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Northeast Iowa Stormwater Education Program

Watershed Guardian Teachers Packet

Northeast Iowa Resource Conservation and Development

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Introduction

Fishing at Backbone State Park

Dear Teachers,

We are very excited you chose to bring your students to Northeast Iowa RC&D's Regional Urban Stormwater Demonstration Site. Thank you for allowing us to help you introduce stormwater and watershed science to your students.

The Watershed Guardian Program is intended to teach students about their watershed, the water cycle, stormwater runoff, the importance of clean water as a natural resource, the connections between communities and local streams and rivers, the impacts people have on the environment, and the actions they and others can take to reduce stormwater runoff and improve water quality at their home, school and in their community. It is also intended to empower the students and spur them to action. The program is presented in three parts, one of which you have just completed by visiting the Stormwater Demonstration Site. The next two parts, explained more in the next section below, include completing the teacher's packet and implementing a conservation practice at your school or in your community.

Lessons in the teacher's packet allow students to perform actual tests to determine the water quality of a particular water source, dive deeper into their watershed, and prepare for implementation of urban stormwater management Best Management Practices (BMPs) in their community. Lessons are coded for Iowa Core Standards making it easier for you to meet State requirements. Lessons in this packet are from the following sources: EPA, Rutgers Institute of Marine & Coastal Sciences, John Santangelo from Central Junior High in Melbourne, Florida, by Eileen Tramontana from the Suwannee River Water Management District in Live Oak Florida, the Illinois Department of Natural Resources, Chicago Wilderness, and World Wildlife Fund.

The Watershed Guardian Program will engage students to participate in a stormwater management movement, and empower them to directly impact their communities through the installation of an urban stormwater practice and to quantify their impact. It will increase their understanding of the issues and build a community of youth leadership.

We are looking forward to being a resource for you through this journey. We encourage you to work through the Watershed Guardian Program. If you have any questions, please feel free to contact the Northeast Iowa RC&D Environmental Education Coordinator, Tori Nimrod.

Thank you,

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The Watershed Guardian Program

Part 1: Field trip to Stormwater Demonstration Site in Postville, Iowa

The City of Postville, Northeast Iowa RC&D, US Environmental Protection Agency, the National Fish and Wildlife Foundation, US Fish and Wildlife Service Partners for Fish and Wildlife, Alliant Energy, and other partners have teamed up to develop a Stormwater Demonstration Site in Postville installing several urban stormwater conservation practices with bilingual interpretation, Spanish and English, of each practice. Students from around Northeast Iowa are invited to visit the demonstration site where they will engage in hands-on learning about the stormwater runoff, the impact stormwater runoff has on water quality, flooding and local streams and river, and about projects that they and others can implement to reduce the impact of stormwater runoff. The site visit will include a tour of the grounds where students will gain an understanding of how urban communities can improve their stormwater management to improve water quality and reduce the impacts of flooding. They will also get an idea of things they can do at home to improve water quality, whether it is not using fertilizer on their lawn, or implementing a rain garden. If time permits, and the teachers desires, the site visit may also include interactive activities like the ones listed below.

- EnviroScape Demonstration
    - *Students will get to explore the relationship between point and non-point pollution. They will also learn the different sources of pollution form both urban and rural areas.*
- Rain Simulation Demonstration
    - *Students will learn the relationship between water and the landscape. Students will gain an understanding of erosion and its effect on our water sources, as well as the importance of ground cover through native vegetation.*
- Rain Barrel Construction Demo
    - *Rain Barrels are very simple ways community members can limit flash flows by collecting rain water and using it around their home. Students will learn how to make a rain barrel that can be used at their home, and the importance of rain water harvest. Community Rain Barrel program is a potential project for the Watershed Guardian Program.*
- Groundwater Movement Demo
    - *The groundwater movement demonstration allows students to learn the relationship between surface and groundwater in the Karst landscape of northeast Iowa. They will learn the importance of water quality in relation to their own drinking water.*
- Kiosk Scavenger hunt
    - *Located around the Regional Urban Stormwater Demonstration Site are education Kiosks that provide extra information on topics such as, the benefits of pollinators, evapotranspiration by trees, and much more. They include Detailed information about the urban conservation practices.*

This scavenger hunt allows students to read the kiosks and get a deeper understanding of Urban conservation.

Part 2: Participation in the cross-curricular Northeast Iowa Stormwater Education Program: Watershed Guardian Teacher's Packet

After students visit the Stormwater Demonstration Site, teachers are encouraged to lead cross-curricular learning through the Northeast Iowa Watershed Guardian Teacher's Packet. Lessons included in this teacher's packet will help students understand the overall impacts of urban stormwater on flooding and water quality. Lessons included in the packet are appropriate for middle school age level students, and each lesson correlates with Iowa core standards. The packet includes a mixture of indoor and outdoor, visual and hands-on, learning activities that apply to almost every student's learning needs. Lessons included in the teacher's packet have been transformed to reflect Northeast Iowa's karst topography. A pre and post assessment measures the students learning throughout the lessons. The teacher's packet also includes project ideas and activities that will prepare teachers and students to implement their own stormwater project. *Please note: the pre-assessment is intended to be implemented before the Field Trip to the RC&D.*

Part 3: Implementation of a Best Management Practice

Teachers who 1) bring their classes to the Northeast Iowa Regional Urban Stormwater Demonstration Site in Postville, 2) implement cross-curricular learning from the teacher's packet, and 3) select and plan for implementation of an urban stormwater BMP, are eligible to apply for the Watershed Guardian Grants. These grants may provide funding for use on implementation of urban stormwater BMPs. There are two tiers of grant awards, one of up to $500, which may be used for smaller projects, and a more competitive grant for up to $5,000. The smaller grants are available for a limited time to teachers and classes to implement urban stormwater BMPs, programs or initiatives at their school or in their community. The larger grants will help classes implement more extensive stormwater BMPs that measurably improve stormwater runoff management at their school or in their community. More detailed information about project ideas and implementation is included in this teacher's packet. The Northeast Iowa RC&D Environmental Education Specialist is available to help with conservation practice development and installation. Student participating in small or large projects will be recognized for the efforts through press releases to local newspapers and through individual recognition as a Watershed Guardian. *Note: No matching funds are required for either grant but students are required to participate in the planning and implementation of the project.*

Special Conditions

There will be special dates throughout the year when individual youth, with or without their families, or youth groups, may visit the stormwater demonstration site without their teacher, outside of school. Although grants will only be awarded to schools for

class projects, these students will be able to become a Watershed Guardian through follow-up implementation of their own stormwater management practice in their home or community. It is also possible that a teacher/class will decide not to follow their visit with implementation of a project but an individual student from that class would like to implement a project with their family and/or friends. In any of these cases, a picture of the individual or youth group during project construction and with the finished project can be submitted by the student/s to the RC&D Environmental Education Specialist if the student/s would like to pursue becoming a Watershed Guardian.

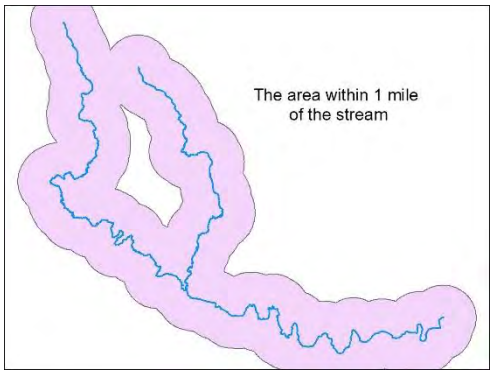
Teachers who are unable to visit the Northeast Iowa Regional Urban Stormwater Demonstration Site in Postville because of school restrictions/regulations may work with the RC&D Environmental Education Specialist to identify other options for viewing urban stormwater practices closer to their school. If they 1) visit other approved sites, 2) complete sections of the teacher packet in their classroom, including completion of the Pre and Post-test, and 3) provide related photographs and information to the RC&D Environmental Education Specialist, they may 4) select and plan for implementation of an urban stormwater BMP, and then 5) apply for a Watershed Guardian grant to implement that stormwater management practice. Their students may also become Watershed Guardians.

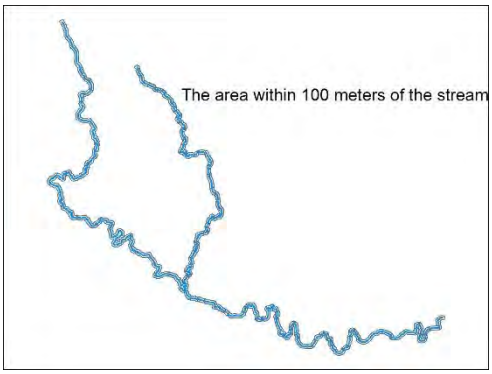
Postville High School Students planting rain gardens at the Northeast Iowa Urban Stormwater Demonstration Site.

Pre-Test Name:_____

JUNIOR WATERSHED GUARDIAN

1. Which map shows the land area of a watershed? The blue line represents a stream or river. **Circle the best choice**





2. What is a rain garden? And what is its purpose?

3. Percent of the earth's surface covered with water
    a. About 71%
    b. About 61%
    c. About 81%

4. Fish, cattails, frogs, water lilies, dragonflies, and all other living things in a pond make up.
    a. a population
    b. a community
    c. an ecosystem
    d. a biosphere

5. What is the name given to the distinctive *landscape* in Northeast Iowa that has been formed through the dissolution of limestone?
    a. Loess
    b. Sinkhole
    c. Karst
    d. Prairie

SENIOR WATERSHED GUARDIAN

6. Term used to describe the cloudiness of a body of water caused by sediment suspended in the water.

7. The most common Iowa aquatic pollutant is?
    a. Soil sediment
    b. Animal waste
    c. Untreated human waste
    d. Plastics and other trash

8. What are the three stages of the water cycle?
    a. evaporation, condensation, precipitation
    b. condensation, precipitation, hibernation
    c. precipitation, dehydration, evaporation
    d. transpiration, dehydration, condensation

EXPERT WATERSHED GUARDIAN

9. Plants that can thrive in really wet conditions are termed
    a. Succulents
    b. Annuals
    c. Hydrophytes
    d. Weird

10. What are 2 factors that will decrease erosion & turbidity?

11. An increase in the amount of impervious surfaces in a watershed could lead to
    a. Increased eutrophication
    b. Increased stormwater runoff
    c. Increased nutrient loading
    d. All of the above

12. What type of soil allows for the fastest infiltration of water?

Pre-Test (Answer Key)

JUNIOR WATERSHED GUARDIAN (WORTH 1 PT EACH)

1. Which map shows the land area of a watershed? The blue line represents a stream or river. **Circle the best choice**

2. What is a rain garden? And what is its purpose?

A rain garden is a special garden made up of sandy soil and plants that have deep roots. These characteristics make it good at infiltrating and filtering polluted water. They are used to catch drainages from small buildings or parking lots that are made up of impermeable surfaces. Purpose is to filter polluted water, improving water quality and reduce flooding by infiltrating more water into the ground.

3. Percent of the earth's surface covered with water
    a. About 71%
    b. About 61%
    c. About 81%

4. Fish, cattails, frogs, water lilies, dragonflies, and all other living things in a pond make up.
    a. a population
    b. a community
    c. an ecosystem
    d. a biosphere

5. What is the name given to the distinctive landscape in Northeast Iowa that has been formed with limestone?
    a. Loess
    b. Sinkhole
    c. Karst
    d. Prairie

SENIOR WATERSHED GUARDIAN (WORTH 2 POINTS)

6. Term used to describe the cloudiness of a body of water caused by sediment suspended in the water. Turbidity

7. The most common Iowa aquatic pollutant is?
    a. Soil sediment
    b. Animal waste
    c. Untreated human waste
    d. Plastics and other trash

8. What are the three stages of the water cycle?
    a. evaporation, condensation, precipitation
    b. condensation, precipitation, hibernation
    c. precipitation, dehydration, evaporation
    d. transpiration, dehydration, condensation

EXPERT WATERSHED GUARDIAN (WORTH 3 POINTS)

9. Plants that can thrive in really wet conditions are termed
    a. Succulents
    b. Annuals
    c. Hydrophytes
    d. Weird

10. What are 2 factors that will decrease erosion & improve water clarity?
Plant ground cover all year round, retention structures (ponds, rain gardens, bio-swales, and other farm practices), native plantings, increase permeable surfaces, etc.

11. An increase in the amount of impervious surfaces in a watershed could lead to
    a. Increased eutrophication
    b. Increased stormwater runoff
    c. Increased nutrient loading
    d. All of the above

12. What type of soil allows for the fastest infiltration of water?
    Soil that is high in sand content.

Section 1: Interactions Within a Watershed

Northeast Iowa has a landscape unlike any other in the state of Iowa. Steep limestone bluffs and rolling hills offer unique interactions between humans and the watershed. This section breaks down the meaning of a watershed and how the landscape and communities within them are connected.

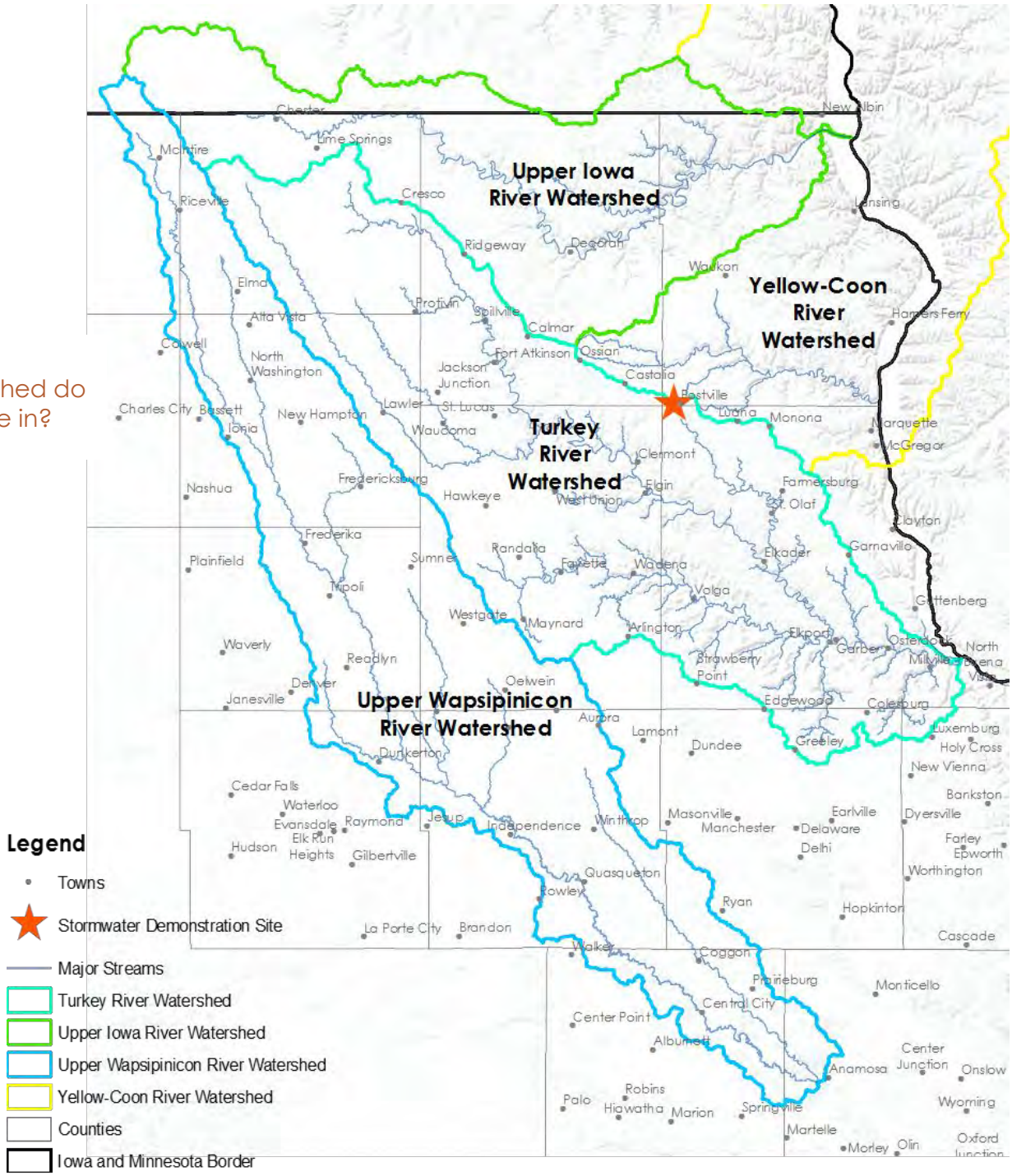
Paint Creek at Yellow River State Forest. Photo taken by Larry Reis.

1.1 What is a Watershed?
1.2 Point Vs. Nonpoint Pollution
1.3 Permeable and Impermeable Surfaces
1.4 Surface and Groundwater interactions
1.5 How do communities impact a watershed?

1.1 What is a Watershed?

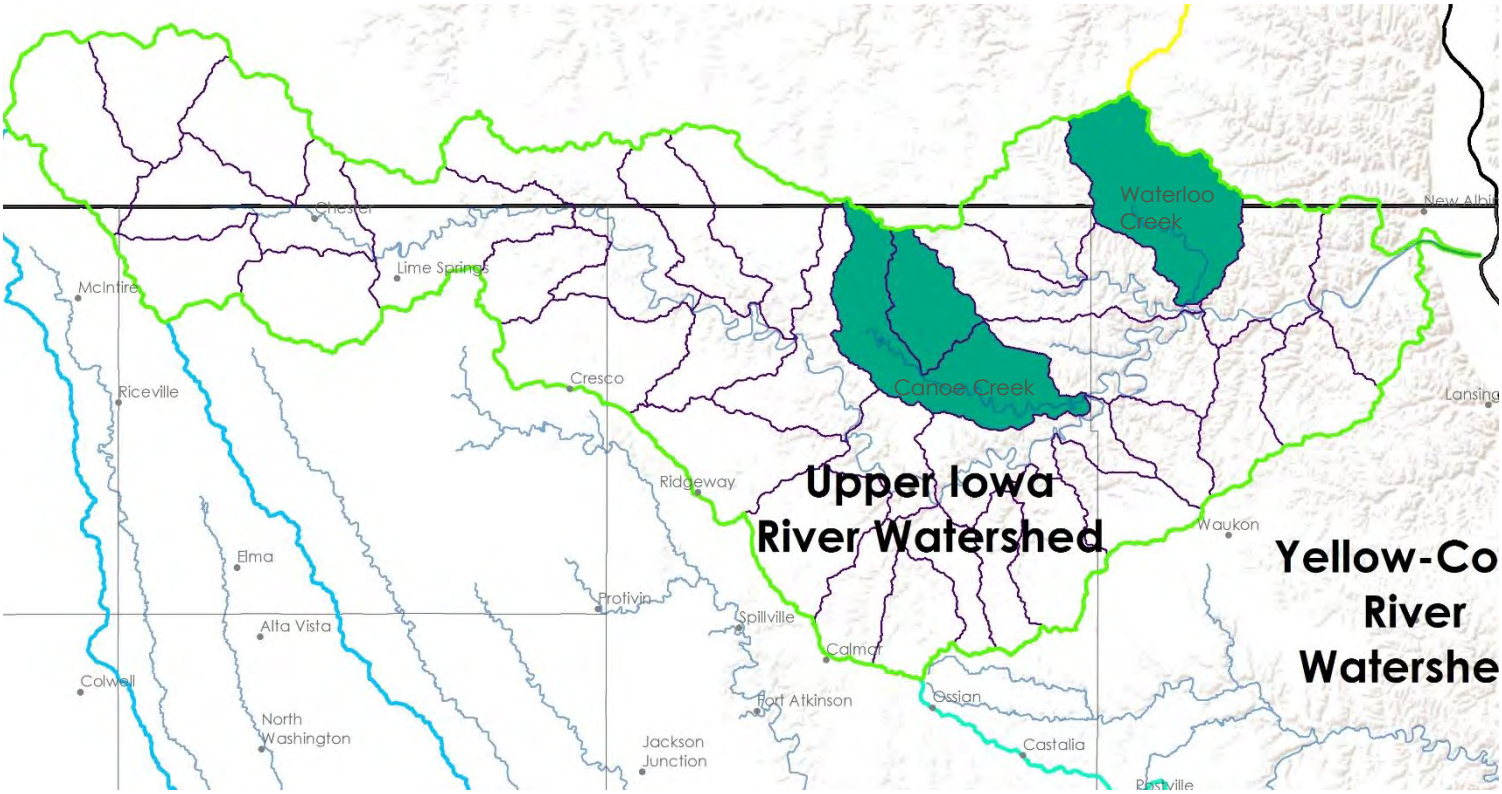
A watershed is an area of land that drains water to a common body such as a nearby creek, stream, river, lake or pond. A watershed is separated from other watersheds by land with higher points of elevation. Since watersheds have higher ground all around them, any water that falls within the watershed flows to the same low point- like the Upper Iowa River, which is the low point in the Upper Iowa River Watershed. The figure below shows large watersheds in northeast Iowa. We all live in a watershed!

Which watershed do you live in?



A watershed can have smaller watersheds nested in it, just as streams flow into rivers. For example, Waterloo Creek and Canoe Creek are smaller streams that flow into the Upper Iowa River, so their watersheds, Waterloo Creek Watershed and Canoe Creek Watershed are nested in the bigger Upper Iowa River Watershed. Conversely, the Upper Iowa River Watershed is also in a larger watershed, the Mississippi River Watershed.

Note: Lessons in this section are modified from lessons by Rutgers Institute of Marine & Coastal Sciences and the Environmental Protection Agency (EPA).



Lesson 1.1a What is a watershed?

Objective	Gain and understanding watersheds and how humans impact a watershed.
Grade Level	3-5
Iowa Core Standards	3-PS2-1, 3-PS2-2, SL.3.1, 3.MD.D.8, 3.MD.C.7; 4–ESS3–1, 4.MD.A.2, SL.4.1, 5.MD.C.3, 5.MD.C.5, 5.MD.C.4, 5-PS2-1
Time	60 mins
Group Size	10-15 students
Materials	- Aluminum baking pan or tray to contain water - Section of newspaper, paper cups, etc. - White plastic grocery bag - Pair of scissors - Beaker of water

PROCEDURE

1. Roll up or scrunch up newspaper into balls or shapes. These will be the higher areas (Hills and bluffs).
2. Create a landscape that has at least one high point and several rolling hills. Try to create a river at the bottom on one side. Be creative.
3. Once you have the newspaper and other items set, you will place a plastic covering over it allowing the plastic to mold to the items. Cut open the white plastic grocery bag to create the plastic sheet. Make sure that none of the plastic extends outside the plastic bin. The edges of the plastic sheet need to be tucked into the bin.
4. You will use the small watering can to create rain. Fill your watering can with the blue colored water (regular water works fine) in the containers at the lab table. CAUTION: Be careful NOT to SPILL the rain! It stains!
5. The watering can will simulate a rain cloud that moves over the landscape. Slowly pour the rain as you move the watering can across the bin. Remember to keep the rain in the bin! As the rain falls on the landscape, pay close attention to where the rainwater goes. Make it rain several times starting and ending in different places.

