a Rain Barrel

Project Summary

While learning about the water cycle, students will investigate local issues related to either urbanization, stormwater, or drought (location dependent). Through their investigation, students will identify local issues and plan for the installation of a rain barrel to mitigate local precipitation-related issues.

Driving Question

How can a rain barrel help to return water to its natural cycle in my own community?

Investigate

Before jumping into action, students must first understand the necessity of their action and the scientific concepts behind the issues. During the investigation stage, you will lead students through brainstorming activities, video investigations, and text and media investigations.

If the concept of a **rain barrel** is unfamiliar to your students, you may need to do some additional brainstorming before beginning the investigation. Have students brainstorm individually about what a **rain barrel** is, using either words or pictures, before sharing as a class.

Have students explore the following resources and take notes in a way that best fits your classroom. The *Into the Dead Zone* video and the *Urbanized Water Cycle a*ctivity have accompanying worksheets which could be turned in, while the additional resources can be explored in any way you prefer.

WATCH

Into the Dead Zone: Day Two: What Happens When We Build Cities?

This video gives students background into how urbanization disrupts the natural water cycle. As an option, have students complete the accompanying worksheet while they watch the video.

Bay 101: Stormwater Runoff

For additional information on stormwater, watch this short video from the Chesapeake Bay Program.

How to Install a Rain Barrel

READ

Why Stormwater Matters (attached to packet, pg. 13)
The introduction to our *Rain Check Action Guide* gives students a concise overview of why stormwater can be a problem for communities around the globe.

SUNY College of Environmental Science and Forestry's Rain Barrel Website
Direct the conversation back to rain barrels and how rain barrels help bring water to the natural cycle, even in a climate with very little precipitation.

DO: Mini-Lab

Urbanized Water Cycle
This activity gives students a hands-on look at the effects that impermeable surfaces have on the water cycle. Abbreviated instructions are below; Click HERE for a comprehensive, stand alone lesson plan.

SET-UP: Students are going to "make it rain" on four different communities and record how that water moves through the hydrologic cycle after precipitation. This simulation is based on a series of scientific studies on land use.

Raindrop proportions for each community represent the distribution of rainfall through various pathways (Evapotranspiration, Runoff, Infiltration) based on the percent of impervious cover in a community. **Do not reveal impervious cover estimates for each community prior to students conducting their experimental rainfall events.** This will be the foundation for discussion during the explanation phase of this activity.

To set up: Create four "community" stations in separate areas of the room or separate lab benches. Each station includes a small paper bag or other container with specific proportions of raindrops; rain drops can be labeled paper cut outs, different colored chips, or whatever you prefer! The proportions of raindrops are as follows:

Community A:	10 raindrops labeled Evapotranspiration
<10% Impervious Cover	6 raindrops labeled Shallow Infiltration
	7 raindrops labeled Deep Infiltration
	2 raindrops labeled Runoff

Community B: 10 – 20% Impervious Cover	10 raindrops labeled Evapotranspiration 5 raindrops labeled Shallow Infiltration 5 raindrops labeled Deep Infiltration 5 raindrops labeled Runoff
Community C: 35 – 50% Impervious Cover	9 raindrops labeled Evapotranspiration 5 raindrops labeled Shallow Infiltration 3 raindrops labeled Deep Infiltration 8 raindrops labeled Runoff
Community D: 75 – 100% Impervious Cover	8 raindrops labeled Evapotranspiration 3 raindrops labeled Shallow Infiltration 1 raindrops labeled Deep Infiltration 14 raindrops labeled Runoff

In small groups students will:

1. Simulate five rain events at each station by drawing 10 raindrops at random from the bag.
2. Record (sample data sheets can be found at the end of this packet) where that water moved after rainfall (evapotranspiration, shallow infiltration, deep infiltration, or runoff).

After gathering data on five rain events:

3. Calculate the percentage of rainfall in each category for each community.
4. Answer analysis questions. A set of questions is included at the end of this packet.