Discussion Questions

What is a watershed?

In your location, where does water go when it rains? (what river, lake or low spot?) Name the stream or body of water.

EXTRA:

Where Will the Water Go?

Google Earth is a powerful and fun mapping tool. Find your location by entering the address in the search box, then drag the "street view" icon onto the map. Kids can tour the neighborhood by using the navigation tools. Note the elevation readout at the bottom of the screen. Find the elevation of your location and of other landmarks, such as parks or shopping centers. Use these elevation readings to determine the high and low points in your neighborhood. Can kids predict how water will flow out of their neighborhood when it rains? Are some parts of their neighborhood more likely to flood during heavy rains than others?

WHERE DOES RAIN WATER GO?

Think about what happens to water when it rains. The raindrops may end up on plants, soil, lawns, rooftops, or pavement. Some of the rain is absorbed by the plants and may later evaporate back into the atmosphere. Some will soak into the soil and end up as groundwater. Rain may even run off the ground into a storm drain, and/or into a particular waterway such as a stream, river or lake. The bodies of water to which rain flows are resources that can be protected through thoughtful action. In Northeast Iowa, which has Karst topography, rain can also flow into sinkholes and "losing streams", delivering surface water that contains high concentrations of sediment, nutrients like phosphorus and nitrate, herbicides, and bacteria, into groundwater supplies, contaminating wells and city water supplies.

Common Stormwater inlet

Rain itself is relatively clean but each time it rains, after the rainwater hits the earth, much of the rain flows downhill, moving and collecting organic matter, pollutants and debris along the way. How much it moves and collects depends on many factors, including but not limited to, how much it rains, what the raindrop lands on, how much of the rain is absorbed where it falls and how much flows off the land. Organic matter that may be picked up or washed away by rain may include things like leaves, hay bales, branches, trees, or human and animal waste. Pollutants may include soil, car oil, road salts, phosphorous, nitrogen, chemicals, and, there it is again, human or animal waste. Debris can include small and/or large waste inadvertently washed into the stream or river like trash bags, picnic tables, lawn furniture, household or business items from flooded dwellings, propane tanks and even cars, trailers and campers. Organic matter, pollutants and debris all end up somewhere and impact someone or something.

https://www.vbgov.com/government/departments/public-works/surface-water-regulation/Pages/get-involved.aspx

Lesson 1.1b Case of the Disappearing Water

Objective	Demonstrate knowledge of the concepts of evaporation
Grade Level	4-6
Iowa Core Standards	5-LS1-1, 5-LS2-1, MS-PS1-4, MS-ESS2-1, 4.MD.B, 5.NBT.B, RL.4.1, RL.6.1, 21.6-8.ES.1-4, 21.3-5.ES.1-4, MS–PS1–4
Time	60 min
Group Size	All students
Materials	– Clear Measuring cups – Water – Copies of activity handouts

PROCEDURE

Introduce the parts of the water cycle

In nature, the energy, or heat of the sun causes water to evaporate into its gaseous, or vapor, phase. Likewise, when we boil water over a burner we are causing it to change from a liquid to a gas. The process by which a substance changes from a liquid to a gas is called evaporation.

Water is continuously being heated and cooled—evaporating, condensing, freezing—depending on its environmental circumstances. As water travels its never-ending cycle between earth and sky, it encounters and mixes with a variety of substances. Some of these substances are pollutants in the sense that they are harmful to living things. Pollution can result both from natural sources and human activities.

Fortunately, through the water cycle, nature provides a variety of mechanisms for cleaning water. For example, evaporation is a natural water cleanser. When water evaporates, it leaves most dissolved substances and waste materials behind. Pollutants can also be filtered out when water moves through soil. Some pollutants settle out in slow-moving water bodies. Nature even employs a host of microscopic organisms to help keep water clean. Unfortunately, however, if pollutants remain in the environment, clean water can easily become polluted all over again as it moves through its cycle

Tell the students that they are going to be water detectives who are being asked to solve the case of the disappearing water.

- Allow students to read the activity handouts.
- Coach students as necessary, but encourage independent thinking as much as possible.
- Make sure students develop a hypothesis before beginning the experiment.
- Experiment
  - Fill cups half full with water and then add other substances (food coloring, salt, mud)
  - Set cups in locations that are sunny and shady.
  - Have students observe what happens to water in sunny vs. shady locations and what happens to the substances in the water as the water evaporates.

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PROCEDURE CONTINUED

- Make sure students remember to check the water level each day.
- When the experiment is over, be sure the students record their results and conclusions.
- Allow the students to work in small groups.

Discussion Questions

- For what reasons might the results of each group's experiment differ?
  - Environmental variables, e.g., one group's measuring cup may be exposed to more or less sun than the other's.

- Suppose that during the days that Mrs. Flowers was gone the weather was sunny and hot; however, when the water detectives conducted their experiment, the weather was cloudy and cool. How would this variable affect the experiment?

- What is a variable? Something that is subject to change or variation; not constant.

Lesson 1.1b Case of the Disappearing Water

NAME: _____

1. Original amount of water in the measuring cup _____.
2. Amount of water in the measuring cup now _____.

3. If Mrs. Flowers has been gone for less than a day, she probably
_____.
4. If she's been gone for less than 3 days, she may be
_____.
5. If she's been gone more than 3 days but less than 7, she's probably
_____.
6. If she's been gone more than 7 days but less than 6 weeks, she's probably
_____.
7. If she's been gone more than six weeks but less than two months, she is
_____.
8. If she's been gone longer than two months,
_____.

Develop a hypothesis: (Tell what you think will happen before you do the experiment.)

9. How long do you think the water was left on the window sill? _____.
10. Where do you think Mrs. Flowers went? _____.

Perform an experiment to establish approximately how long it took for the water to evaporate.

Directions:
Write down today's date. _____

- Fill a measuring cup to the 1-cup line.
- Put the cup in a sunny window.
- Record how many days it takes for the water in the measuring cup to be at the three/fourths cup line.

Write your conclusions.

11. It took approximately _____ days for the water to evaporate.
12. Where should Frank begin looking for Mrs. Flowers? _____
_____.

Make notes about your observations
_____.
_____.
_____.

THE CASE OF THE DISAPPEARING WATER

by Susan M. McMaster

The Water Detectives Anonymous were called to the home of Mrs. Flowers. When they arrived on the scene, Mrs. Flowers' grown son, Frank Flowers, was frantic. His mother was missing! The detectives asked Frank how long his mother had been missing.

"That's just it," Frank said. "I've been traveling a lot and kept forgetting to phone her. Now I feel terrible. I have no idea where she is or how long she's been missing."

"Do you know of some places where she might have gone?" asked one water detective.

Frank wrinkled his brow and thought hard. "Well," he said, "her habits are very predictable. If she has been gone less than a day, she probably just went shopping. If she's been gone for less than 3 days, she may be visiting one of her sisters. She always says 'Guests are like fish; they start to stink in 3 days!' She would never visit anyone for more than 3 days."

"If she's been gone more than 3 days, but less than 7," continued Frank, "she's probably taking a vacation on a cruise ship. I'm sure she can't afford more than a 7-day cruise. If she's been gone more than 7 days but less than 6 weeks, she's probably received the grant that she applied for—she wants to study art in Europe. If she's been gone more than 6 weeks, she is probably at her mountain cabin. However, she never stays there more than 2 months. If she's been gone longer than 2 months, aliens must have captured her and taken her to another galaxy. She loves her plants and her home. She would never stay away longer than 2 months for any reason.

"I think we can help you solve this mystery," said another water detective who had been looking around the house.

"Did you find a note? Asked hank hopefully.

"No," said the detective, "but I did find this glass measuring cup in the window."

"Oh," said Frank, "that's nothing. Mother is very particular. Every morning she fills the measuring cup to exactly one cup. Then she puts it in the window sill to warm in the sun for a little while before she waters her African Violets. She is very careful about how much water she uses because she doesn't want to overwater or under-water the plants."

"Aha!" said the water detective, "Just as I suspected, this is precisely where we must begin our search. The measuring cup now has exactly 3/4 of a cup of water."

"Are you saying someone stole 1/4 of a cup of water?" asked Frank.

"No wonder his mother didn't bother to tell him where she was going!" muttered one of the detectives.

"No, sir," said another water detective, trying to keep a straight face. "It's a matter of evaporation. Ya' see, water evaporates into the atmosphere. The warmth of the sun changes the liquid into water vapor that we can't see. After a while the water vapor condenses and forms into clouds. Eventually, the water comes back to the ground as rain or snow or hail. Over time, the water evaporates again. It's part of the water cycle."

"To make a long story short," said another detective. "We're going to conduct an experiment. We'll put a cup of water in a sunny place and keep track of how long it takes to evaporate. Based on that experiment, we will estimate how long ago Mrs. Flowers left the measuring cup in the window sill."

"What a relief!" said Frank. "What should we do now?"

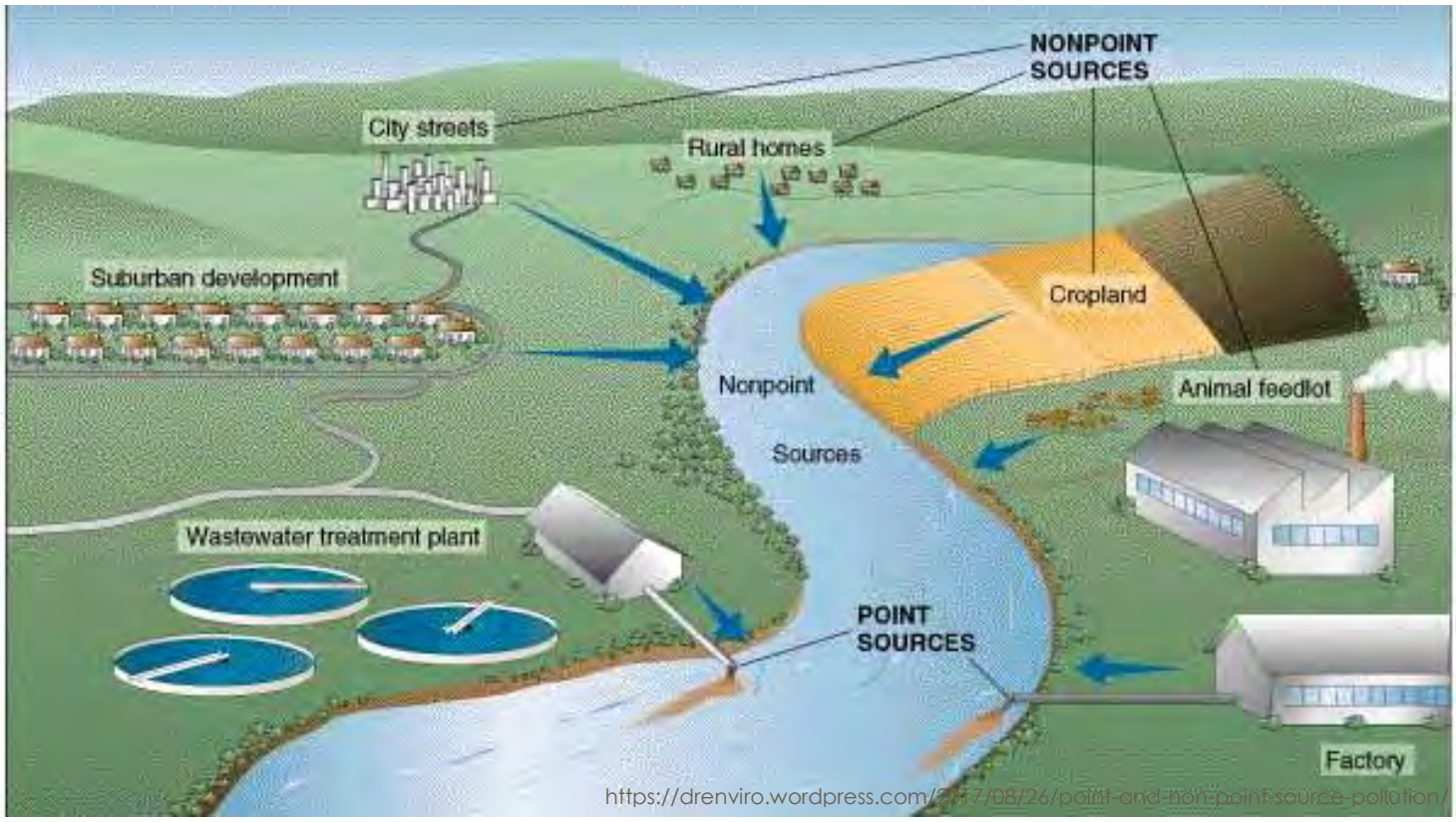
"I suggest you water the plants," replied yet another detective.

1.2 Point Vs. Non-Point Pollution

Water pollution within a watershed can be identified as the overabundance of one or more natural or human-made substances in water. There are two major types; Point and Non-point pollution.

Point Source Pollution can be traced to a single source, such as a pipe, culvert, or ditch.

Non-Point Pollution comes from a much wider source and is not limited to a single outlet. Runoff from eroded fields, fertilizers, feedlots, and gasoline and oils from roads and parking lots, are a few examples.



Our rivers and lakes are used as sources of drinking water, recreation, wildlife habitats, irrigation and for industry. All organisms on Earth need water to live. If the land is misused or pollutants are spilled, the receiving stream will be effected, as well as all the streams and rivers that the receiving stream flows into. It is important to protect the lakes, rivers and watersheds to preserve the water quality that we depend upon.

Lesson 1.2a Non-Point Source Pollution

Objective	Demonstrate what an average storm drain collects during a rainfall event and how the water from storm drains can impact water quality and aquatic environments of local streams and rivers.	
Grade Level	4-7	
Iowa Core Standards	SL.6.2, SL.7.2, 4–ESS3–2, 3–5–ETS1–2, 5–ESS3–1, SS.5.2, 21.3–5.ES.1, 21.3–5.ES.2, 21.3–5.ES.4, SL.6.1, SL.6.2, SL.6.3, MS–ESS3–2, MS–ETS1–2	
Time	60 min	
Group Size	All students	
Materials	– Aquarium – Rectangular box – Water – Watering Can – Stray bottle	– Green Food coloring – Vegetable Oil (Motor Oil) – Sand, soil, pebbles (erosion) – Grass clippings (or shredded paper) and twigs – Trash, wrappers

PREPARATION:

Fill the aquarium half-way with water and place it on an accessible area where it can be easily viewed by the students. Cut a hole in the bottom of the box and place the box on top of the aquarium. The box represents the storm drain and the aquarium represents the waterway that the stormwater mixes into after entering the storm drain. Leave the sides of the aquarium uncovered so that the students can view its contents.

PROCEDURE

- Introduce this activity with a discussion of storm drains and storm drain systems and their purposes. Discuss where the water and objects that float down into a storm drain go. Have students list all of the things that they can think of that might enter a storm drain during a rain storm.
- Assign a group of students to each pollutant. Discuss each pollutant, including its use or origin and how it could enter the storm drain.
- Have each group of students place their pollutant into the storm drain. Use the watering can to create rain to wash the pollutant into the waterway. While washing each pollutant into the waterway, review the pollutant and its use or origin. Discuss the following: How does the pollutant damage the environment? Do the people who are responsible for the pollutant want to damage the environment? Why did they do what they did? How can this type of pollution be stopped?
- After adding all of the pollutants, examine the contents of the waterway. Discuss how the waterway has changed and how viewing this change makes the students feel.

Discussion Questions

1. What types of the pollution are natural?
2. What types of pollution are added by people living in the local communities?
3. How can we remove the pollution from the water?
4. What could be done to stop pollutants from entering storm drains?

Variations to Demonstration

Have the groups of students responsible for the pollution think of ways to remove the pollution from the aquarium. Try some of the removal methods. Which pollutants were easy to remove? Which were difficult to remove?

Lesson 1.2a Point Vs. Non-Point Source Pollution

NAME: _____

Classify the following as either point (P) or non-point (NP) source pollution.

_____ Boats in a lake

_____ Oil dumped in a stream

_____ Pipe Discharge from a wastewater treatment plant into the river.

_____ Homeowner washing driveway with a hose

_____ Automobile leaking brake fluid

_____ Construction site erosion

_____ Pouring lawn clippings into storm drain.

_____ Factory illegally dumping waste into local waterbody.

_____ Effluent from failing septic tank.

_____ Pouring antifreeze down the storm drain

_____ Spraying garden to eliminate bugs

_____ Over fertilizing a yard

_____ Runoff from a parking lot

True or false

_____ Stormwater runoff carries sediments, nutrients, and bacteria into waterbodies.

_____ A septic tank requires little or no maintenance once installed.

_____ Excess fertilizing has no effect on aquatic plants and animals.

_____ Soil erosion increases the turbidity (Cloudiness) of water.

_____ It is important to repair automobile gas or oil leaks promptly.

1.3 Permeable and Impermeable Surfaces

Did you ever wonder why water levels rise in a stream or river after a rain, or why some rains cause flooding and other rains do not? To understand the connections between rainfall and water levels in rivers, it is important to understand the concept of stormwater runoff and how it affects the streams and rivers.

Stormwater runoff occurs when rain falls onto the land and then flows off the surface or through the soil and enters a stream that is at a lower elevation. Stormwater runoff also occurs when more rain falls during a particular period of time than can be absorbed by the soil because the soil is already saturation, or all the spaces in the soil are already filled with water. The amount of runoff depends on the amount of rainfall, the type and depth of soil, the type of land cover, and the amount of water that is already in the soil.

Different types of land uses affect the amount and quality of runoff. Land uses include urban (cities and towns), farming, livestock grazing, transportation, and natural uses. Urban land use can result in increased surface runoff from impervious surfaces, like houses, businesses, schools, roads, driveways and parking lots. Urban and rural transportation structures, like roads and bridges, can disrupt the natural flow patterns of water and can result in increased runoff from impervious cover.

Permeable surfaces allow particles and water to move through the surface into the ground. Examples of permeable surfaces are prairies, forests, permeable pavers, lawns, and gardens. Some permeable surfaces allow more water to move through the surface than others.

(Left) Permeable pavers in Monona. (Right) Decorah city Prairie

Impermeable surfaces do not allow rain or any water to easily move from the surface into the ground. They block the majority of water from infiltrating into the ground. Instead of soaking in, water will pool or runs off of an impermeable surface. Many people recognize that cement and asphalt are impermeable or that houses and businesses are impermeable because they appear solid. However, many people don't understand that other surfaces that may look permeable are really impermeable, like gravel roads, gravel driveways and gravel parking lots.

(Top) Runoff of an impermeable Street during rain event.

(Left) Ponding on impermeable surface during rain event. Stormwater Demonstration Site before implementation of conservation practices.

Lesson 1.3a Impervious Vs. Pervious Surfaces (Done at SDS)

Objective	Define runoff and learn how it affects the water level in a stream or river. Observe how different land covers in a watershed affect surface runoff.
Grade Level	5-8
Iowa Core Standards	RI.6.4, RST.6–8.3, 6.EE.C.9, SS.6.2, 5.MD.B.2, 5.MD.A.1, 21.3–5.ES.1, 21.3–5.ES.2, 21.3–5.ES.3, 21.3–5.ES.5
Time	60 min
Group Size	All students
Materials	– Three 500 mL beakers – Three 11.75"X8.56"X1" foil broiling pans – Three larger aluminum foil baking pans – Piece or brick, concrete or asphalt – Piece of sod – Student sheets

PROCEDURE

- Start by asking the students what happens to streets and low water crossings during storms. Ask them what happens to water levels in streams and rivers when it rains.
- Prepare for this activity by cutting a large opening in the smaller edge of the three aluminum foil broiling pans for the water to drain out.
- Ask the students to place the brick, cement or asphalt on top of one of the pans, place the sod piece in the other pan.
- Instruct the students to place the three broiling pans at an angle inside the larger aluminum baking pan so that each broiling pan drains into the baking pan
- Have them pour 500 mL or another specified amount of water onto the highest end of the pan containing the sod. They should record the initial amount on a table.
- Instruct the students to allow the water on the sod to drain into the drain pan for 10 seconds
- Have the students pour the contents of the drain pan (baking pan) into an empty graduated beaker or glass measuring cup and record the amount of water that is recovered
- Instruct the students to subtract the amount of water recovered in the drain pan from the amount of water applied initially to obtain the amount of water retained by the sod. They should record this amount in the table
- Have the students repeat steps 5-8 for the pan containing the now wet sod
- Have the students repeat steps 5-8 for the pan containing the tile and sponges

PROCEDURE CONTINUED

- Ask the students to construct a graph showing the amount of runoff vs. the types of land surfaces

Discussion Questions

- What type of ground cover does the brick, cement or asphalt represent?
- What do the large aluminum baking pans represent?
- How did the different surfaces affect runoff into the pans?
- What effect do streets, houses and parking lots have on the amount of surface runoff that is produced by a storm?
- Where does this runoff go?
- If the river cannot hold all the runoff, what happens to the extra water?
- Which do you think produces less runoff and flooding, an area covered by a lot of concrete, or an area covered by a lot of grass and soil?
- If it has recently rained and the soil is wet, what effect will it have on runoff if it rains again?

Further Evaluation

Start by having the students relate the observations that they made with their models to the area around their home or school. Then, ask the students to write a short paper about runoff and pollution in their town or area. Have them describe the geography and types of land uses that they observe in the area where they live? As their city or town grows and more homes, streets and parking lots are built, have them describe what might happen with runoff and how this might affect flooding.

Lesson 1.3a Impervious Vs. Pervious Surfaces Student

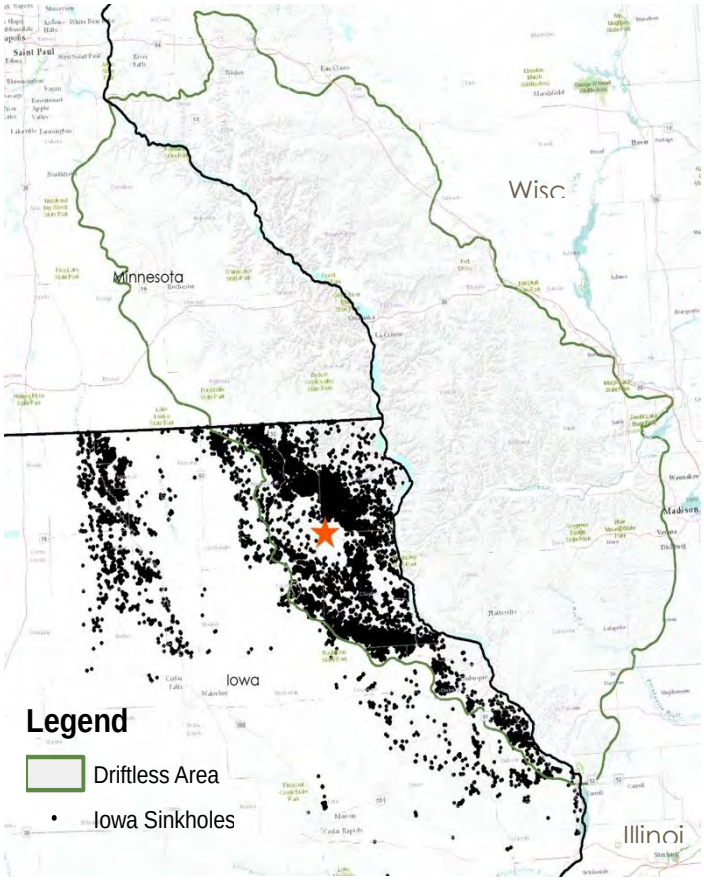
Ground Cover	Dry sod	Wet sod	Brick, Cement or Asphalt
Volume of water Applied (mL)			
Volume of water caught as runoff (mL)			
Volume of water retained (mL)			

1.4 Surface and Groundwater Interactions

Northeast Iowa is a part of the Driftless Region, which encompasses portions of four states, including Iowa. The Driftless Region is characterized by Karst topography, which is not found anywhere else in Iowa. Karst topography is characterized by shallow soil to bedrock layers and many limestone rock features. Cold water springs, sinkholes and disappearing streams are a few examples of karst features that allow you to easily see how the surface and groundwater interact in a karst landscape. Sinkholes provide direct pathways for surface runoff to reach water that is underground, referred to as groundwater or aquifers. Sinkholes can be small in depth and diameter or very large.


Loosing Stream

Sinkholes are natural depressions in the land formed by dissolving limestone. They form when groundwater dissolves rock from underground, and the ground above slowly or rapidly collapses. Sinkholes of any size indicate there was a cavity in the bedrock near the surface. Formation of a new sinkhole or continued collapse of an existing sinkhole, indicates the presents of groundwater beneath the surface.



Sinkholes in Iowa.

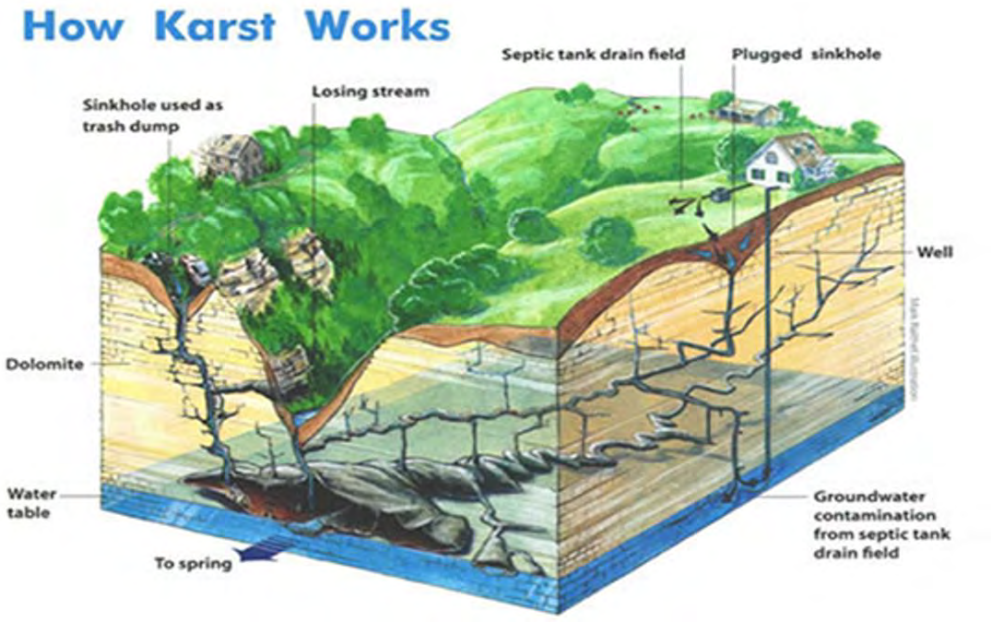
When they are located in a crop field, sinkholes are often surrounded by trees. When a sinkhole is located on the bottom of a stream, water from that stream can drop into the hole and go underground. Although some water in the stream or river may flow past the in-stream sinkhole, there is less flow downstream of the in-stream sinkhole than there is upstream because some of the water is going underground. Thus, the stream or river section is called a *losing stream*.

Northeast Iowa's Karst topography allows rainfall to runoff the land and flow into sinkholes delivering surface water that contains high concentrations of sediment, nutrients like phosphorus and nitrate, herbicides, and bacteria to contaminate ground water. Much of the drinking water in Northeast Iowa comes from wells that are drilled into the underlying groundwater sources called aquifers. Many of the wells in northeast Iowa are shallow, which puts them at high risk for contamination. They are most often contaminated by nitrates and bacteria. Wells that drill into deeper aquifers are better protected from contamination like bacteria and chemicals that may enter shallow aquifers from sinkholes. Unfortunately, they may have higher levels of rust or other contaminants.

Springs are places where groundwater immerges from underground out to the land surface. Although springs in Northeast Iowa generally have greater amounts of water coming out of them during and after rainfall events, the majority of springs have small trickles or streams of water coming out of them and are difficult to find. A few springs have much greater amounts of water flowing and may even create waterfalls. Some popular parks in Northeast Iowa have springs and waterfalls that the public can visit.

Dunning Springs, Decorah

Sinkholes and springs offer a distinct relationship between people and our water resources. There are dozens of coldwater trout streams in Northeast Iowa that exist because the cold water coming out of springs flows into them. The diagram below shows how karst features interact with each other and the environment, both above and below ground.



Lesson 1.4a Surface and Groundwater Pollution

Objective	Observe the connected between surface water and groundwater. Experience the difficulty in cleaning polluted water
Grade Level	4-6
Iowa Core Standards	21.3–5.ES.1, 21.3–5.ES.2, 21.3–5.ES.3, 5–PS1–3, 5–PS1–4, RST.6–8.3, SL.6.1,
Time	60 min
Group Size	3-4 students
Materials	- One 266 ml clear plastic cup - Sufficient clean pea-sized gravel to fill the cup - Three 240 ml paper cups - One pump dispenser from soar or lotion container - 3.9 L water - One bottle of food coloring

PROCEDURE

1. Divide class into groups of three. Provide each group with one clear plastic cup ¾ full of pea sized gravel, one paper cup with holes in the bottom, one paper cup with no holes punched in the bottom, and one paper cup ¾ full of water, and one pump dispenser.

2. Instruct the students to hold the 240-ml cup with holes in the bottom over the cup containing the pea-sized gravel. Then add the water contained in the other 240 ml cup. Ask the students what they think the water simulates (rain).

3. Explain to the students that rain enters the gravel and becomes groundwater. This process is called infiltration.

4. Instruct the students to dig a hole in the center of the gravel. Ask them what the hole simulates. (Answer: lake or pond). Have students observe the connection between the level of water in the lake and how it corresponds to the level of water in the gravel.

5. Add two drops of food coloring (to simulate pollution) to each model lake. Have the students place the pump dispenser in the gravel beside the lake and pump water into the paper cup with no holes. Observe the color of the water in the cup.

6. Have students add small amounts of clean water to their models while pumping. Continue to add water and pump out polluted water until it becomes clear.

Discussion Questions

Where does the pollution pumped from the ground water come from?

How can pollution from a lake get into the ground water?

Was it easy to clean up all the pollution in the water?

Lesson 1.4b Sinkholes in a Cup (Skip if visited the Stormwater demonstration site)

Objective	Observe the formation of sinkholes in Karst Landscapes
Grade Level	4-8
Iowa Core Standards	4–ESS1–1, 4–ESS2–1, 4–ESS2–2, 5–PS1–3, MS–ESS2–2, MS–ESS2–3, MS–ESS3–1, MS–ESS1–4, MS–ESS2–4
Time	45 min
Group Size	All students
Materials	- 8oz foam cup - Thin sponge - Empty 2-liter soda bottle - Sugar - Sand - Scissors - Piece of paper

PROCEDURE

1. Introduce sinkholes and karst landscape characteristics with students.
2. Make a hole about the size of your thumb in the bottom of the foam cup.
3. Cup a circle the size of the cup bottom from a thin scouring pad. Place this circle in the bottom of the cup.
4. Place a column of sugar in the center of the cup and surround it by sand. To do this, make a tube by rolling up a piece of paper and place it in the center of the cup. The paper tube should be about the same height and one half the diameter of the cup. Fill the inside of the tube with sugar and the outside of the tube with sand (the sand should be between the paper tube and the sides of the cup). Carefully remove the paper tube. Place a thin layer of sand over the sugar.
5. Cut the bottom off a two-liter soda bottle at about the same height as the foam cup to create a dish. Fill it about one-third full of water. This will symbolize groundwater.
6. Place the cup with the sugar and sand in the water. Watch as the water fills into the cup and the sugar dissolves and runs out. A sinkhole is formed in the cup as the surface sand sinks into the area where the sugar dissolved. (You may need to remove the cup from the dish of water to allow the water to drain out of the cup and the sinkhole to form).

DISCUSSION QUESTIONS

What natural process is demonstrated as the sugar is dissolved by the water and the surface sinks?
What type of rock does the sugar represent?
What characteristics must a rock have to be suitable for forming sinkholes and caves?
What does the water in the dish represent?
Why did the sinkhole form only over the sugar deposit?

1.5 How Do Communities Impact a Watershed?

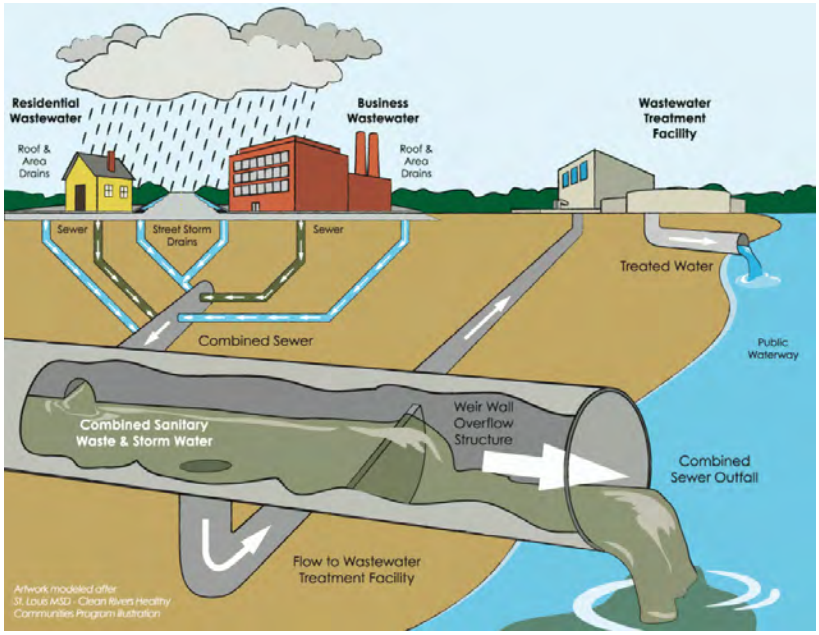
Water Movement Through Communities

Many Northeast Iowa communities are located in more than one watershed. Some of the watersheds they impact are obvious because a stream or river flows through or near the community so community members understand they are in the "watershed" of that stream or river. Other watersheds are less obvious because the stream or river associated with them is far away and not visible from the community. Also, smaller watersheds are part of larger watersheds, so a community is typically in a smaller watershed and a larger watershed. The water moving through communities flows from the highest elevations in the town, which may or may not be obviously to the community members, to the lowest elevation, which is typically a stream or river. Along the way, the water picks up and pushes nutrients and pollutants. The pollutants and sediment that the water carries or pushes from the higher elevations accumulate as they move through the town and on through the larger watershed/s that encompasses the town.

Community Location in the Watershed

Where a community is located within a watershed impacts how their community members perceive watershed issues, flooding, rivers and other issues. Communities situated in the lower elevations of watersheds, along streams and rivers, typically have more community members that notice how heavy rainfall events impact stream and river flow and increase flooding within a community. They may be more likely to have been impacted by flooding and they may also want to be more proactive and do things to prevent flooding. Communities in the upper areas of a watershed, especially those without streams and rivers running through them, may have community members that are less aware of the impact that their actions can have on downstream flooding. They and their community may have always "managed" heavy rainfall events and stormwater runoff by directing the stormwater out of town as fast as they could. Unfortunately, the stormwater that flows through and from any community doesn't just impact their community members. Storm water that is sent downstream also impacts rural and urban downstream neighbors, including other communities. Some of the neighbors that are impacted can be very close, on a nearby farm or in a nearby town. Others people may be several counties or states away. Everyone in Northeast Iowa lives upstream of someone. Fortunately, rainfall and the water that flows through every community can be managed in such a way as to help prevent flooding and pollution in the community and downstream of the community. Also, if all communities and community members work to Improve the health of their watershed, they can collectively have a big impact on what happens to their neighbors and even to people further downstream in other counties and states.

Movement of nutrients



Urban communities like cities and towns make up a smaller area within Northeast Iowa watersheds than farms and natural areas, but they can contribute to the health of the watershed in large ways. One of the most obvious ways communities contribute to the movement of nutrients is through their treatment of sewage water. Sewage water is collected at a wastewater treatment plant or lagoon where water is treated before entering a nearby stream or river. Community members can become more informed about how they can help maximize their wastewater treatment plant. For example, they can make sure that their sump pumps and drain spouts are not directed into drains that flow to waste water treatment plants. Citizen should also remember that neither their toilet nor their sink is a trash can. They should not flush or dump contaminants like prescription drugs, oil and other pollutants down their toilets or drains.

Healthy lawns, trees, shrubs and flowers help make communities more beautiful and they help keep our streams and rivers clean. Unfortunately, when it rains, excess fertilizer can wash off of lawns and gardens and into streams and rivers where it promotes algae blooms and aquatic weed growth. These excess nutrients can lower dissolved oxygen levels in streams and rivers and may even release ammonia, which is toxic to fish. It is best for community residents to test their soil before they start fertilizing, to be careful about when and how they apply fertilizers and what types of fertilizers they use. Simple measures can have big impacts. For example, leaving grass clippings on a lawn can help reduce nitrogen applications by 30 to 40 percent.

Cities and towns contain large areas that are impervious to water, including streets, buildings, sidewalks, parking lots etc. In some cities, when rain flows off of impervious surfaces it flows directly to and through a stormwater system that takes it to a nearby stream or river. Urban areas typically increase the amount of pollutants entering the stream after a storm because the impermeable surfaces do not allow the rain to infiltrate into the soil. (Infiltration into the soil allows nutrients and pollutants to be filtered out by the soil and used by plants.)

During rain events, rainfall can flow down streets and wash additional sediment and chemicals into streams and rivers. These additional pollutants have an effect on the organisms within that stream and within the entire watershed. Rain and stormwater runoff that flows across hot city streets, parking lots and other warm or hot surfaces increases in temperature. When it flows into a stream or river it can increase the temperature of the stream or river. Many coldwater aquatic species that live in Northeast Iowa streams, including trout, are very temperature sensitive and cannot survive in warm water.

Movement of Water

Urban communities affect the volume and speed of stream and river flows during a rain event. Communities with a lot of impervious surfaces increase the speed that rain and stormwater flows off the land and into streams and rivers. Through installation of more porous surfaces and urban stormwater best management practices, like bioswales, raingardens, permeable pavers, wetlands, rooftop gardens, ponds, and native habitat, communities can slow the flow of stormwater runoff.

Why Do Rivers Curve?

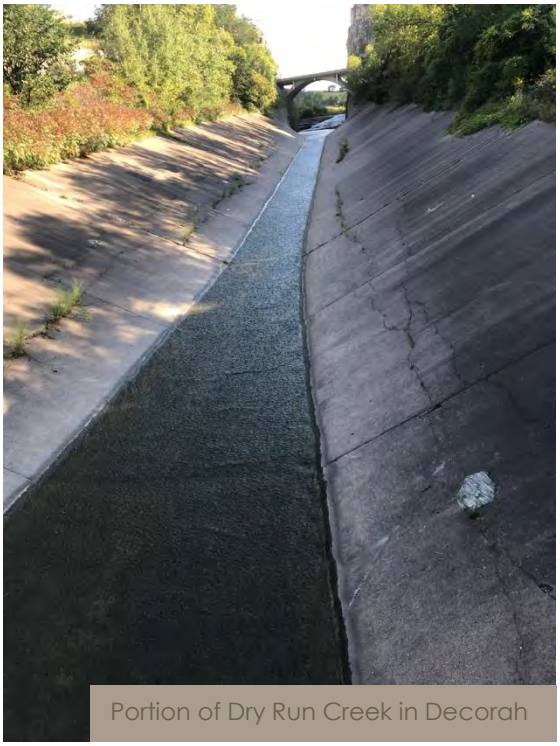

Stream curves

Streams and river naturally meander, or follow a winding course from one point to the next. They don't just move downstream, they also move side to side. Meanders, or bends in the river, are the result of both erosional and depositional processes. The bends in the river seem to move over time as the deepest and strongest flow of the water naturally erodes the sediment from the river banks on the outer curve of the meander in some places and deposits sand and soil on the inner curve of the meander where the water is slower and has less force. River users might not understand the process but may notice and appreciate the sandy deposition as a sandbar where they can soak up the sun or look for pretty rocks; others notice the deep pools where the river bank is steep and the fishing is good. The exact geometry of river meanders is dependent on many factors but ultimately the meander arc-length may be a unique function of the width of the channel no matter what stream or river you are studying.

Meandering river channels are asymmetrical with the deepest part of the channel, the thalweg, moving back and forth across the center of the river in a repeating S pattern, eroding the bank on the right, then moving down stream and across the channel

and eroding the left bank, then back to the right, and so on. Meanders increase in size over time as land is eroded on the outside of the bend.

It takes longer for water in a meandering river to reach any distance than it does for a river that has artificially been straightened because the water has to travel further. A good comparison is a path on a steep hill that winds back and forth. If a person wants to get down the hill in a hurry, they could quit walking back and forth on the path and just go straight down the hill. Their walk would be shortened in physical length and time.



Portion of Dry Run Creek in Decorah

Some Northeast Iowa communities altered the flow path of a stream or river by building a channel that confines and directs the flow of the stream or river. In some cases, the channel was buried underground. This practice helped the towns move the water through their community more quickly by reducing the area of the community through which the stream or river flowed. This "channelization" increased the speed of the stream or river and may have exacerbated downstream rural and urban flooding as it sent fast destructive flows to the downstream neighbor. Today, many communities, like Dubuque, are restoring community streams.

Meandering rivers can also hold more water because they are longer than those that have been straightened. When people try to stop the natural process of meandering rivers by straightening them, or even by placing rock or cement in them to stop them from meandering, the force of the river that would otherwise be expended is sent downstream. This increases downstream flow, force and flooding.

For more information on how rivers form and change have your students watch this short you tube video.

"Why do Rivers Curve"- https://www.youtube.com/watch?v=8a3r-cG8Wic

Section 2: Benefits/ Importance of Urban Conservation and Stormwater Management

Urban communities have the ability to manage their stormwater to improve or degrade the quality of their watershed(s). This section will explain flooding, water quality, recreation, and wildlife in Northeast Iowa and how they are interrelated.

Turkey River by Jessica Rilling

2.1 Flood Reduction

Flooding has a major impact on Northeast Iowa communities every year. Some years, flooding occurs more than once in a community or county. According to research conducted by the Iowa Flood Center, there are counties in Northeast Iowa that have had more Emergency Disaster Declarations than most counties in Iowa. In fact, Northeast Iowa counties rank in the top 30 Percent for the highest number of disasters per square mile, along with counties located on the coast who are frequently in the path of hurricanes. Howard, Winneshiek, Allamakee, Chickasaw, Fayette, Clayton, Black Hawk, and Buchanan counties have each had over 13 Flood-related FEMA Disaster Declaration in the last 30 years.

Upper Iowa River Watershed: Dug Road Trail after the August, 2016 heavy rainfall event

Floods cause communities and their residents physical, emotional, economic and social damage. Their destructive power greatly impacts the lives of residents who lose homes, possessions, businesses, income, time and, in tragic instances, their lives or the lives of family and friends. In many cases, flooding impacts the vulnerable community members the most, including those with the least ability to move or recover from financial loss, those with the lowest incomes, and/or elderly community residents on fixed incomes.

Turkey River Watershed: City of Elgin during the flood of August, 2016

Community members whose homes are not damaged can be indirectly affected by flooding in several ways. They might spend time or money helping family members and/or friends who are affected by flooding. They might be forced to miss work or

school because of flooding. They may have to drive long distances around damaged or closed roads or bridges temporarily or longer. The debris carried by flooding in Northeast Iowa pollutes downstream streams and rivers, costing millions of dollars in clean up and hazardous waste disposal and destroying wildlife habitat.

When water moves off the land quickly, it can also destroy in-stream and near stream habitat fish, turtles, mammals and other animals need to survive. It can disrupt natural reproduction of trout and other aquatic species and has even been known to drown and wash livestock and pets downstream.

2016 Mississippi River backwater pond near Lansing, Iowa.
Hazardous waste and trash from flooding extended more than half a mile.

Downtowns and business districts that experience flooding can temporarily and/or permanently lose businesses, greatly impact the economy and social structure of a community for years or permanently. Damaged public infrastructure, including city and county roads and bridges, cost residents millions of dollars for repair or replacement. According to the Federal Emergency Management Agency, the State of Iowa spent 1.3 billion dollars on flood recovery just for repair of public infrastructure between 1988 and 2016.