After students have answered analysis questions, reveal the impervious coverage in each community and discuss analysis questions

RESEARCH

Now it's the students' turn to learn more about **rain barrels** locally. Direct students to conduct research on rain barrels and stormwater runoff in your local community. How students conduct and report their research is up to you, they can work individually or in groups, on all topics, or just one and share! Topics to research:

- Local article or news story that relates to stormwater issues ~~to~~ in your community,
- Local laws and regulations regarding stormwater runoff,
- At least one local organization working on stormwater issues or rain barrel installation in your community.

As an extension, you can have students conduct an interview with a member of the community that relates to their research. Tips for conducting an interview can be found in our Action Guides.

PROBLEM STATEMENT

Now that your students have completed their investigation, they should be able to craft a problem statement.

A problem statement should answer three questions:

- What is the problem or need?
- Who has the problem or need?
- Why is it important to solve?

Problem statements are written in the following format: **Who** need(s) **what** because **why.**

Ex. ***Washington, DC schools*** need ***rain barrels*** because ***stormwater runoff from impervious surfaces are contaminating our local rivers.***

For this project we have partially filled in a problem statement for you. Your students will be brainstorming the **why** portion. Complete the problem statement and have students refer to it often during the remainder of the investigation phase.

Our community needs **a rain barrel** because ____.

For additional discussion, you could have students answer the project's driving question in more depth. How you choose to have students answer this question is up to you, it could be in a reflection paper, as a group discussion, or a presentation. The "answer" to the driving question should include reference to your action.

Driving Question: *How can a rain barrel help to return water to its natural cycle in my own community?*

Prepare

Your class has identified *why* your community needs **a rain barrel**, now you must determine your plan for action.

AUDIT

To determine the best location for a rain barrel on your school property (or within your larger community), complete the *Rain Check School Stormwater Management Audit* to identify areas of your school or community that could most benefit from a rain barrel.

Audits give you a way to collect information by making observations, asking questions, and documenting findings with photographs. This audit will focus on the stormwater and runoff around your school property, including how it moves over the land, where it goes, and the surfaces that affect the water cycle.

There are different ways to approach the stormwater audit as a class. Select one of the methods below:

1. *Create a list of all current stormwater management practices and issues.*
2. *Construct a scale map of school grounds using graph paper. Once the map is constructed, follow the audit instructions using your paper map.*
3. *Create an interactive map using Google's My Maps Engine and/or Google Earth. One My Maps map can be utilized at the same time on many different devices, allowing for great collaboration.*

If you are using Google's My Maps, first outline the school property so you have specific and clear boundaries. As you work through the audit, add different markers for each Stormwater Capture Feature, Low Impact Development Feature, and Poor Water Flow Indicator as noted in the list below. Objects that take up a large area, such as gardens and swimming pools, can be outlined, then measured with the line tool in My Maps. Similarly outline all impervious surfaces including parking lots, athletic courts, roadways, and roofs. Pictures can be an incredibly helpful addition to your audit.

Data collection is divided into four main areas:

- *Stormwater Capture Features*
  - *Downspouts*
  - *Downspout Catch Basins*
  - *Storm Drains*
  - *Stormwater Outfalls (area where many storm drains empty)*
- *Low Impact Development (LID) Features*
  - *Rain barrels or cisterns*
  - *Pervious sidewalks or lots*
  - *Green roof or living wall structure*
  - *Rain gardens*
  - *Native Plant Gardens*
  - *Food Gardens*
- *Poor Water Flow Indicators*
  - *Soggy patches or puddles on pervious surfaces*
  - *Puddles or standing water in impervious surface*
  - *Evidence of erosion (bare ground, scour, channels through dirt)*
  - *Moss or slippery wet areas on pavement*
  - *Water damage (cracks) on pavement*
  - *Hills or slopes*
- *Impervious Surfaces (in most cases)*
  - *Any structure on property (buildings, sheds, etc.)*
  - *Parking lots*
  - *Sidewalks*

Once you have created your map using the Rain Check School Stormwater Management Inventory, you will begin to identify and prioritize areas of the school property where you can have the largest impact. Discuss ways you can slow *down stormwater on your school property and return rainwater to its natural cycle. Areas near downspouts, especially where there is puddling or signs of erosion, will be the best places to install a rain barrel.*

Now that you have completed your audit, and agreed on where your rain barrel should be installed, it's time to take action!

Take Action

Paint your Rain Barrel! Once you've received your rain barrel from Barrels by the Bay and decorating instructions, go for it! Allow students to express themselves

Plan your installation day so that everything goes smoothly! Make sure that all team members and volunteers know where to be when and that everyone is assigned a job or duty. Consult Barrels by the Bay Learning Guides for proper installation and maintenance practices.

Enjoy your day! The planning is over, the materials are purchased, and it is time for your install! Be sure to compliment yourself on your success and spread the word about your accomplishments!

Share

Share your story with the world! Get creative and share your story over some of your favorite media (social media, YouTube, blogs, school newspapers, etc.). There is no limit to how you choose to share! Be sure to share your story with EarthEcho as well by emailing education@earthecho.org.

Urbanizing the Water Cycle

Data Sheet

Community ______

	Rain from Storm Event 1	Rain from Storm Event 2	Rain from Storm Event 3	Rain from Storm Event 4	Rain from Storm Event 5	Total Drops	Mean Number of Raindrops
Deep Infiltration							
Shallow Infiltration							
Evapo-transpiration							
Runoff							

What was the total number of raindrops sampled? ______________________________

What was the percentage of rain that returned to the aquifer through:

Deep Infiltration? __________________ Shallow Infiltration? _____________________

Infiltration? (both) _________________

What was the percentage of rain that moved through the water cycle through:

Evapotranspiration? __________________ Runoff? __________________

Analysis Questions

What factors could cause the differences in the amount of runoff and infiltration between these communities?

How could the differences we see in each community impact the natural water cycle for the area?

What community do you predict has the cleanest overall surface water (rivers, streams, lakes, and ponds)? Why?

Stage 1: Check It Out →INVESTIGATE

Why Stormwater Matters

Consider what your community looked like before you had paved roads, skyscrapers, malls, supermarkets, apartment buildings, and movie theaters. The landscape was completely different. Most of what people used came from the local environment. People grew the crops they needed to feed their families, perhaps with extra to share or sell. Animal agriculture was on a small scale, with animal waste integrated into farm life as manure. Without refrigeration, simple methods were employed to preserve food. Without electricity, people went to sleep and awoke according to the natural rhythms and cycles of the day. They created their communities around access to water—surface water and ground water for wells. Rain was critical for survival. Rain filled creeks, rivers, streams, and ponds. Rain soaked into the ground, with soil acting as a natural filtering system, to fill our underwater systems of seemingly invisible waterways.

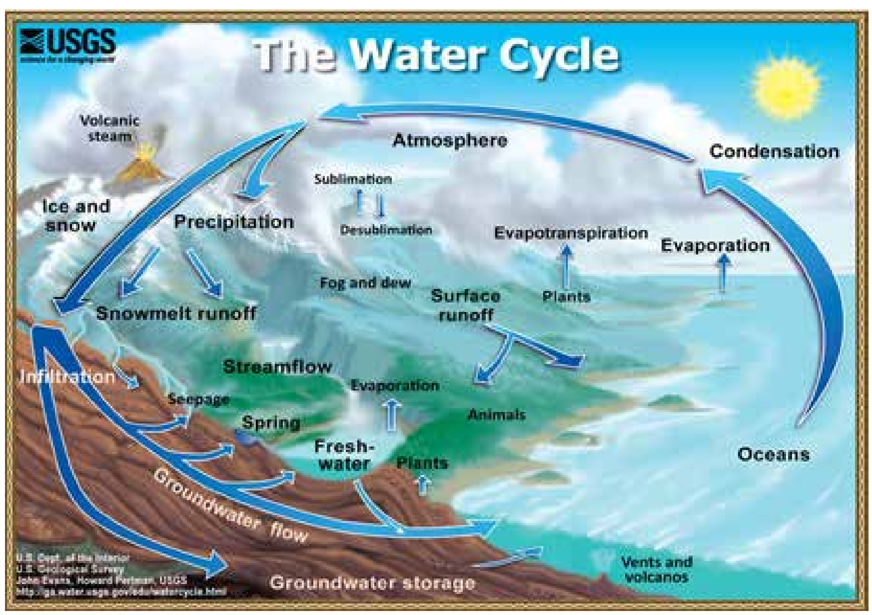
Investigating Your Skills and Talents!