Many Northeast Iowa communities have systems in place to respond when flooding threatens so that they can protect residents and property. Sand bagging, pumping water from a vulnerable area to a less populated area or back into the river, building walls, and closing roads are just a few examples. However, these *responses* to high water are not as effective at preventing flooding as efforts to hold water in the upper parts of the watershed can be. Both urban and rural residents can act to prevent flooding before it becomes a problem.

The Iowa Flood Center has modeled how and which actions across a watershed can collectively accumulate to prevent flooding on any given stream or river. Many communities in Northeast Iowa, including those in the Upper Iowa River, Turkey River, Upper Wapsipinicon River, and Maquoketa River watersheds have helped form and joined Watershed Management Authorities in an effort to encourage and find ways

for many urban and rural residents, cities, counties and soil and water conservation districts to work together to reduce flooding.

Northeast Iowa students from the Upper Iowa River, Turkey River, Upper Wapsipinicon River, and Maquoketa River watersheds can find out if their community is participating in a Watershed Management Authority by visiting http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Watershed-Management-Authorities/Current-Iowa-WMAs and clicking on the link for their watershed.

Discussion

Have you ever been directly impacted by a flood?

What are some ways you have seen your community respond to flooding?

What are actions you and your family take to respond to flooding?

Is your school located in a community that is participating in a Watershed Management Authority?

Has your community or a nearby community implemented any pro-active projects so they don't contribute to downstream flooding?

Turkey River Watershed: Bridge destroyed between Clermont and Eldorado, IA from June, 2008 flood (left)
Upper Iowa River Watershed: Flooding June, 2008 (Right)

Note: Lesson in this section is modified from a lesson by John Santangelo from Central Junior High in Melbourne, Florida

Lesson 2.1a How much is an inch of rainfall?

Objective	Students will measure the volume or rainfall that falls on an area of school grounds (building, parking area, etc.).
Grade Level	5-12 (Adapt discussion questions two your grade level)
Iowa Core Standards	W.5.2, W.5.10, SL.5.1, 5.OA.A.1, 5.NBT.B.5, 5.MD.A.1, 5.MD.C.3, 5.MD.C.4, 5.MD.C.5, 21.3–5.ES.5, WHST.6–8.4, 6.G.A.1, 7.G.B.6, MS–ESS2–1
Time	Two class periods
Group Size	3-4 students
Materials	- Clear cylindrical plastic squeeze bottles - Knife, Scissors or other cutting instrument - Ruler - Writing materials - Meter or yard stick - Calculator (optional)

PROCEDURE

Making a rain gauge

- Cut the top of the clear cylindrical bottle so the bottom piece has straight sides, invert the top of the bottle in the bottom portion
- Use a ruler to mark increments of one centimeter or inch form the bottom of the gauge.
- Place the rain gauge in an open space away from trees or buildings. (Make several rain gauges and place them at locations around the school grounds to calculate the average rainfall).

Data Collection

- To calculate the area of the school grounds, measure the length and width (Students may use twine, marked in meter or one-foot increments, or a tape measure, to speed this process)
- Determine the volume or rainfall, convert the amount of rainfall to meters or feet.
- The students should then multiply the area of the school grounds by the amount of rainfall, this will give them the volume of rain in cubic meters or cubic feet.

Questions

If one cubic foot of water weighs 62.5 pounds, what is the weight of the water that fell on the school grounds during our collection period?

What happened to the water that fell to the ground? Where did it go when it left the school site?

How much water was absorbed in different areas of the school site (Concrete, grass, bare soil, gravel)?

What are potential pollutants that water may have picked up as it ran off the school site?

How might the pollutants affect the stream or river they ran into?

LOOKING FOR A CHALLENGE?

1. Calculate the force of water if it all entered a stream at once and accelerated at 5 meter per second (m/s/s), 10 m/s/s, or 15 m/s/s {Force=mass(kg) X acceleration (m/s/s)}.

2. Write a brief essay explaining why it is important to slow the rate at which runoff water enters waterways.

2.2 Water Quality

Water coming directly from urban areas after a rain storm contains larger amounts of contaminants like nitrogen, chloride, insecticides, oil, and sediment. Many urban residents apply fertilizers, insecticides, and herbicides to their lawns, which are washed off and carried into the streams. City streets and parking lots contain high levels of oil, antifreeze and other chemicals that leach from automobiles, as well as salt and sand during the winter months. Areas with poor soil health contribute large amounts of runoff to nearby streams and rivers.

Stream bank erosion near bridge in the Upper Iowa River Watershed

Soil Erosion is the gradual destruction and washing away of soil by water, wind or other natural agents. Soil is the greatest pollutant by volume in Iowa's stream and rivers. There are three types of Soil erosion, gully erosion, sheet erosion, and rill erosion.

- Sheet erosion is when water removes even layers of soil from the surface.
- Rill erosion is when the water makes channels up to 30 cm deep.
- Gully erosion is the removal of soil in which a deep channel is formed.

Stream full of sediment and other pollutants after a heavy rainfall event.

During rain fall events, water carries soil, as well as the nutrients that are attached to the soil, into nearby streams and rivers. Many areas of Northeast Iowa have very thin layers of topsoil, which means that the depth of the soil on top of the limestone bedrock may be only a few feet thick as opposed to dozens of feet thick. Plants need soil to grow. The lack of deep soil makes it even more important that Northeast Iowans keep soil from eroding away during rain events.

Pollutants in streams and rivers are detrimental to trout and other aquatic organisms. Sediment that washes into the water causes the water to become cloudy, making it difficult for aquatic organisms to find food. Increased sediment in water can clog fish gills making it difficult for them to breath, it can destroy their habitat, covering bugs and/or plants they would eat and covering the rocks where they would normally lay their eggs so the eggs can no longer survive. They also increase temperature by absorbing more sunlight. Increased levels of phosphorus in water speeds up plant and algae grown, which takes away oxygen from Trout, and

aquatic insects, which can lead to death. E. coli bacteria is a fecal indicator bacterium that is used to detect pathogens in water. Animal and human waste contain these E. coli bacteria, a harmful pathogen that can harm or kill water organisms, as well as, cause humans to get sick. Several Northeast Iowa streams and rivers are currently listed on the State of Iowa's "303(d) Impaired Waters Listing."

You can find out more about Iowa's Section 303(d) Impaired Waters Listing, and additional resources and maps related to that listing at http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/Impaired-Waters

Checkout the Upper Iowa water quality data at https://data.upperiowariver.org/
Turkey River Water quality data: http://turkeyriver.org/water-sampling/

"July 17th, 2018 E. coli warning Clear Lake, IA. Recent testing found levels of e-coli higher than the state standard of 128 colony forming units. It's not recommended for swimmers to enter the area. Recently a second grader from Polk county died from illness caused by E.coli bacteria, but it's currently unknown where she was exposed to it. John Iagios swam at Mcintosh when he was 15 - and accidentally swallowed some contaminated water...which resulted in him falling gravely ill and being rushed to the hospital." KIMT news

Lessons in this section are modified from a lesson plan by Eileen Tramontana from the Suwannee River Water Management District in Live Oak Florida, and the EPA.

Lesson 2.2a Water Pollution Inspection Activity

Objective	Students will understand that contaminants may not be detected by seeing, smelling, or feeling.
Grade Level	3-12
Iowa Core Standards	HS–ESS2–5, HS–LS2–7, MS–ESS2–4, 3–5–ETS1–2, 4–ESS3–2, 5–ESS3–1, MS–ESS3–3
Time	30-40 min
Group Size	4-5 students in each group
Materials	- 6 baby food jars - 1 teaspoon of salt - 1 table spoon of vinegar - 5 drops of tobacco Sause - Milk - River or local well water (especially effective if you can find well water that has yellow staining and sulfur odor - Motor oil - Paper towels

PREPERATION

The teacher will need to prepare the baby food jars by thoroughly cleaning them to eliminate any trace odors left by the baby food. Place one ingredient in each jar along with water. I the sample containing river or well water, you would not add water. Label each jar as sample A, B, C, D, E, F. Keep record of what increased was added to each sample.

PROCEDURE

1. Break class into teams
2. Give each team a sample to examine, caution the students not to taste the samples, but to use their other senses.
3. Have the student's answer the questions of the student sample sheet
4. Let each team examine each sample
5. When every team has examined each sample, review the samples as a class, ask various teams to give their finding s and conclusions about the samples. Remind them that there are no wrong answers, each person's observations are valid and each member does not have to agree with the other team members if they have a reason for their disagreement.
6. After examining each sample, tell them what was placed in each sample and discuss the drinkability and possible water treatment process.

Students should begin to realize that not all contaminant have a smell or are visible. Some samples that may not be aesthetically pleasing are perfectly drinkable. All wildlife has to depend on whatever water source is available to survive no matter what the condition of the water.

Sample	A	B	C	D	E	F
What color is the sample?						
What does it smell like? What might be in the sample? Is the sample drinkable to humans? To wildlife? Can the sample be made drinkable? How can it be cleaned?						
Is it expensive?						
Is the samples really undrinkable because it may look of smell bad?						

Communities can implement stormwater practices that allow water to slow down and filter out sediment and nutrients before entering neighboring streams and rivers. Many of the streams and rivers in Iowa experience spikes in flow, pollutants and excess nutrients after a rain event. Limiting these spikes improves the health of the streams and rivers and allows residents, wildlife and the community to use them to their full potential.

Decorah City Prairie by Larry Reis

Lesson 2.2b Role of Plants in Water Filtration

Objective	Students gain understanding of the roll plants have in filtering the water moving through a watershed
Grade Level	4-7
Iowa Core Standards	4.MD.A.1, 4–ESS3–2, 5–ESS3–1, MS–ESS2–1
Time	Two class periods
Group Size	3-4 students
Materials	- 6 potted plants, roughly 6 to eight inches in diametric and holes in the bottom. Keep them moderately dry, as if they had not been watered for a couple of days. - 6 clear containers, such as cups, which will support the plants and allow drainage to be viewed. - Soil from outside. The best soil is loamy, with smaller particles than sand - Unsweetened powered drink mix, preferably grape or cherry for color - Vegetable oil - One or two different household cleaners (one should be liquid and the other solid

PREPERATION

Set up the potted plants, each in its own cup. Slowly pour six to eight ounces of clean water through the pot, and check the percolation rate through the pot. Loosen or tighten the soil so that water percolates at about one ounce per minute. The rate should be fast enough to prevent long waiting periods, but slow enough not to carry very much soil through the pot.

PROCEDURE

1. Place the potted plants into the top of their cups. Pour clean water slowly through one of the pots and watch it percolate through the bottom of the pot. The water should look as clean as what was poured.
2. Add a gram or so of soil to 6-8 ounces of water and stir so that the soil is well suspended and distributed in the water. Pour slowly into another flower pot. The water percolating through should look much cleaner than the dirty water poured.
3. Add about one ounce of vegetable oil to 6-8 ounces of water, stir (they won't mix completely) and pour into a third pot. See if the vegetable oil percolates through or is caught up by the plant roots.
4. Add some powdered drink mix to 6-8 oz. of water and pour through a fourth pot. See if the water percolating through retains the color.
5. Add some powdered cleanser to 6-8 oz. of water and pour through a fifth pot. Is the cleanser retained in the soil?
6. Add some liquid soap to the water (an ounce or so in 6-8 oz. water). Does the soap percolate through the soil?
7. Using the "contaminated" plants, pour some clean water at the same rate through each one (simulating a rain shower). Is more of the "pollutant" rinsed away from the soil by the clean water?

Lesson 2.2b Role of Plants in Water Filtration

Helpful Tip:

Have a few extra empty flower pots with holes in the bottom to demonstrate water as it comes off of impervious surface like streets. Can also demonstrate other plant and soil types, such as clean rock of different sizes and clay vs sand soils.

DISCUSSION QUESTIONS

1. In what ways can plants and soil benefit drinking water quality?
2. We saw plants and soil remove some types of impurities from water. How might the plants remove larger quantities?
3. Can plants and soil remove any type of impurity from water?
4. What other organisms in the soil-plant system might aid the uptake of water pollutants?
5. What is the role of rainwater moving through contaminated soil?

2.3 Water Resource Based Recreation and Economic Development

Water resources are very important to every community.
Streams and river provide beauty, recreation and economic vitality for all Northeast Iowa residents.
Northeast Iowa's streams and rivers attract fisherman from around the nation who are in search of high-quality streams and rivers and the habitat they provide. To find out more about the economic benefits of trout angling read about the 2016 Trout Unlimited Survey.

Kayaking on Upper Iowa River

http://www.darestoration.com/documents/Economic%20Impact%20Summary%20of%20Trout%20Angling%20in%20the%20Driftless%20Area.pdf

Northeast Iowa's streams and rivers also attract tourists who kayak, canoe or float the rivers. According to research conducted by the Minnesota DNR, water resources are even a major factor for residents and visitors when they are deciding which biking trail to ride. Trail users prefer walking and biking on trails developed along rivers and streams. According to studies conducted by the University of Northern Iowa, water and land trails in Northeast Iowa generate millions of dollars annually for Northeast Iowa communities and businesses. Travelers who visit Northeast Iowa to enjoy the water resources stay in hotels, eat at restaurants, and shop at local stores, benefiting multiple businesses and business owners. By paying hotel/motel tax and local option sales tax, they also benefit all community and county residents. Therefore, polluted or impaired streams and rivers are not only harmful to humans who drink or recreate in them but also to the greater community who may have economic decline that is tied to the loss of tourism associated with the pollution. Communities that implement urban stormwater runoff best management practices help protect and enhance the near and downstream outdoor recreational opportunities that support their businesses. Some stormwater improvement practices, including native plantings, development of new green spaces, ponds and wetlands, also immediately create recreational opportunities for community members and visitors. They provide additional park spaces for children and additional areas for bird watchers and fishermen, while reducing flooding and improving water quality.

Fishing on the Mississippi

2.4 Wildlife habitat

Run off from city streets and residential lawns can carry soil, nutrients and harmful pollutants that can kill or harm fish and other organisms in the streams and rivers. Runoff water from city streets, parking lots and other surfaces can also warm to a much higher temperature than cold water streams or even rivers. During the summer months' city streets can reach a temperature of over 140 degrees F.

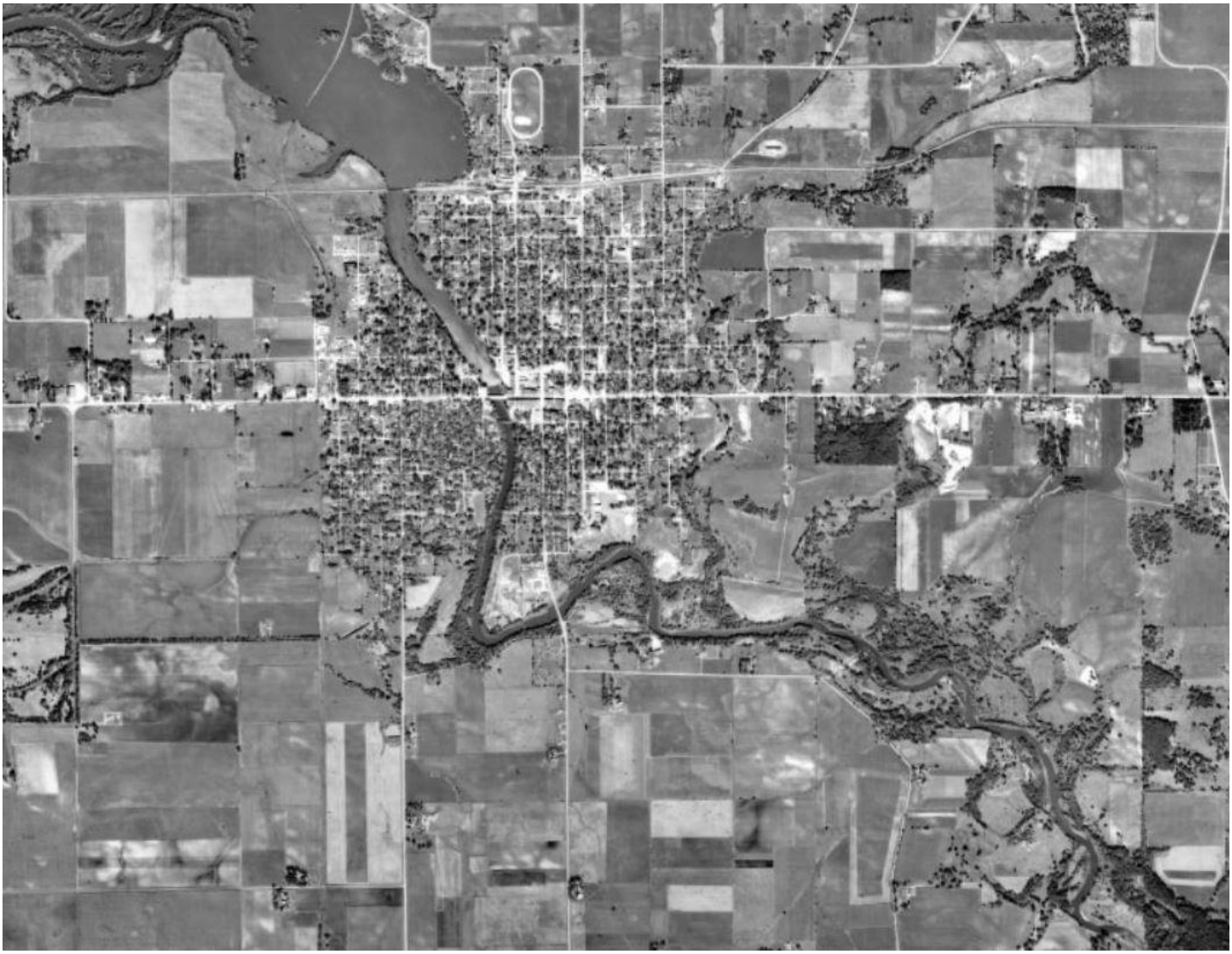
Two rainbow trout caught on Northeast Iowa streams.

Trout, an essential fish species in Northeast Iowa, thrive in cold water that is at or below 60 degrees Fahrenheit. Brook Trout, which are the native trout species in northeast Iowa are temperature sensitive. According to EPA, ***Runoff from a 100 percent impervious surface, like a city street, can increase summer stream temperatures by 10 degrees!*** Depending on the current temperature an increase of ten degrees could negatively affect the behavior, metabolism, reproduction, growth and vulnerability to disease of brook trout and many other aquatic organisms. Michael Siepker, Iowa DNR Fisheries Management Biologist, explains the effect of water temperature, ***"A 10 degree change in water temperatures can be detrimental to trout, especially when water temperatures are already near the upper limits of what trout can survive in. Other factors such as the species of trout present and other simultaneous changes in water quality (such as changes in dissolved oxygen levels) can also influence the amount of temperature change trout populations can withstand. Although, short-term increases in water temperature typically don't result in mortality of trout, temperature changes can negatively affect their feeding behavior."***

Implementing stormwater conservation practices creates additional areas for wildlife, while improving stream and river resources for fish and other organisms. Urban conservation projects such as prairie, orchards, and butterfly gardens create habitat for many pollinator species like bees, butterflies, and other insects. They also provide habitat for birds and other small mammals. Conservation practices work to improve water quality for fish and other small microorganisms living in cold water stream habitats and rivers.

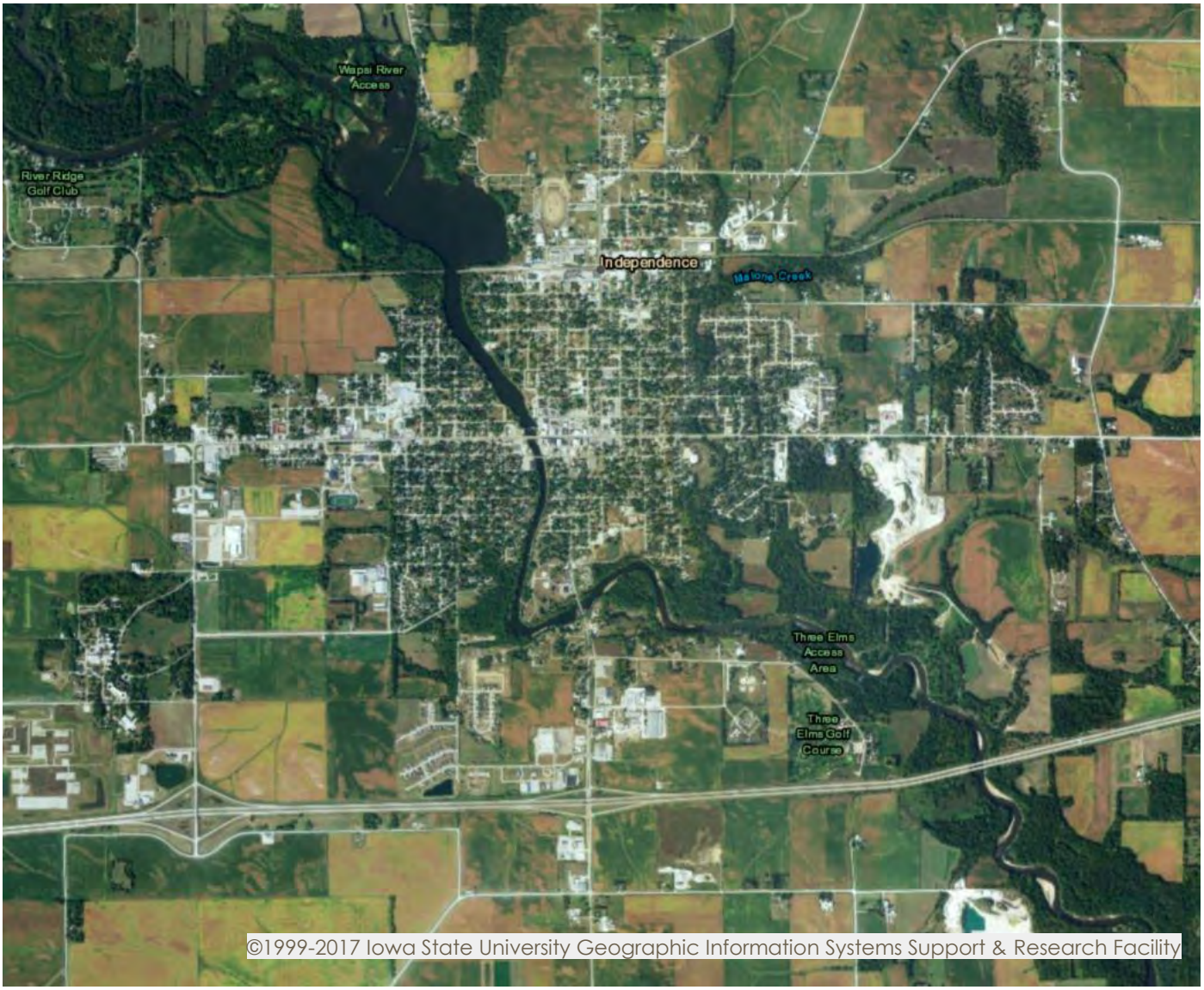
The photo below shows the increase in development in the city of Independence, Iowa between the years 1950 and 2017. Increases in development usually means increase in the amount impermeable surfaces and the destruction of permeable surfaces.

Can you spot the differences?
How does an increase in development affect the Upper Wapsipinicon River watershed?



City of Independence 1950

b



City of Independence 2017

Discussion Questions

Why is urban conservation important to you?

What are ways you can improve water quality, recreation, wildlife, or reduce flooding in your community?

Lesson on Biodiversity is originated from the Illinois Department of Natural Resources, Chicago Wilderness, and World Wildlife Fund.

Lesson 2.4a What is your Biodiversity IQ?

Objective	Students gain understanding of the importance to biodiversity.
Grade Level	5-8
Iowa Core Standards	SL.5.5, SL.5.1, SL.5.2, 5–LS2–1, W.6.7, RI.7.4, MS–LS2–1, MS–LS2–2, MS–LS2–4, 21.6–8.ES., MS–LS2–5
Time	One class period
Group Size	2-3 Students or individually
Materials	- Copy of the Quiz

PREPARATION

Did you know that there are insects that imitate plant parts, birds that map their migration by the stars, and fungi that find their way into your favorite foods? According to the Iowa Association of Naturalist, Iowa is home to nearly 1,800 plant species and 750 vertebrate species. There are also thousands of invertebrate species, including about 2,000 species of moths alone. Some organisms rely on special habitats and specific organisms for food and shelter. The destruction of habitat is one major factor causing species to become endangered.

PROCEDURE

Biodiversity quiz

- Distribute the quizzes to small groups of students or individual students. Review vocabulary that may be unfamiliar to your students.
- Have students complete the quiz
- Pass out the answer keys and allow students to score their tests.
  - How did they do?
  - Where they surprised by any of the answers? Which ones?

DISCUSSION

Explain that the quiz was designed to point out some interesting facts about the natural world, as well as to introduce the topic of biodiversity.

- Ask the students what they thing biodiversity means
- Create a class definition of biodiversity
- Ask the students to use this definition and the quiz to determine why biodiversity is important
  - Examples may include food, clothing, housing, ecosystems, natural beauty and more

TAKE HOME EXERCISE

- Write each letter of the alphabet on a separate slip of paper.
- Fold the slips, put them into a container and have each student pick one.
- Then have each student write a poem or limerick about an animal, plant or other life form that lives in Iowa and starts with his or her letter.
- As an option, have the students draw or cut out pictures to go along with their writings and compile them into a book. Possible titles for the book include Biodiversity A to Z, An Encyclopedia of Biodiversity or A Poetic Look at Biodiversity.
- You could also have the students present their poems to younger students

Lesson 2.4a What is your Biodiversity IQ? - Answers

Each correct answer is worth one point, even if there is more than one correct answer per question. Maximum possible = 62 points.

1. Which of the following animals could the fastest human outrun in a 100-yard race?
c. American Woodcock
e. Wild Turkey

Lots of animals are quick on their feet (or wings, or scales, or fins), but speed doesn't necessarily count much these days in the race for survival. Cheetahs, for example, are the fastest land animals in the world (may reach speeds of about 70 miles per hour)—but they're also among the world's most endangered. The fastest humans can finish a 100-yard dash in under 10 seconds. That calculates to about 25 miles per hour; although humans can't sustain that speed long-term. The warthog and domestic cat can both attain speeds of about 30 miles per hour. The wild turkey can run at about 20 miles per hour, and the American woodcock flies slowly at about five miles per hour maximum.

2. Which of the following actually exist?
a. ants that "herd" aphids for food
b. slime molds that creep across the ground
c. trees that can grow with their roots under water

Certain kinds of ants eat the sugary substances excreted by aphids, which are insects that suck plant juices. The ants actually herd colonies of aphids by moving them from place to place and protecting them from enemies. Some slime molds have two distinct phases in their life cycle. In the reproductive phase they are stationary, like a plant with a stalk. From this stalk they produce spores. These slime molds may also exist as mobile amoeba-like organisms that feed by engulfing material. Bald cypress trees grow in swamps in southern Illinois, as well as in the southern United States. These huge trees can grow with their roots continually submerged because of their unique feature, called "knees."

3. Which of the following animals can consume at least half of its body weight in food each day?
a. little brown bat
b. masked shrew
c. ruby-throated hummingbird

These small animals need huge amounts of food each day to survive. In fact, a mother little brown bat that is feeding babies must consume more than her body weight in insects each night.

4. Which of the following best describes the word "biodiversity?"
c. the variety of all life on earth

The variety of life on earth includes plants, animals, microorganisms, ecosystems, genes, habitat diversity and more.

5. United States Fish and Wildlife Service agents at O'Hare International Airport in Chicago once found which of the following?
c. 10 baby turtles

Agents at O'Hare found the baby turtles rolled up in a sock inside the back of a camera. Annual trade in wildlife and wildlife products is estimated at $10 billion and up to 25 percent of the trade is illegal. That amounts to $2.5 billion in black market wildlife trade — one of the largest black markets in the world!

6. Scientists studying bug zappers have learned some interesting facts. Which of the following are amount them?
c. Bug zappers could be bad news for certain bird, fish, bat and flower species.
d. There are more than four million bug zappers being used in the United States.

A study at the University of Delaware on bug zappers came up with some "shocking" results. It revealed, for example, that many species of mosquitoes are not attracted to bug zappers at all. Instead, the zappers' blue light attracts harmless insects in droves, many of which provide food for birds, bats and fishes. Some of the insects that zappers zap is also important to plants, which need the insects for pollination.

7. Blackpoll warblers are tiny birds that migrate between North America and South America each year. Which of the following statements about them are true?

a. They use the stars for navigation.
d. If they burned gasoline instead of body fat for fuel, they'd get 720,000 miles to the gallon.

Animals that migrate often have remarkable navigational skills. Many use the sun, stars, land patterns and other means to reach their destination, which may be thousands of miles and several countries away. And many migrators are able to get where they're going on very little fuel. For example, migrating birds often travel huge distances and eat very little along the way. They have incredibly energy-efficient bodies that "burn" body fat for fuel. Some birds, such as the tiny blackpoll warbler, get the equivalent of thousands of miles per gallon of fuel! But being able to get from point A to point B doesn't matter much if the habitat an animal is traveling to has been destroyed. That's one reason why international efforts to conserve habitat are so important.

8. Which of the following can be considered an enemy of the Great Lakes?

a. zebra mussel
b. spiny water flea
c. mercury
d. sea lamprey

The Great Lakes are the world's largest source of fresh water. But this incredible ecosystem is facing serious threats. Nonnative species, such as the zebra mussel, sea lamprey and spiny water flea, compete for food or threaten the health of native animals. Chemicals, such as mercury, that end up in the Great Lakes, often last forever and even enter the food chain, making fish in certain areas unsafe for humans and other animals to eat.

9. What's the most serious threat to biodiversity?

b. habitat loss

All over the world habitats are being turned into agricultural land, harvested for wood and fuel, and destroyed or changed to build roads, schools, malls and other human developments. Because the human population is growing so quickly and consuming so many natural resources, habitat loss is occurring at a rapid pace.

10. The items on the left have been (or are being) developed into important medicines for humans. Match each item with the medicine made from it by writing the letters in the appropriate blanks.

b bread mold (antibiotic)
c willow tree (pain reliever)
d vampire bat saliva (medicine to unclog arteries)
a mayapple (heart medicine)
e coneflower (immune system booster)

Biodiversity is like a gigantic pharmacy. Consider plants: more than one-fourth of the drugs commonly used today were originally derived from plants. Animals are a potentially important source of medicines, too. In fact, you never know where a future medicine might pop up. Who would have thought that vampire bat saliva could be useful? No wonder researchers are looking to biodiversity to find treatments and cures for cancer, AIDS and a host of other diseases.

11. Which of the following are true statements about little brown bats?

a. Baby bats weigh 20 to 25 percent of their mother's weight at birth.
b. Heart rate during flight can reach 1,000 beats per minute.
d. A little brown bat may live 20 to 30 years.

Bats are amazing animals. Though bats reproduce at a relatively slow rate, the large size of the babies, called pups, helps to increase the chance of survival. Little brown bats only eat insects they catch while flying. All this activity produces a heart rate of up to 11 beats per minute. They also have an unusually long life span for a small mammal and may live 20 or 30 years.

12. Without fungi, which of the following would you <u>not</u> be able to do?
a. eat pizza topped with mushrooms
b. bake bread
c. live in a world free of dead things lying all over the place
d. put blue cheese dressing on your salad

While some forms of fungi may seem less than noble—athlete's foot fungus, for example—the world could not function long without these humble life forms. Fungi and bacteria play a key role in breaking down organic matter and recycling it back into usable nutrients. Without them, dead things would definitely pile up! Besides, without fungi we wouldn't have tasty treats such as mushrooms, yeast bread or blue cheese.

13. Which of the following statements are true?
c. More than 5,000 different kinds of potatoes have been identified in South America's Andes Mountains.

The potato actually originated in South America. In Peru, some family farmers grow as many as 12 kinds of potatoes. Most supermarkets sell only four or five potato varieties. In the United States, Idaho and Washington produce the most potatoes.

14. Which of the following are actual species of animals found in Illinois?
a. Southern flying squirrel
b. Bull Snake
c. Wild Indigo Duskywing
d. Pirate Perch

These are just a few examples of some of the many strange and wonderful creatures of Iowa.

15. If you decided to throw a party to celebrate the diversity of life on earth and wanted to send an invitation to each species, how many invitations would you need?
d. more than 1.5 million

Scientists have estimated that as many as 100 million species may actually exist—they just haven't gotten around to identifying all of them yet.

16. Which of the following statements about short tailed shrews are true?
a. Your cat may bring one to you.
b. They use a form of echolocation, like bats.
c. Shrews are known as the "tigers of the small animal world."
d. Shrews are venomous.

Short-tailed shrews are seldom seen in nature because of their size and ability to hide, although, house cats seem to find their share. Short-tailed shrews make up for their poor eyesight by using a form of echolocation to find their food. Shrews are without a doubt one of the most ferocious mammal predators. Once they catch their prey, their venomous saliva immobilizes it.

17. Biodiversity includes:
a. the color of your eyes
b. the creatures in your neighborhood soil
c. Iowa
d. your classmates

Biodiversity describes the incredible variety of life on earth—and that includes the diversity among genes (which control inherited traits like the color of your eyes), species (from huge whales to tiny soil creatures) and ecosystems (from lush cypress swamps to the harsh environmental conditions of a prairie).

18. If we gave a prize for "the strongest creature for its size," which of the following would win?
c. ant

An ant can carry a load up to 50 times its body weight.

19. Which of the following would people have to do without if there were no bees?
a. almonds
b. honey
c. cucumbers
d. apples
e. celery

Bees are worth billions of dollars to the agriculture industry. Each year bees pollinate millions of acres of almond and apple trees, cucumbers and celery. Other favorite foods we'd miss without bee pollinators include watermelons, avocados, plums, pears, blueberries, cranberries, cherries and cantaloupes.

20. Which of the following is an example of an ecosystem service?
a. a ladybird beetle that protects your garden by eating aphid pests
c. a wetland that filters dirty water
d. an ocean that controls the earth's climate

Ecosystem services include the "free services" provided by ecosystems around the world—and which most of us take for granted. For example, wetlands help control floods, filter pollutants from water and provide habitat for all kinds of birds, fishes and other animals. Ladybird beetles eat aphids, which are common garden pests. And oceans act as a giant thermostat, interacting with the atmosphere and land to control earth's climate.

21. Some of the world's most fascinating creatures live in really unusual places. Which of the following is sometimes a home for another living thing?
a. a caterpillar's abdomen
b. a termite's gut
c. a white-tailed deer's intestine
d. a human's forehead

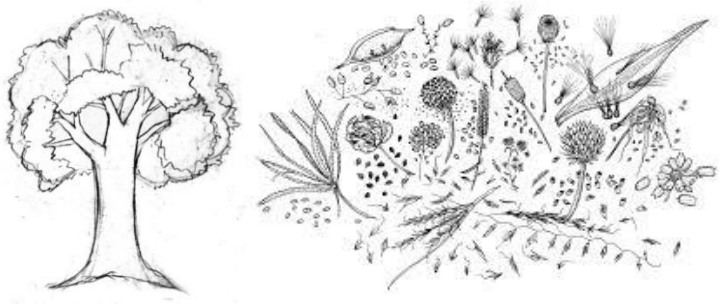
The larva of a tomato hornworm may become host to the eggs of the parasitic ichneumon wasp. As the wasp larvae develop, they use the caterpillar for food. Deep within a termite's gut lives a tiny protozoan that helps to digest the termite's woody diet. The white-tailed deer belongs to a group of hoofed mammals that have bacteria living in their digestive tracts. The primary type of bacteria changes through the year to insure the deer can always digest the available food source, that is, green plants in the spring and summer and bark, twigs, grain and acorns in fall and winter. Without knowing it, most human beings have mites on their forehead. Mites are slender creatures with a wormlike body and a spidery head. A mite is so small it is almost invisible. One species (Demodex folliculorum) dwells in the hair follicles, and another (Demodex brevis) lives in the sebaceous glands.

22. If you had a job that put you in charge of saving all Iowa species on the edge of extinction, how many endangered and threatened species would you need to save?
d. 234

You'd be pretty busy conserving habitats for 234 plant and animal species. And that's only the number of species of plants and animals listed as threatened and endangered in Iowa by the Iowa DNR. Some scientists estimate that up to 27,000 species become extinct worldwide each year, and we never even knew that most of them existed.

23. The eastern prairie fringed orchid was once common in the prairies of Iowa. Which of the following statements explains why this plant is now endangered in Iowa?
c. Habitat loss due to agriculture and development.

Habitat loss is the number one threat to plants and animals. Most of the wet prairie habitat favored by the orchid has been drained and used for agriculture or development. In Iowa, less than 0.1 percent of native prairies remain undisturbed



Lesson 2.4a What is your Biodiversity IQ? Quiz

NAME:_____

Circle all that are correct. Many questions have multiple correct answers.

1. Which of the following animals could the fastest human outrun in a 100-yard race?
a. cheetah
b. warthog
c. American woodcock
d. domestic cat e. wild turkey

2. Which of the following actually exist?
a. ants that "herd" aphids for food
b. slime molds that creep across the ground
c. trees that can grow with their roots under water
d. none of the above

3. Which of the following animals can consume at least half of its body weight in food each day?
a. little brown bat
b. masked shrew
c. ruby-throated hummingbird
d. none of the above

4. Which of the following best describes the word "biodiversity?"
a. endangered species
b. different kinds of planets in the solar system c. the variety of all life on earth
d. biographies about famous biologists

5. United States Fish and Wildlife Service agents at O'Hare International Airport in Chicago once found which of the following?
a. 18 California king snakes
b. 45 pounds of elephant ivory
c. 10 baby turtles
d. 16 vampire bats

6. Scientists studying bug zappers have learned some interesting facts. Which of the following are among them?
a. Insects are attracted to bug zappers because of the zappers 'smoky smell.
b. Bug zappers are great for ridding summer nights of mosquitoes.
c. Bug zappers could be bad news for certain bird, fish, bat and flower species.
d. There are more than four million bug zappers being used in the United States

7. Blackpoll warblers are tiny birds that migrate between North America and South America each year. Which of the following statements about them are true?
a. They use the stars for navigation.
b. They make frequent pit stops at fast-food restaurants.
c. They don't really need to migrate.
d. If they burned gasoline instead of body fat for fuel, they'd get 720,000 miles to the gallon.

8. Which of the following can be considered an enemy of the Great Lakes?
a. zebra mussel
b. spiny water flea
c. mercury
d. sea lamprey

9. What's the most serious threat to biodiversity?
a. scientists collecting specimens
b. habitat loss
c. tourists
d. pollution

10. The items on the left have been (or are being) developed into important medicines for humans. Match each item with the medicine made from it by writing the letters in the appropriate blanks.

__ bread mold	a. heart medicine
__ willow tree	b. antibiotic
__ vampire bat saliva	c. pain reliever
__ mayapple	d. medicine to unclog arteries
__ coneflower	e. immune system booster

11. Which of the following are true statements about little brown bats?
a. Baby bats weigh 20 to 25 percent of their mother's weight at birth.
b. Heart rate during flight can reach 1,000 beats per minute.
c. Little brown bats drink the blood of birds and small mammals.
d. A little brown bat may live 20 to 30 years.

12. Without fungi, which of the following would you not be able to do?
a. eat pizza topped with mushrooms
b. bake bread
c. live in a world free of dead things lying all over the place
d. put blue cheese dressing on your salad

13. Which of the following statements are true?
a. Potatoes originated in Ireland.
b. The United States grows most of its baking potatoes in Washington.
c. More than 5,000 different kinds of potatoes have been identified in South America's Andes Mountains.
d. The French fry, invented by Madame Bonaparte during the French Revolution, became one of Napoleon's favorite snacks.

14. Which of the following are actual species of animals found in Iowa?
a. Southern flying squirrel
b. Bull Snake
c. Tiger
d. Wild Indigo Duskywing
e. Pirate Perch

15. If you decided to throw a party to celebrate the diversity of life on earth and wanted to send an invitation to each species, how many invitations would you need?
a. 150
b. about 3,000
c. 652,983
d. more than 1.5 million

16. Which of the following statements about short-tailed shrews are true?
a. Your cat may bring one to you.
b. They use a form of echolocation, like bats.
c. Shrews are known as the "tigers of the small animal world."
d. Shrews are venomous.

17. Biodiversity includes:
a. the color of your eyes
b. the creatures in your neighborhood soil
c. Iowa
d. your classmates

18. If we gave a prize for "the strongest creature for its size," which of the following would win?
a. bobcat
b. bald eagle
c. ant
d. turtle

19. Which of the following would people have to do without if there were no bees?
a. almonds
b. honey
c. cucumbers
d. apples
e. celery

20. Which of the following is an example of an ecosystem service?
a. a ladybird beetle that protects your garden by eating aphid pests
b. a company that rakes people's yards
c. a wetland that filters dirty water
d. an ocean that controls the earth's climate

21. Some of the world's most fascinating creatures live in really unusual places. Which of the following is sometimes a home for another living thing?
a. a caterpillar's abdomen
b. a termite's gut
c. a white-tailed deer's intestine
d. a human's forehead

22. If you had a job that put you in charge of saving all Iowa species on the edge of extinction, about how many endangered and threatened species would you need to save (based on what we know today)?
a. 12
b. 250
c. 917
d. 480

23. The eastern prairie fringed orchid was once common in the prairies of Iowa. Which of the following statements explains why this plant is now endangered in Iowa?
a. The extreme temperatures due to global warming prevent this sensitive plant from producing seeds.
b. People dig up the plants to use in their flower beds.
c. Habitat loss due to agriculture and development.
d. It is the favorite food of white-tailed deer.

24. Which of the following environments on our planet are too harsh to support life?
a. boiling sulfur springs, where temperatures are commonly 212° Fahrenheit (100° Celsius)
b. deep-sea hydrothermal vents called "smokers," where the temperature can reach 662° Fahrenheit (350° Celsius)
c. the frigid ice of the Arctic and Antarctic
d. all of the above
e. none of the above

Section 3: Understanding Stormwater Management Practices

3.1 Best Management Practices (BMPs)
3.2 What's Happening in Northeast Iowa
3.3 Developing effective student/class projects
3.4 Cross-curricular components of urban conservation and stormwater management

Northeast Iowa communities can manage stormwater using techniques that improve watershed function, reduce flooding and improve water quality. This section discusses strategic use and placement of specific best management practices in communities.

Section 3.1 Best Management Practices (BMPs)

Best management practices (BMPs) are methods or techniques that have been recognized through scientific assessment to be most effective and practicable for achieving an objective. The BMPs referred to in this publication are specifically associated with preventing or reducing non-point source pollution and with reducing stormwater runoff flow to help improve water quality and reduce flooding. The specific BMPs recommended for use by urban communities are rain gardens, bio-swales, rain barrels, infiltration trenches, permeable pavers, soil amendment, tree and native plantings, ponds and wetlands, and green roofs. Each of these practices is explained in more detail below.

Lessons in this section were derived from EPA's Stomwater Management Lesson Plans, Soil-net.com, and the Northern Rhode Island Conservation District.

RAIN GARDEN

Rain gardens are gardens that help slow down, soak up, and filter polluted water from downspouts, driveways, roof tops and other small areas. They are designed to hold water for a short period of time (Less than 24 hours) to allow the soil and plants to trap absorb and filter out pollutants like fertilizers, oil, pesticides and sediment, while recharging ground water supplies. Rain gardens contain native flowers and grasses that have deep roots and can soak up water and hold soil in place. Rain gardens can also be great pollinator and butterfly gardens that provide food in the form of sugary nectar or protein packed pollen grains for bees, butterflies, moths, birds and other pollinator species. As these pollinators forage, they spread pollen between flowers enabling plans to live and reproduce.

BENEFITS

- Reduce flooding
- Filter Pollution
- Replenish groundwater
- Provide wildlife habitat
- Prevent sewer overflows

THE AVERAGE HOME RAIN GARDEN NATURALLY FILTERS 30,000 GALLONS OF WATER PER YEAR, ENOUGH TO FILL A BATHTUB 600 TIMES

For more information on how to design and construct a rain garden open the link below.
http://www.rainscapingiowa.org/en/rainscapes/rain_gardens/

BIO-SWALES

A Bio-swale is a ditch that allows runoff from larger areas like streets, parking lots, and small neighborhoods to soak into the ground. Water flows into the bio-swale where contaminants and excess sediment is filtered by the soil and native plant roots before entering the city stormwater system and emptying into a neighboring stream or river. This BMP is often coupled with a curb cut, to allow water running off of a street to be directed to a bio-swale.