As you begin to learn more about stormwater issues, find out, also, the unique abilities of every member of your group. Conduct a ***Personal Inventory*** by interviewing each other about your interests, skills, and talents. Make a list. Refer to this list as you develop your plan of action. Any photographers? Great for documentation. Does someone like to write? Ideal for composing a press release. Any artists? Excellent for graphic designs. Find a Personal Inventory document on page 28.

How different our world is today! Every element of that description needs a rewrite to fit into what we see in our neighborhoods and communities, or what we know to be true about industry of all forms. We live in a world of abundance. Manufacturing is on a huge scale as is agriculture to feed the growing global populace, now over 7 billion people.

Fortunately, there is an international recognition and acknowledgement that our natural planetary resources are limited. The "green" movement of eco-awareness is global, with many countries adopting protective policies. While going green is of tremendous importance, keep in mind that all things green can only grow with blue: water.

Worldwide awareness of looming water crises has stirred discussion in all parts of the globe. Unpredictable weather conditions have caused unexpected long-term droughts. Pollutants taint once pure streams. Today, *every* water resource is at risk from contaminants that seep into our groundwater or pour from storm drains or pipes into rivers and waterways.



You have already heard that the amount of water on earth remains the same, regardless of the population. In school the science of water is taught repeatedly at many grade levels as the *hydrologic cycle*, the ongoing exchange of precipitation and evaporation. Water evaporates from the earth's surface and falls back as precipitation—rain, snow, sleet—back onto the land, oceans, and interconnected systems of waterways. The water returns to the oceans either on the surface as river runoff and or beneath the surface of the earth as groundwater flow.

Common sense tells us that with a

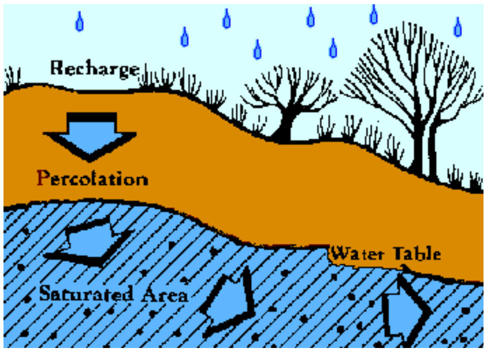


image from http://academic.evergreen.edu/g/grossmaz/KIEPERME/IMAGES/recharge.gif

limited supply of something as precious as water, we would all make a concerted effort to protect every drop. Instead, our way of life interrupts the hydrologic cycle. The key rainstorms that in days long past would soak into the ground replenishing our groundwater are obstructed. What are these impediments? Pavement. Concrete. The *built* environment keeps water from this natural and critical ongoing exchange.

While we often see the hydrologic cycle in its simplest depiction with water from the oceans *evaporating* to the clouds, then *precipitating* on land to be brought to the sea through rivers and streams, this model is oversimplified. The urbanization of the hydrologic cycle has deep impact on our ecosystems by diverting water from pathways that are critical to water purity and storage. What are some of these concerns?