More information:
http://www.rainscapingiowa.org/documents/filelibrary/bioswales/Bioswales_ForWeb_C587135B39622.pdf

BENEFITS

- Provides recreational opportunities
- Reduce flooding
- Filter Pollution
- Replenish groundwater
- Provide wildlife habitat
- Prevent sewer overflows

Bio-swale a part of the City of West Union Street revitalization project.

RAIN BARREL/RAIN HARVEST SYSTEM

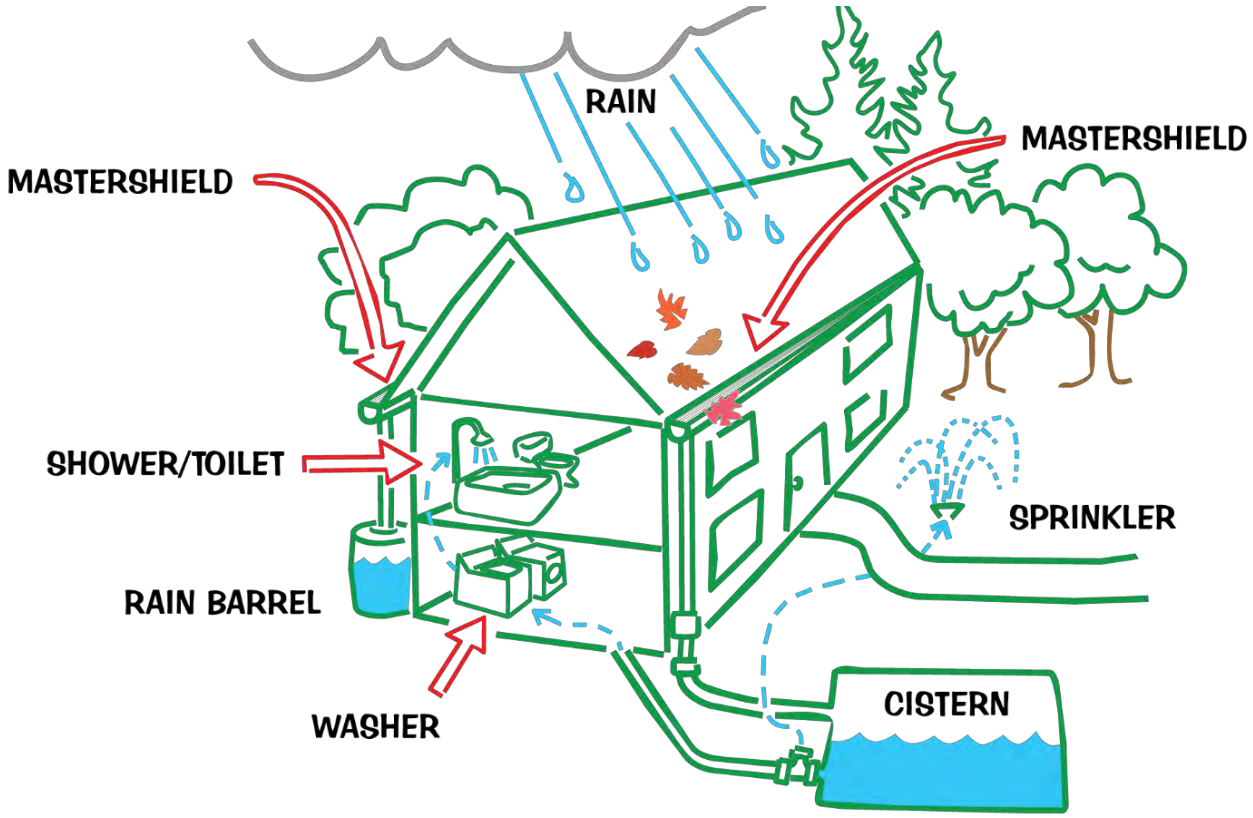
Rain Barrels are used to collect water runoff from the roofs of houses or small buildings. A storage container usually a barrel of some kind is attached to the down spout of a building and collects runoff from the roof. Water stored in these containers is used to water outdoor flower and vegetable gardens during times of little rain. Rainwater harvest systems are similar to rain barrels but they collect water from buildings with very large roofs, like factories. Water collected from these large surface areas is often reused within the factory, or for a drinking water source. Rainwater is full of oxygen, free of harmful salts, fluoride and other compounds contained in normal treated water.

Common household Rain Barrel

More information:
http://www.rainscapingiowa.org/en/rainscapes/rainwater_harvesting/

BENEFITS

- Rain water is better for plants and soil
- Obtain a water storage in time of drought
- Reduce runoff and runoff pollution
- Have a free source of water that can be used in any way



Mastershield.com

Lesson 3.1a Rain Barrels

Objective	Students will gain an understanding of rain barrel function and benefits
Grade Level	3-5
Iowa Core Standards	3–5–ETS1–1, 3–ESS3–1, RI.4.2, RI.4.7, SL.3.4, SL.5.1
Time	60 mins
Group Size	3-4 students
Materials	- Handouts - Plastic bottle, foam strips, construction pater glue, tape - Sticky notes - Colored pencils, markers or crayons

PROCEDURE

Evaluate prior knowledge of rain barrels by completing a "What I Know, What I Want to Know, and What I Learned" (KWL) Chart

Hand out the KWL Chart and allow table groups (3-4 students) about two minutes to come up with as many things they know or wonder about rain barrels. Each table group will share with the class at least two things they discussed.

Suggested questions to ignite brainstorm activity:

1. What is a rain barrel?
2. What is the purpose of a rain barrel?
3. What materials are used to build a rain barrel?
4. Where can a rain barrel be used?

Introduce vocabulary and discuss rain barrel elements

Hand out the Rain Barrel Vocabulary Sheet and review it with the students. Use the diagram on the next page to aid understanding.

Show pictures of different kinds of rain barrels to the students.

Have students analyze what they observe, and record their observations in journals or on paper.

Rain barrel components

1. Downspout
2. Mosquito screen
3. Sump hose
4. Rain Barrel
5. Spigot

PROCEDURE CONTINUED

As a group, have students answer the following questions: Answers are shown below

1. What are the benefits of a rain barrel?
    a. Reduce stormwater runoff which reduces the amount of sediment and other pollutants that would be washed away with the runoff into storm drains and local streams.
    b. Healthy water for plants. (Rainwater is naturally soft unlike treated water)
    c. Conserve water/groundwater recharge. The slow release of the water allows it to soak into the ground, which supplies water to local streams in between storms.
    d. Save money; rain barrel water can be used for irrigation.

2. What are the steps to install a rain barrel? Put the following steps in order.
    a. Place bricks, concrete blocks, or pressure treated wood under the barrel to elevate it to create a platform (a higher barrel equals higher water pressure).
    b. Cut off part of the downspout. Leave space to reattach the downspout end piece. c. Put the rain barrel in place beneath the downspout with the top ring and mosquito screening on top to collect rain water from the roof.
    d. Reattach the curved down spout end piece to the down spout.
    e. Connect at least 10 ft. of 1 ¼ inch of sump hose to the overflow hole.

Build a class rain barrel

Sources on how to build a rain garden are listed below. Find the one that fits your class.

http://cceonondaga.org/resources/how-to-build-a-rain-barrel

http://www.iowadnr.gov/Portals/idnr/uploads/pins/rain%20barrel%20flyer%20081614.pdf

https://www.bhg.com/gardening/yard/tools/make-a-rain-barrel-save-water/

https://www.familyhandyman.com/smart-homeowner/how-to-build-a-rain-barrel/view-all/

Summarize the lesson and reiterate the benefits of rain barrels.

Connect discussion back to stormwater and the different types of stormwater BMPs. Have students fill out "What I learned" part of KWL

Expand knowledge of rain barrels with activities out of the classroom:

- Students can work with parents to build a rain barrel at home
- Students can work together to create a choreographed song and dance about rain barrels

Rain Barrel KWL Sheet

What I Know	What I Want to Know	What I Learned

Lesson 3.1a Rain Barrel Vocabulary

Downspout: A pipe that carries rainwater from a roof to a drain or rain barrel.

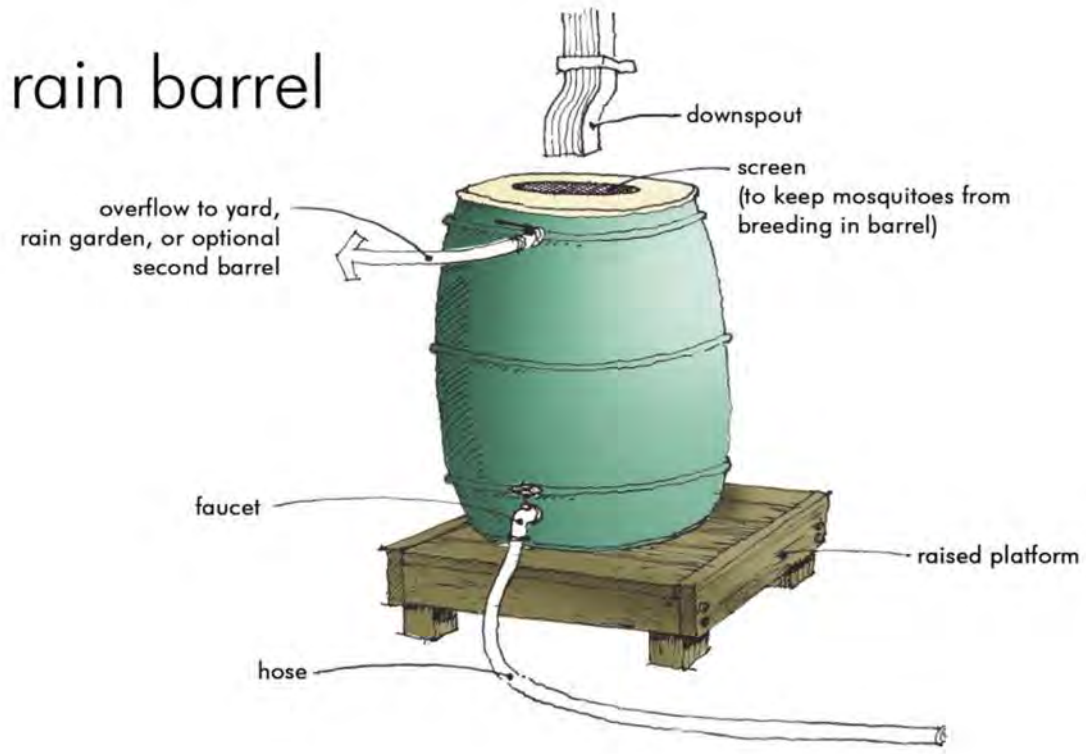
Mosquito screen: A mesh netting that prevents mosquitos from breeding in the rain barrel water.

Rain barrel: A barrel that collects and stores rainwater from a roof. It is installed at the base of a downspout coming off the roof.

Spigot: A device used to control the flow of water out of the rain barrel.

Stormwater Runoff: Water that originates during precipitation events and flows over the land. It can pick up sediment, pollutants, and debris as it moves.

Sump hose: A hose used to direct overflow water out of the rain barrel.

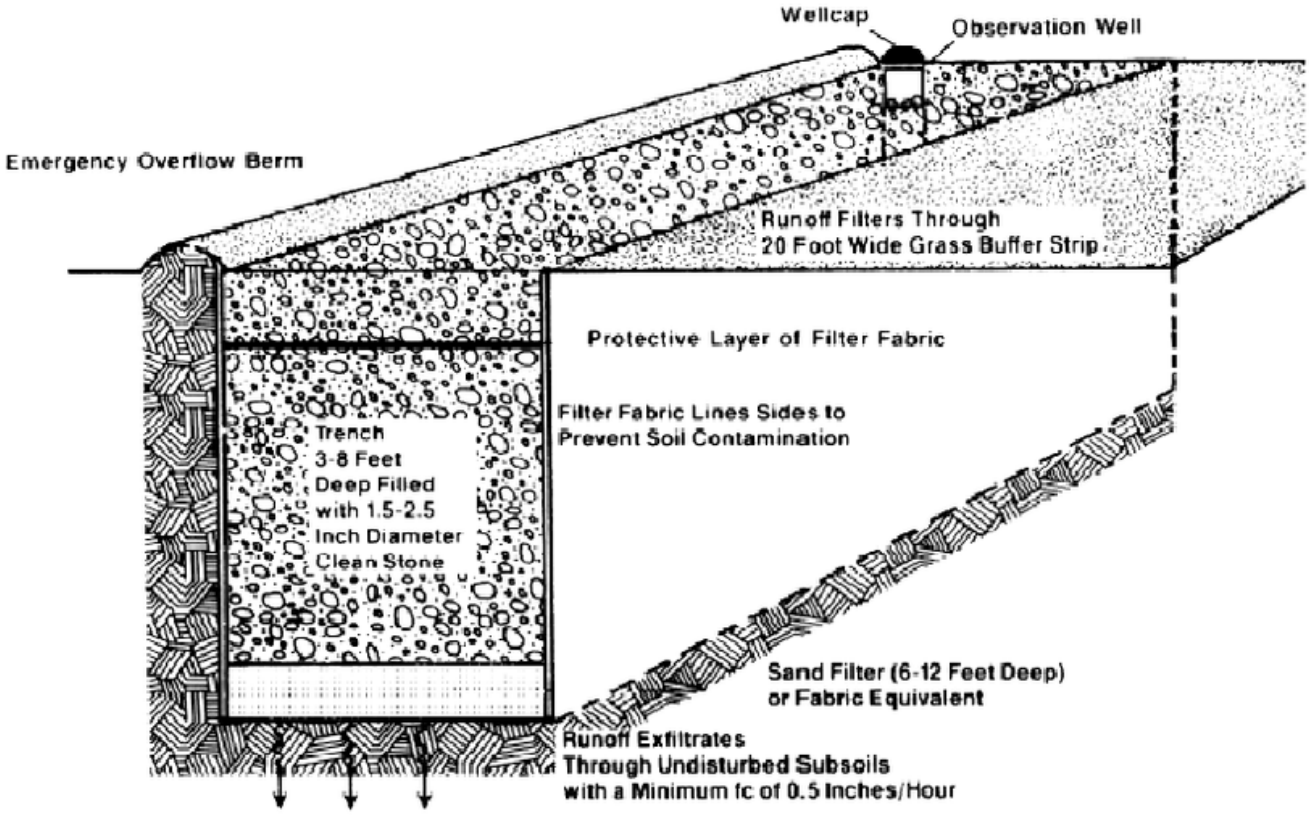


INFILTRATION TRENCH

Infiltration trenches are shallow 3-12 foot holes that are filled with stone to create an underground area that holds water. Runoff is directed towards the trench and water moves down through the rock filtering pollutants out of the water. They can also be topped with a soil layer and planted with grass or native plant mix. Infiltration trenches are placed along the side of buildings, parking lots or streets to capture runoff coming from those impervious surfaces.

BENEFITS

- Reduces the volume of runoff
- Remove sediment, metals, nutrients bacteria and other pollutants
- Reduces downstream and local flooding
- Provides groundwater recharge
- Appropriate for small sites
- Can be utilized where space is limited, due to narrow dimensions



PERMEABLE PAVERS

Many city streets and sidewalks are made of cement or asphalt that is impervious to water. Permeable pavers are an interlocking brick like system that allows water to infiltrate through the grooves between pavers. They are used as a method of paving vehicle and pedestrian pathways, and are most useful where there is little heavy machinery traffic. Permeable pavers are commonly installed on sidewalks, parking lanes along streets, and parking lots. They reduce the amount of impermeable surfaces within a community.

More information:
http://www.rainscapingiowa.org/en/rainscapes/permeable_pavement_systems/

BENEFITS

- Recharge local groundwater supplies
- Improve water quality by removing pollutants out of runoff water
- Immediate infiltration reduces time and distance that rainwater flows over heated surfaces like street temperatures (reduced temperature of stormwater runoff)
- Reduce flooding

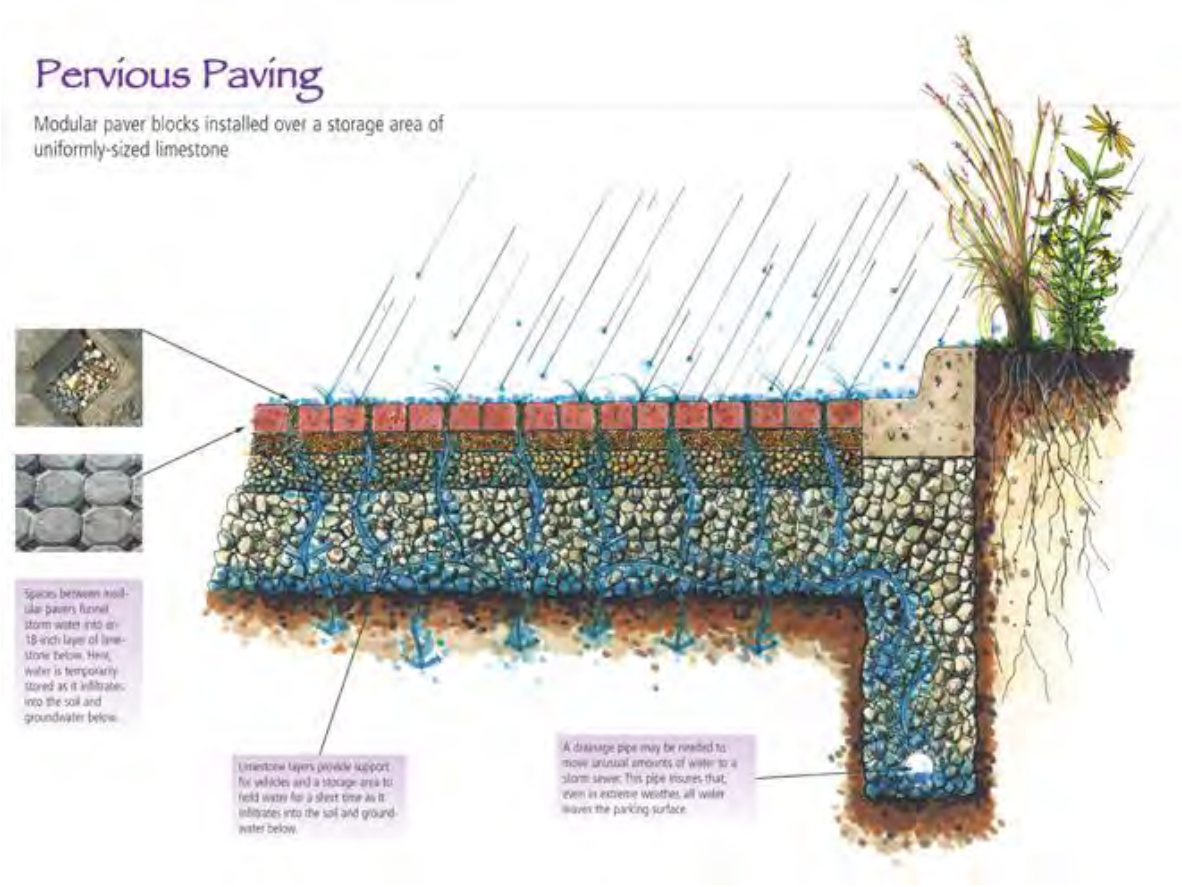


Illustration by Doug Adamson, RDG Planning & Design, provided by USDA-NRCS in Des Moines, Iowa.

Downtown Elgin, IA permeable paver parking lanes.

According to Fehr Graham Engineering and Environmental, permeable pavers infiltrate water at a rate of 350 gallons per minute.

Lesson 3.1b Calculating Storage Volume

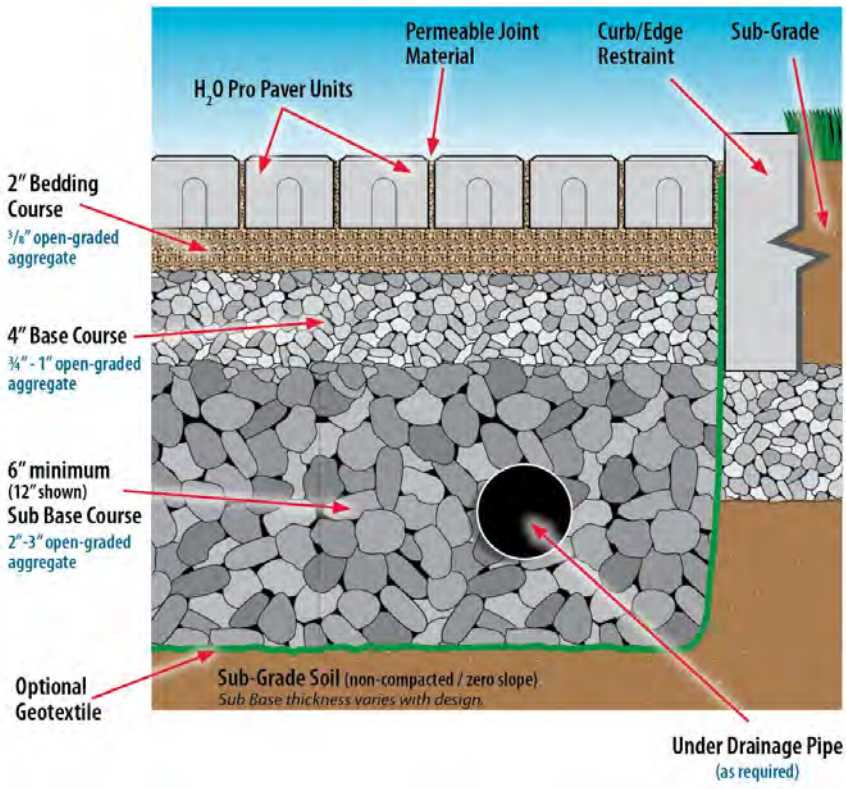
Objective	Students will gain an understanding of permeable paver surfaces and how to calculate runoff storage
Grade Level	6-12
Iowa Core Standards	7.EE.B.3, 7.EE.B.4, 6.EE.B.6, MS–ESS3–2, HSA.CED.A.1, HSA.CED.A.4, HSF.IF.B.4
Time	90 mins
Group Size	3-4 students
Materials	- Handouts - Measuring things - Journal or paper for recording observations

PROCEDURE

Evaluate prior knowledge of permeable pavement with class discussion

1. What makes a surface permeable?
2. Compare and contrast the difference between impervious and pervious surfaces?
3. What problems can impervious surfaces cause?
4. What are different kinds of permeable surfaces?
5. What is the purpose of permeable surfaces?

Introduce vocabulary and permeable paver elements



Introduce the variables used to calculate volume and depth

CALCULATE STORAGE VOLUME OF THE RESEVOIR LAYER

$$V_{storage\ (ft^3)} = D_{reservoir\ (ft)} \times P_{reservoir\ (0\text{-}0.99)} \times A_{surface\ (ft^2)}$$

Where:

$V_{storage}$ = total volume of the stormwater storage
$D_{reservoir}$ = depth of the reservoir layer of stone
$P_{reservoir}$ = porosity of the reservoir stone (percent air space)
$A_{surface}$ = total surface area of permeable paving

As variables:

$$V = D \times P \times A$$

EXAMPLE 1:
If an 80 ft by 20 ft parking lot has a reservoir layer that is one ft deep, what is its storage volume?

First, find the necessary variables:

$A = 80ft \times 20ft = 1600\ ft^2$
$D = 1\ ft$
$P = 0.35$
(Assume P = 0.35 for all problems)

Then, plug the variables into the equation:

$$V = 1ft \times 0.35 \times 1600\ ft^2$$

Finally, multiply to solve for the storage volume:
$V = 560\ ft^3$

Introduce the 24-hour rainfall chart to students

The rain fall chart shows the amount of rain (in inches) that occurs in a 24-hour period for different types of storms. The storm return periods are an estimation of how likely a storm is to occur annually. A return period of 100 means that a storm of that size is likely only to return once every 100 years, of there is a 0.1% chance of the storm occurring at any time. The table compares rain fall data from Northeast and Southwest Iowa and Northeast Minnesota.

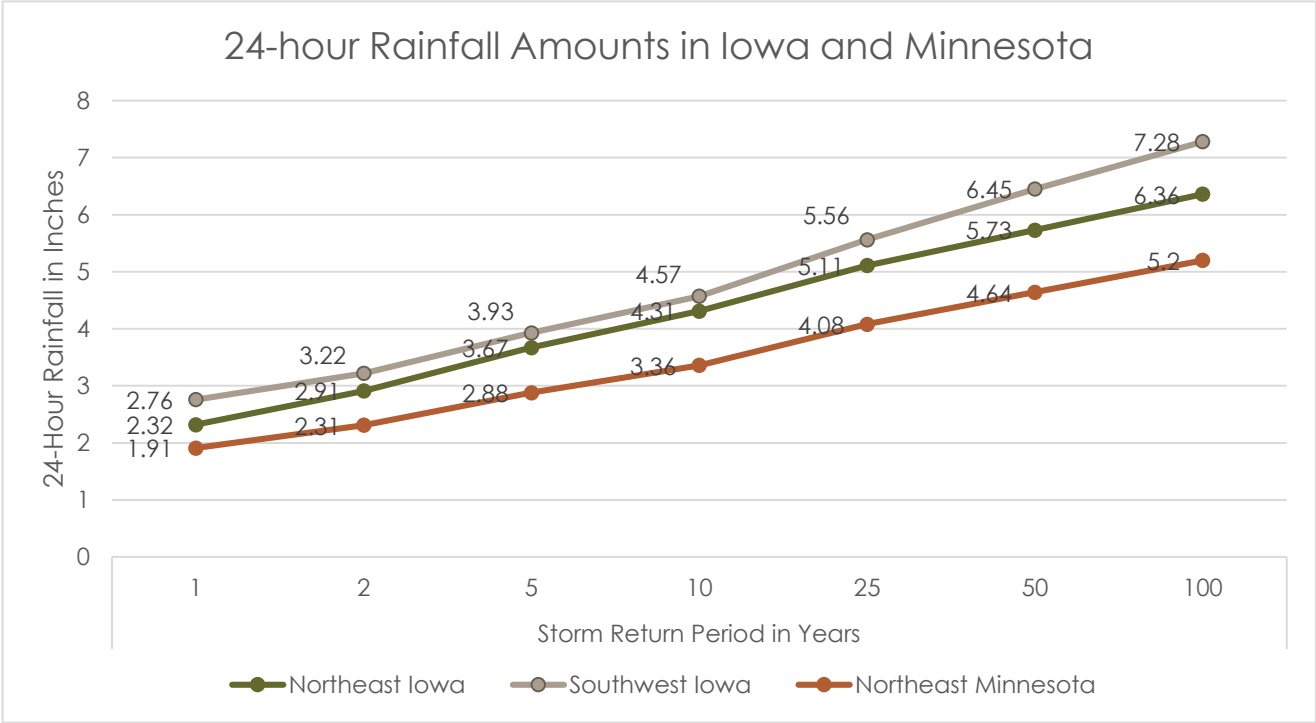


Table Data from:
Huff, Floyd A., and James R. Angel. Rainfall Frequency Atlas of the Midwest. Illinois State Water Survey, Champaign, Bulletin 71, 1992.

After discussing the chart, explain how permeable pavement systems must be designed to store different storm sizes. Have students explain the relationship of the reservoir depth to a permeable pavement system's storage volume capacity. The deeper the reservoir, the more storage volume.

Using the equation and example below, work as a class to determine if the parking lot from example 1 can store a 100-year storm. Students should work through the example on their questions work sheet.

CALCULATE VOLUME OF A STORM IN A CERTAIN AREA

$$V_{storm(ft^3)} = T_{rainfall\ (in)} \times A_{surface\ (ft^2)}$$

Where:

V_{storm} = total volume of the storm

$T_{rainfall}$ = total rainfall in inches

$A_{surface}$ = total surface area of permeable paving

As variables:

$$V = T \times A$$

EXAMPLE 2:
What is the volume of rain that will be distributed to an 80 ft by 20 ft parking lot if the total rainfall is 7 inches?

First, find the necessary variables:

T = 7 in = 7/12 in = 0.583 ft
A = 80 ft x 20 ft = 2400 ft^2

Then, plug the variables into the equation:
V = 0.583 ft x 2400 ft^2

Finally, multiply to solve for the total storm volume:
V = 1,399.2 ft^3

Discuss with students:
Knowing the storage volume of the parking lot, will the reservoir layer be able to store a 7 in storm?
Answer: NO. How deep would the reservoir need to be to be able to store all of the rainwater?

Calculate storage volume of your school parking lot

Have students measure a permeable paved area on school property (if none on site, you may use any paved area). If possible, find the actual reservoir depth for the permeable parking lot. If not, assign a hypothetical depth. Once all variables are collected, students should use the equations from the examples to calculate storage volume needs for that parking lot.

Have students reflect on their new permeable pavement knowledge

Students should complete the rest of the question sheet in class or take it home for individual homework.

Summarize the lesson and reiterate the benefits of permeable pavement.

Connect discussion back to stormwater and the different types of stormwater BMPs

Expand knowledge of permeable pavement with activities out of the classroom

- Students can calculate the volume of different sized rain events on paved areas at their home
- Students can research areas in their city that use permeable pavement techniques

Helpful Tip:

The calculations can also be used to help students refresh knowledge of conversions between feet and inches, as well as cubic feet to cubic inches, to gallons

Lesson 3.1b Permeable Pavement Vocab

Groundwater: Water that collects or flows underground in the soil, pores, or crevices of rocks.

Infiltration: The process by which water on the ground surface enters the soil.

Low Impact Development (LID): Design that works to treat stormwater as close to the source as possible to prevent erosion and polluted water sources.

Permeable Pavers: A hardscape surface that allows water to infiltrate through it into the ground or an underdrain. These include porous asphalt, permeable pavers, pervious concrete, and aggregate.

Porosity: Also known as 'void fraction,' it is the measure of the empty spaces in a material. (reservoir layer porosity)

Rainfall Depth: The total amount of rain falling in a given period, measured in inches.

Reservoir Layer: The storage area underneath a permeable surface that collects and stores surface runoff. It is usually full of No. 57 or No. 2 stone.

Storage Volume: The amount of water a reservoir layer can hold based on size and the porosity of the stone it contains.

Storm Return Period: An estimation of how likely a type of storm is to occur in a given amount of time. A return period of 100 means that a storm of that size is likely only to return once everyone 100 years.

Underdrain: Usually a perforated pipe underlying a porous gravel material. Its purpose is to allow water to slowly drain out of the reservoir so it is ready for the next storm.

Lesson 3.1b Permeable Pavement Worksheet

Name:

Use the equations and the example problems to answer the questions in the space provided.

To calculate the storage volume of a permeable pavement's reservoir area, three variables need to be found: The depth of the reservoir layer (D_r), the porosity of reservoir layer (P_r), and the area of the permeable surface (A_s). Multiplying these three variables results in the Storage Volume (V_s).

$$V_{storage} = D_{resevoir} \times P_{resevoir} \times A_{surface}$$

As variables:

$$V = D \times P \times A$$

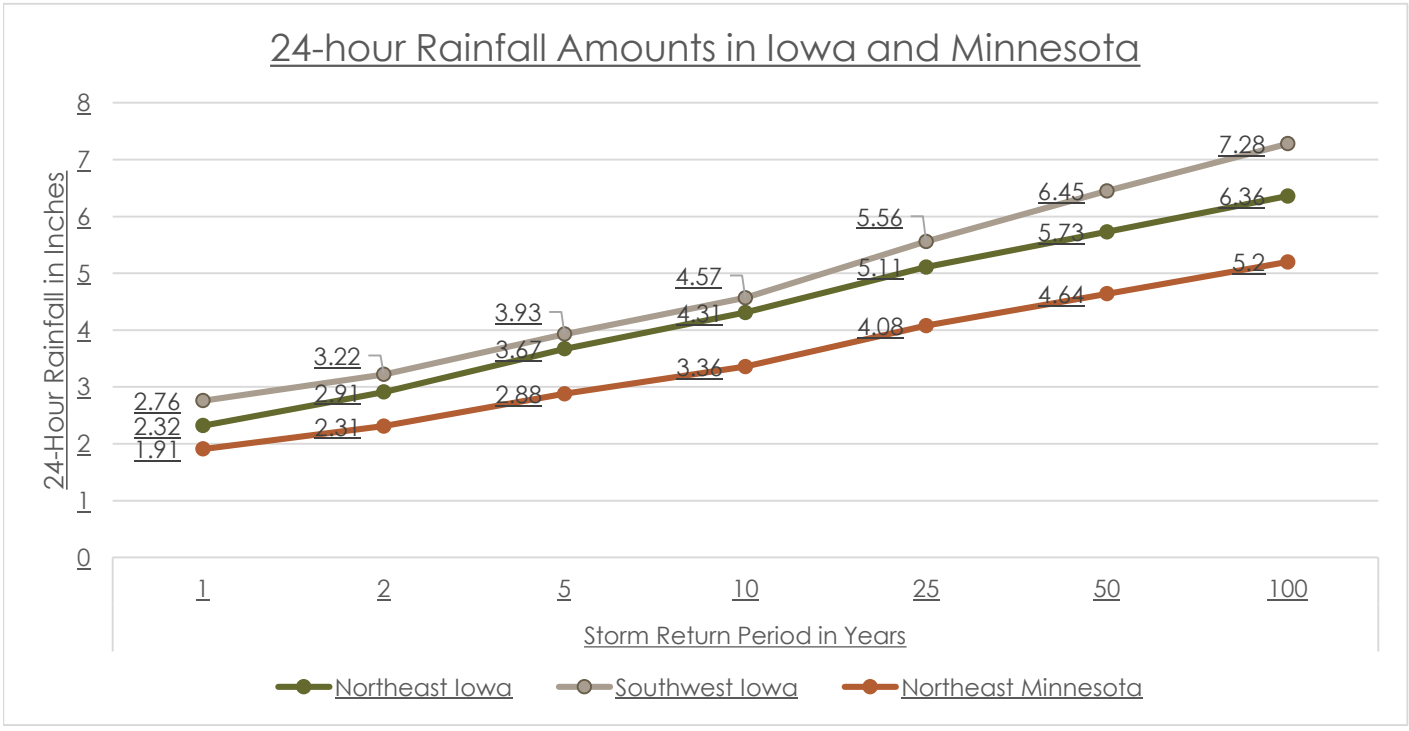
(Assume P = 0.35 for all problems)

Multiplying the rainfall totals (T) in inches and the area of a given surface (A) results in the Storm Volume (V_{storm}).

$$V_{storm\ (ft^3)} = T_{rainfall\ (in)} \times A_{surface\ (ft^2)}$$

As variables:

$$V_{storm} = T \times A$$



Example 1: If an 80ft by 20ft parking lot has a reservoir layer that is one-foot-deep, what is its storage volume?

Example 2: What is the volume of rain that will be collected on the 80ft by 20ft parking lot if the total rainfall is 7 inches?

1. What is the highest level of storm return that a 12ft by 30ft permeable driveway in northeast Iowa would be able to store if it has a 1.5ft deep reservoir? (P=0.35)

2. What does the minimum depth of a reservoir layer need to be for a 30ft by 20ft patio to be able to store a 10-year storm in Southwest Iowa?

SOIL AMENDMENT, NATIVE PRAIRIE AND TREE PLANTINGS

There are three major soil textures, sand, silt and clay. Each of them infiltrates water differently. Sand has large grains that create large pores and infiltrates water very quickly, while silt and clay have much smaller grains and small pores that infiltrate water much slower. Loamy soil is a combination of sand silt and clay, which is optimal for most plant growth. Soil amendment is replacing or adding something to soil to improve its physical or chemical properties. In many cases, sand and organic matter are added to a top layer of soil that is high in clay and silt content. Soil amendment helps ensure that the top layer of soil can infiltrate and hold more water. It also helps plants thrive. The added organic matter increases the amount of water the soil can absorb. Each one percent increase in soil organic matter can help healthy soil hold 20,000 gallons more water per acre. Soil amendment is often implemented at the same time as other best management practices including native prairie and tree plantings.


Photo by Jessica Rilling

Both soil amendment and native plantings increase stormwater runoff absorption and nutrient uptake. They also help filter pollutants. According to the Iowa DNR, just one mature tree can store 50 to 100 gallons of water during large storms. Native plantings have many other benefits as well. They are an important factor in the hydrologic cycle, increasing evapotranspiration to capture and move water from the soil to the atmosphere. (*Evapotranspiration is the transfer of water from the soil to the air by evaporation of water directly from the soil, as well as the water taken up by plants and released to the air as vapor through plant leaves.)* Once native plants take up and transpire water from the soil, they make room in the soil for more stormwater runoff to be stored. Evapotranspiration capacity for trees is closely tied to the tree's canopy size. Unfortunately, Iowa is ranked 9th in the nation for urban canopy loss.

Trees block wind, reducing soil erosion. They also add beauty and shade to parks and streets, cooling the ground and keeping water runoff cool when it hits the surface. According to the Iowa DNR, the air temperature is 10 degrees cooler in the shade of a tree.

Native plantings add habitat and provide an important food source for humans, pollinators, birds, mammals, and other animals and insects. According to the Iowa DNR, oak trees in Iowa support at least 534 species of butterflies and moths, providing habitat needed for reproduction. Communities can use simple guidelines to minimize tree loss and maximize tree benefits. They can manage tree plantings so that no more than 10% of all the trees in a community are the same kind of tree, inspect trees regularly for disease or stress and generally limit pruning or trimming of trees to late winter or early spring.

Pollinators are animals, primarily insects, that fertilize plants. Over 75% of the world's flowering plants depend on pollinators, including bees and butterflies. Plants need fertilization to produce the fruit, vegetables, crops, nuts and seeds that people and animals enjoy and to reproduce the next generation of plants.

Unfortunately, many of the insect pollinators we rely on are struggling to survive due to loss of habitat, insecticides, disease and other factors. Pollinator gardens can help provide habitat for many different types of pollinators. Pollinator gardens can be best developed using prairie flowers that are native to the area because some pollinators need very specific plants to survive and will not eat nectar from introduced or non-native plant species. In some cases, plants from Asia or Europe can be toxic to our local insect herbivores like birds, that rely on local insects as part of their diet.

The majority of species in a pollinator garden are native *flowering* plants. Trees, including fruit trees, also flower. Pollinators, including bees, butterflies, and other insects, need the sugary nectar and pollen that prairie flowers and fruit trees provide in order to survive.

Some pollinators need different types of plants at different times in their life cycle. The Monarch caterpillar, for example, will only eat milkweed, a type of plant that contains a sticky white substance that is poisonous to other animals but the Monarch butterflies eats nectar from a variety of flowering plants. Monarchs are migratory butterflies that depend on flowering plants throughout their journey to and from Mexico, so small pollinator gardens are very important re-fueling stations.

The best pollinator gardens contain plants that flower in spring, summer and fall, so that bees, monarchs and other pollinators have energy all season long. Plant stems and leaves are even beneficial for insects, including some pollinators, during the winter months as they provide important shelter when the temperatures drop.

Although some insects do fly south, like monarchs and some dragonflies, most of our insects spend the winter trying to survive in Iowa. The stems, leaves, leaf litter, thatch, and even the soil in native plantings can and do provide shelter for a variety of insects. Thick leaf litter is ideal for overwintering. Clearing away leaves and other garden and forest ground cover creates cold dry conditions that are difficult for native insects, including butterflies, katydids, praying mantid and others, to survive. Butterflies like painted ladies, commas, and question marks, hang their chrysalids upside down from a horizontal stem. The red admiral butterfly spends the winter within a

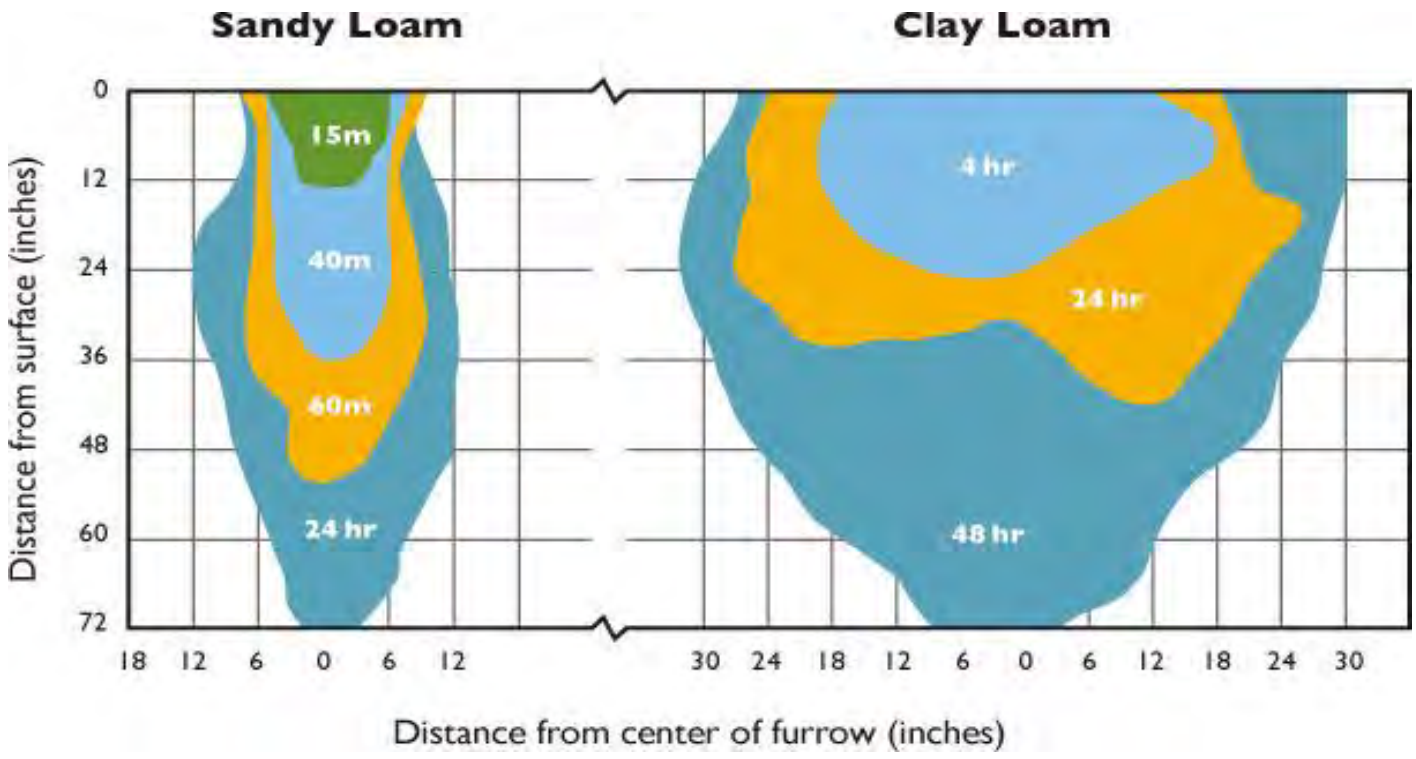
hibernaculum (winter residence), a tiny leaf rolled with silk at the end of a young cherry seedling branch. Unfortunately, many people "clean up" their butterfly gardens, by raking the leaves and stems in the fall.

(Note: Even small yard flowers can be important habitat for insects. The violet for example provides habitat for great spangled and regal fritillaries who spend the winter as larvae in the duff near the violet. When the violets are mowed in the spring, the fritillary larvae that make it through the winter could be killed and/or the violets they would eat, before emerging as butterflies, could be destroyed.)

BENEFITS

- Provides recreational opportunities
- Increases the amount of water infiltrated through soil
- Improves the health of the soil
- Increases plant growth
- Reduces flooding
- Improves water quality
- Provides year-round habitat

More information:
http://www.rainscapingiowa.org/en/rainscapes/native_landscaping/
http://www.rainscapingiowa.org/en/rainscapes/soil_quality_restoration/
http://www.rainscapingiowa.org/en/rainscapes/urban_foreststree_boxes/



Lesson 3.1c Soil Type Observation

Objective	Student will understand characteristics of sand, silt and clay soil types.
Grade Level	4-7
Iowa Core Standards	5–PS1–3, W.6.1, WHST.6–8.7, W.5.2 W.4.4,
Time	60 min
Group Size	All students
Materials	– 1 news paper – Small sample of each type of soil, clay, sand/gravel, and silt (rich in organic matter)

PROCEDURE

- Spread one sheet of newspaper on desk
- Place one spoonful of each type of soil in the newspaper
- Observe and record the following characteristics about each soil sample
  - Color
  - Texture
  - Size of particles
  - Smell
  - Ability to form into a ball when squeezed

Lesson 3.1c Soil Type Observation: Data Sheet

NAME: _____

	Clay	Silt	Sand
Color			
Feel			
Particle Size			
Smell			
Ability to hold together in a ball			

Data Analysis:
Write a description of each soil using whole sentences.

White a sentence stating how the three soils differ from each other.