- **Infiltration**: Due to pavement, concrete, impaction, or other impervious surfaces, rainwater often cannot *infiltrate*, or penetrate the ground thereby absorbing into soil and filling the spaces between soil particles. As a result, the land and the area underneath it become uninhabitable by plants because there is no water stored in the soil for plants to use. Plants not only utilize water for respiration and photosynthesis, they release water vapor back into the atmosphere through *evapotranspiration* as part of the hydrologic cycle. Additionally, rainwater must infiltrate to begin the process of *percolation*, another critical pathway for water within the hydrologic cycle. As you will learn by reading more of this Action Guide, communities are promoting keeping water where it falls, infiltrating into the soil, and avoiding runoff.
- **Percolation**: We need *percolation*, the slow movement of water through the porous spaces of soil and permeable rock so our *aquifers* are recharged and refilled. While we may think more about the bodies of water we *do* see, these underground reservoirs matter and some are quite deep.
- **Groundwater recharge**: *Groundwater recharge* is water that has successfully soaked into (infiltrated) the ground, and moved through pores and fractures in soil and rock (percolated) to the water table. The *water table* is the depth at which soil and rocks are fully saturated with water. Recharge maintains the supply of fresh water that flows through the groundwater system to wells, streams, springs, and wetlands.
- **Evapotranspiration**: Water has to get back to the atmosphere to keep this hydrologic cycle ongoing. Evapotranspiration is the sum total of *evapo* + *transpiration*, or evaporation + plant transpiration, the water moving through the plant's roots system and being released as vapor through the leaves. All of nature depends on a balance. Too much evapotranspiration can negatively impact the amount of groundwater recharge. All is connected. The hydrologic cycle works best when, in healthy ecosystems, precipitation can travel through a variety of pathways. By blocking these natural pathways for water with concrete, asphalt, and roofing materials, we have created unnatural circumstances. Stormwater runoff is a result of our intrusion into what Mother Nature had designed.

Check the Glossary on page 49 for more key words that relate to stormwater found throughout this guide.

So what happens instead of what Mother Nature had in mind? In many of our cities, stormwater moves quickly along impervious surfaces, such as roads and roofs, where water cannot penetrate. Along the way that water picks up a variety of contaminants like plastic bottles, brake dust from cars, and pet feces that is carried along until it eventually reaches a *storm drain*. Storm drains are essentially holes or cut outs in our roads and curbs that have a variety of designs. All are connected to underground pipes and most are made to keep large debris out while allowing water to pass and not pool on streets or parking lots. Once in the storm drain, stormwater from many places is combined and channeled through a system of tunnels to an *outfall*. Outfalls are the points where stormwater or drainage discharges from a sewer pipe, ditch, or other means to a receiving body of water. The stormwater from multiple sources with multiple contaminants empties into a body of water. This polluted water is labeled as *nonpoint source (NPS) pollution* since there is no single, identifiable source of the nutrients or toxins that are present in the stormwater.

As you would expect, chemical contaminants like oil and pesticides have a negative impact on aquatic ecosystems in the streams, rivers, and lakes that receive stormwater. More surprising is that some of the most debilitating impacts come from sources that occur naturally. While nutrients like nitrogen and phosphorus are essential for plant growth both in the water and on land, the amount of these nutrients that are available limits plant growth in most aquatic ecosystems. Nutrient levels fluctuate depending upon a variety of factors including periodic flushing of nutrients through the ecosystem during large rain events. But high nutrient concentrations can also be brought to aquatic ecosystems through stormwater and agricultural runoff. These high concentrations cause imbalance within the ecosystem that often results in *eutrophication* of the water body. Eutrophication is characterized by sudden bloom, or increase, in phytoplankton (microscopic plants and algae) that results in a dramatic reduction in the dissolved oxygen available for plants and animals. So for our rivers, lakes, and oceans more is certainly not better where nutrients are concerned. As a matter of fact, these excess nutrients result in *dead zones* where only bacteria can live. These huge volumes of nitrogen and phosphorus regularly enter our waterways through the inappropriate application of commercial fertilizer and manure, uncontrolled domestic animal waste from livestock and pets, and untreated wastewater from homes and businesses.

Why does stormwater matter? For the same reason our planet matters: this is our home.

DEAD ZONES: Where in My world?

According to the National Oceanic and Atmospheric Administration (NOAA), a dead zone can occur in oceans and lakes all over the world where little to no oxygen is dissolved in the water. Most aquatic life either dies, or, if mobile like fish, leaves the area. Do some investigating: find the dead zone closest to where you live.