Lesson 3.1d Soil Type Infiltration

Objective	Student will understand the difference in infiltration between the three soil textures
Grade Level	4-7
Iowa Core Standards	4–ESS2–1, 4.OA.A.2, 4.MD.A.2, 5.MD.A.1, 5.MD.B.2, 5–PS1–3, 6.EE.C.9, MS–ETS1–3
Time	60 min
Group Size	2-3 students
Materials	– One sheet of news paper – 3 test tubes – One test tube holder – One plastic spoon – 3 soils: clay, silt, and sand – One water dropper – One container of water

PROCEDURE

- Put one sheet of newspaper on desk
- Place three test tubes (Same size) in the test tube holder
- Fill one test tube halfway with sand, one with silt and the other with clay
- Adjust soil levels so all test tubes are equal
- Measure the height of the soil in millimeters and record it on your data sheet (all should be within 2 millimeters of each other)
- Fill 5mL water dropper with water
- One person looks as the clock (Second hand) while the other person empties one full dropper on water into the test tube of clay.
- Time how long it takes the water to reach the bottom of the test tube.
- Record the time on the data table
- Do the same with the test tube filled with silt. Record the time it takes one full dropper of water to reach the bottom
- Do the same with the test tube of sand. Record the results.
- Graph the results on the height of soil on the y-axis and time of the x-axis.
- Calculate the infiltration rate or each soil type and record your results.
- Clean up:
  - Empty dirt into garbage
  - Place empty rest tubes and spoons into container of soapy water provided
  - Recycle newspaper
  - Wash hands and desk
- Write the analysis and conclusion of your experiment below your Data Table.

Lesson 3.1d Soil Type Infiltration: Data Sheet

NAME: _____

Soil type	Height of soil (Millimeters)	Time for water to drain through soil (Seconds)	Infiltration rate (millimeters/second)
Clay			
Silt			
Sand			

Data Analysis

Which soil type had the fastest infiltration rate?

Based on the soil characteristics studied in the previous experiment, why do you think that soil type had the fastest infiltration rate?

How do all three soil types compare to each other?

If you wanted to build a pond that holds water for long periods of time, what soil type would you want at the base of your pond? Why?

PONDS AND WETLANDS

Wetland at NICC Dairy Center Calmar, Iowa

According to US EPA, *"Polluted stormwater runoff is a leading cause of impairment to the nearly 40% of surveyed US water bodies that don't meet water quality standards.* Northeast Iowa has several "impaired" waters, including portions of every major river. EPA notes that *"Over land and via storm sewer systems, polluted runoff is discharged, often untreated, directly into local water bodies. When left uncontrolled, the resulting water pollution can result in the destruction of fish, wildlife, and aquatic life habitats; a loss in aesthetic value; and threats to public health due to contaminated food, drinking water supplies, and recreational waterways*."

In Northeast Iowa, large quantities of warm, quickly flowing, stormwater runoff can greatly impact coldwater streams and rivers. It washes away aquatic habitat and warms the cold water so that coldwater trout and other species may have difficulty surviving or reproducing. In some cases, stormwater runoff carries excess sediment, nutrients and pollution into the streams and rivers. Excess nitrogen and phosphorus carried by stormwater can cause algae to grow faster than ecosystems can handle. Excess algae or "algae blooms" can decrease or eliminate the oxygen in the water that the fish and other aquatic life need to survive.

Phase I and Phase II of the federal *National Pollutant Discharge Elimination System* (NPDES) stormwater program calls for municipalities to limit stormwater pollution. Ponds and wetlands are larger best management practices (BMPs) that immediately provide reductions in stormwater runoff flow from both urban and rural areas, thus reducing downstream flooding and improving water quality. Because they are so effective and are measurably impactful, community NPDES programs across the nation, including many in Northeast Iowa, include the installation of public and private wetlands and ponds as tools to help control runoff volume and mitigate pollution from runoff.

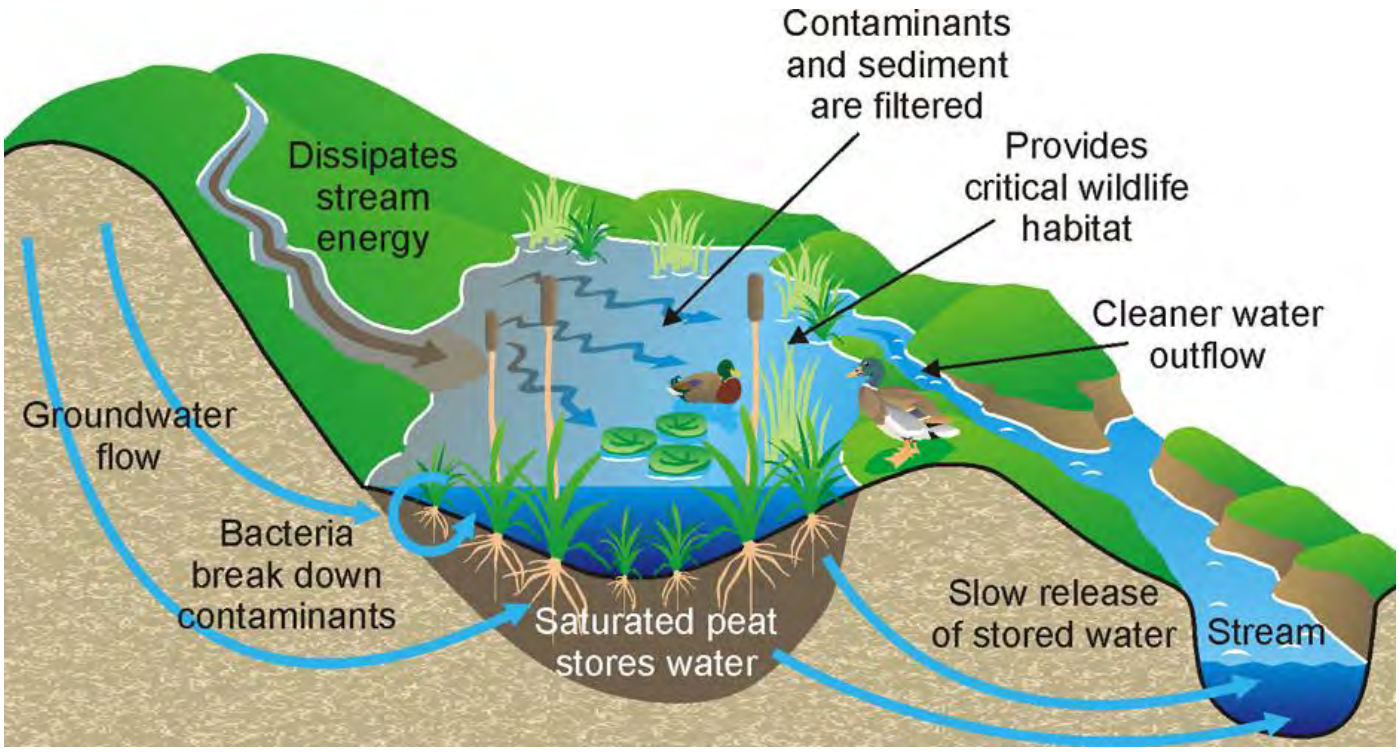
Urban wetlands are typically areas of native plantings that are filled with stormwater runoff during rain events and, in some areas, hold water permanently. Many urban ponds and wetlands are specifically designed to allow sediment and pollutants to settle out and/or infiltrate into the ground. The native plants in and around ponds and wetlands can use the nutrients, such as phosphorous and nitrogen, carried by the stormwater and thus reduce the discharge of nutrients into local streams and rivers. Wetland have the ability to hold a large volume of water reducing local and

downstream flash flows that may occur during heavy rainfall events. Ponds are similar to wetlands, but they hold deeper water permanently. In many cases ponds can even be stocked with fish. Both ponds and wetlands provide wildlife habitat for aquatic and terrestrial species including but not limited to deer and other mammals, fish, waterfowl and other birds, amphibians, reptiles, butterflies, dragonflies and other insects, etc. In many communities, wetlands and ponds are built together to maximize the benefits of both.

Wetlands and ponds can also become a rich recreational resource for a community, providing birding, hunting, water recreation, fishing and wildlife watching opportunities. Some Northeast Iowa communities have even developed trails and campgrounds near or adjacent to their ponds and wetlands.

BENEFITS

- Reduces stormwater runoff
- Reduces downstream flooding
- Improves water quality
- Provides recreational opportunities
- Provides habitat for aquatic and terrestrial species



GREEN ROOFS

A" green roof or living roof is a roof of a building that is totally or partially covered by soil or some type of a growing medium and green vegetation. Plants are grown over a waterproofing membrane that may include additional barriers and drainage aspects. Green roofs may also include additional layers and systems depending on the climate.

West Union, IA Green Roof

In large urban cities where there is very little green vegetation and the majority of the surfaces are impervious, there is a higher average temperature than in the surrounding countryside. This temperature difference is called Urban Heat Island Effect (UHIE). UHIE occurs because the concrete and brick structures and the black asphalt streets and rooftops absorb heat from the sun and release that heat back into the air. By absorbing the heat and radiating it out again overnight, dark roof surfaces make the UHIE much worse, especially during summer months. As the UHIE increases, residents typically increase air conditioner and fan use, leading to increased energy use and demand on the energy system. Many large cities also have high levels of air pollution, including carbon dioxide, heavy metals, airborne particles and volatile organic compounds, that could be reduced with vegetative plantings. Unless deliberate action is taken, the larger the community, the more the UHIE and air pollution issues compound. Excessive heat and air pollution can lead to increase health risks, especially in elderly and young children.

Green roofs planted on the top of buildings reduce the amount of heat being absorbed by the roof and lower the amount of heat being reflected and radiated back into the air. The plants and soils evaporate moisture through evapotranspiration. Evapotranspiration cools the air around the building. The plants also help clean pollutants out of the air and provide oxygen. Green roofs can be planted in native vegetation, or in flower and vegetable gardens, providing additional benefits by creating new, healthy, community and private food sources.

Some studies show that the an even greatest benefit is realized when green roofs are combined with green walls, enveloping the entire building in vegetation and providing as high as an 84% reduction in cooling demand. Many large communities have introduced policies that require green roofs. Munich Germany has required green roofs on new buildings since 1996. In Hamburg Germany, the tax on a roof with just five centimeters of planted soil is half that of an ordinary roof. In 2017, the German Roof Gardens Association estimated that Germany had over 58 square miles of green roofs. Toronto Canada estimates that greening their city's rooftops could decrease the

UHIE by as much as 2 degrees and reduce energy for cooling by $12 million. Tokyo Japan has introduced a policy that requires 20% of all new flat surfaces on government buildings be green roofs and 10% of all flat roofs on private dwellings be green roofs. Cordoba Argentina has mandated green roofs to reduce UHIE and air pollution. Paris France has a strategy to reduce the impact of heatwaves that includes almost 250,000 acres of green roofs and walls.

In addition to reducing UHIE and air pollution, green roofs reduce and slow stormwater runoff. Although the amount varies based on the vegetation density and types, depth and structure of the soil or growing medium, design of the drainage system and other factors, in some instances runoff can be reduced by more than 75%. As they slow and utilize rainfall, they also help decrease stormwater runoff and subsequently improve water quality.

Green roofs also add habitat for wildlife and provide a more aesthetically pleasing landscape for humans. When planted into edible landscape/gardens, they can provide an important public or private food source, especially in inner city "food deserts" or urban areas where grocery stores are scares or missing, where it is difficult to buy affordable or good-quality fresh food, especially fruit and vegetables. Food producing roof gardens can be especially impactful in low income areas.

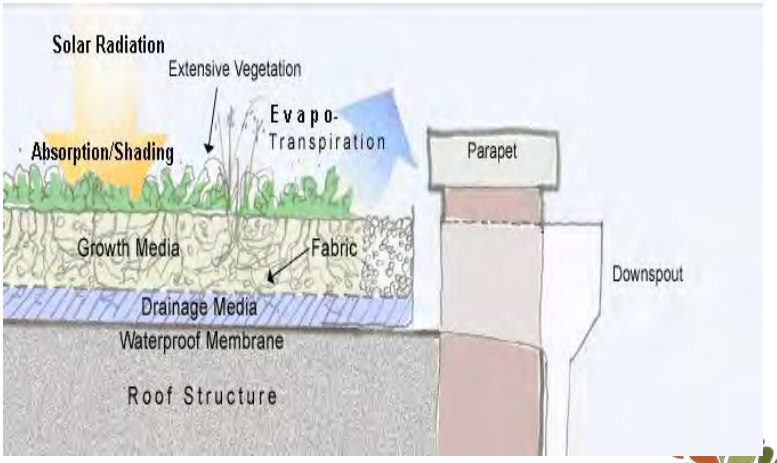
A green roof can also insulate the building it covers from weather and noise. Weather insulating is greatest in the summer months when the vegetation reflects the direct sunlight rather than absorbing it and the evapotranspiration provides additional cooling. The combination of soil, plants and other components of a green roof also absorb and reflect sound waves. The degree of sound insulation depends on the thickness of the green roof structure, especially the substrate and the vegetation but buildings with green roofs can be nearly 50 percent quieter than those without them.

Green roofs can also be referred to as eco-roofs, vegetated roofs, living roofs, and Horizontal Vegetated Complex Partitions.

More information:
http://www.rainscapingiowa.org/en/rainscapes/green_roofsliving_walls/

BENEFITS

- Reduce roof stormwater runoff
- Improve water quality
- Lower urban heat/reduce UHIE
- Conserve energy/reduce energy use
- Improve air quality
- Provide healthy food choices
- Provide wildlife habitat
- Provide insulation from weather and noise



Section 3.2 What's Happening in Northeast Iowa?

IOWA WATERSHED APPROACH

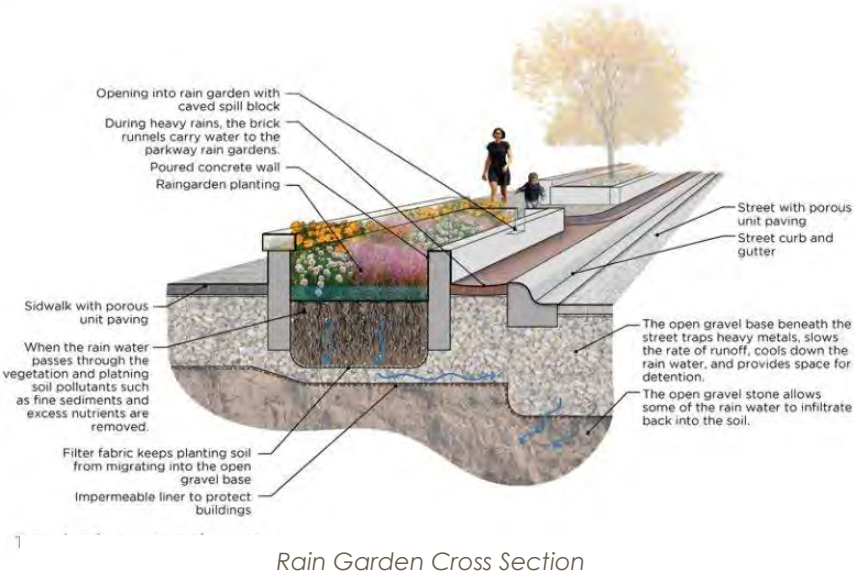
The Iowa Watershed Approach was initiated after devastating flooding occurred in Iowa in 2008. Many Northeast Iowa communities have been severely impacted by flooding before, after and during 2008, but in 2008 the flooding in Cedar Rapids garnered national attention. In fact, analysis conducted by the Iowa Flood Center found that over the past 30 years, counties in Northeast Iowa have had more federal disaster declarations related to flooding than most counties in the US. Counties like Howard, Winneshiek, Allamakee, Chickasaw, Fayette, Clayton, Black Hawk and Buchanan have experienced more than 13 flood-related FEMA disaster declarations in the last 30 years. Several Northeast Iowa communities that were settled in the 1800s have been completely destroyed by flooding. Millions of federal dollars were directed to Iowa to help Cedar Rapids with flood recovery and prevention. Provisions were also added to the Iowa Code 466B, the Surface Water Protection and Flood Mitigation Act and a portion of the federal funding was also used to 1) Develop and support a State Watershed Planning Advisory Committee 2) Establish Iowa's first 6 WMAs, including the Turkey River Watershed WMA and 3) For the Iowa Flood Center to complete Hydrologic Analysis and Pilot Projects in 3-4 watersheds to prove that a watershed approach could indeed prevent flooding.

The entire endeavor was collectively referred to as the Iowa Watershed Approach (IWA). The IWA encourages political entities, including communities, counties and Soil and Water Conservation Districts throughout the state, to formally unite as Watershed Management Authorities (WMAs) within watersheds, across political boundaries, through 28e agreements. Each Iowa WMA is governed by a Board of Directors made up of appointed representatives of the participating political subdivisions. Each WMA must invite all cities, counties and SWCDs to participate in the WMA and the WMA Board. WMAs may assess flood risk, assess water quality, assess options for reducing flood risk and improving water quality, monitor and educate. Political subdivisions are not required to participate but can be involved in more than one WMA. The WMAs cannot acquire property. Once united as WMAs, the partners are encouraged to work with private and public partners to analysis their watershed and to develop scientifically sound Watershed Resiliency Plans. They are also encouraged to implement projects and initiatives that will improve watershed resiliency, reduce flooding and improve water quality. In 2016, the U.S. Housing and Urban Development granted the State of Iowa a second influx of federal funding, 96.9 million dollars, to expand the Iowa Watershed Approach to new watersheds. The funds where distributed to nine Iowa watersheds, including two Northeast Iowa watersheds, the Upper Iowa River Watershed and the Upper Wapsipinicon River Watershed. Each of these watersheds created a WMA Board comprised of city, county and SWCD members. Each WMA also worked with partners to hire a WMA Coordinator who works directly with landowners to implement flood reduction practices in targeted sub-watersheds. Twenty-year Watershed Resiliency Plans have and are being developed by and for WMAs to guide the WMAs and their partners in the years ahead. Each WMA Watershed Resiliency Plan includes an Outreach and Education Plan that includes incorporating Urban and rural conservation into schools and other educational programs in Northeast Iowa.

WMA meetings are open to the public and each WMA has a website where more information can be found. More information on the Turkey River WMA can be found at www.turkeyriver.org, more information on the Upper Iowa River WMA can be found at www.upperiowariver.org, and more information about the Upper Wapsipinicon River WMA can be found at www.upperwapsi.org. Information about the Iowa Watershed Approach and the statewide efforts can be found at the Iowa Watershed Approach website.

CITY OF WEST UNION

In 2008, West Union was designated a Green Pilot Program by the Iowa Department of Economic Development. The community developed and implemented one of the most extensive and comprehensive innovative urban conservation plans for a community of its size in Iowa and the nation. Partners implemented dozens of sustainable practices, including energy efficient opportunities for businesses and urban stormwater runoff BMPs, many of which are interconnected. The city constructed a 6-block streetscape project that included permeable paver streets and sidewalks, bio-swales, rain gardens and green roofs. Not only does this project treat all the rain water that falls on the city, it also draws community leaders and visitors from around the state who want to see the BMPs first hand. The City of West Union was featured in many news articles and magazines. They were even featured on the Discovery Channel on May 6th, 2013. Watch the video here. Although they had already received accolades and recognition for their efforts, the community has continued to work with partners, including Northeast Iowa RC&D, to implement additional urban stormwater runoff BMPs, including installation of additional permeable pavers on parking areas and sidewalks.



Rain Garden Cross Section
Image Courtesy of the City of West Union

CITY OF MONONA

In 2014, the city of Monona borrowed funding from the State Revolving Loan Fund (SRF) to improve their waste water treatment plant. Because of the loan, the city was eligible to compete for the SRF Program grant to implement innovative urban stormwater runoff practices. With assistance from Northeast Iowa RC&D, the City secured the SRF Sponsored Projects Grant. The project the city implemented was to replace an impermeable and eroding gravel parking area with permeable pavers. The project occurred at the parking lot of their aquatic center. Monona also planted native

prairie on a highly erodible slope adjacent to the new permeable parking area. A few years
later, the City secured additional SRF program dollars to install permeable pavers on Bulldog Boulevard. adjacent to the pool parking lot. They also worked with the US Fish and Wildlife Partners for Wildlife Program and the Iowa DOT to implement a trail project

State Urban Conservationist, Wayne Petersen joins city representatives and other regional, state and federal partners at the Grand Opening of the award-winning project at the Monona Aquatic Center

adjacent to Bulldog Boulevard that included extensive native prairie plantings (specifically butterfly friendly species).

The projects dramatically improved the quality and decreased the quantity of stormwater runoff from the area from the area greatly improving the water quality in the nearby stream ultimately in the Turkey River. The city also worked with the Clayton County Soil and Water Conservation District (SWCD) to identify and implement additional BMPs along the stream. The projects earned the City of Monona the Governor's, Iowa Environmental Excellence Award. One of the fascinating things about the City of Monona's efforts are that students maintain the butterfly gardens with help from their teachers and families.

CITY OF POSTVILLE

The City of Postville sits on a watershed divide. Part of the city is located in the Yellow River Watershed, and part of the city is located in the Turkey River Watershed. Both rivers are listed on the Iowa's 303d list of Impaired Waters because of high levels of bacteria. The city of Postville worked closely with the Turkey River Watershed Management Authority in the Development of the Turkey River Watershed Resiliency Plan to discuss potential stormwater conservation practices. In 2016, the city of Postville borrowed funding from the State Revolving Loan Fund (SRF)

to improve their waste water treatment plant. Because of the loan, the city was eligible to compete for the SRF Program grant to implement innovative urban stormwater runoff practices. With assistance from Northeast Iowa RC&D, the City secured the SRF Sponsored Projects Grant. The project allows the city to implement several urban conservation practices throughout the community, including practices at the Regional Urban Stormwater Demonstration Site. The Demonstration Site includes multiple urban conservation best management practices, like rain gardens, trees and native plantings, a rain barrel, and a bioswale. The site attracts, and educates communities and youth from around the region on urban conservation, and ways they can implement best management practices in their own communities. Implementation of urban stormwater practices throughout the community noticeably improved the water quality and reduced the amount of runoff from the community.

IOWA'S DAIRY CENTER, CALMAR, IOWA

With assistance from the Winneshiek County Soil and Water Conservation District (SWCD), an urban conservation demonstration projects grant was awarded by the Iowa Department of Agriculture and Land Stewardship (IDALS) in 2015. The focus of this project was to reduce the storm water and consequent nutrient runoff at Iowa's Dairy Center in Calmar. Built in 2000, no storm water controls were installed on the livestock buildings or parking areas which account for about three acres, or 75%, of the total impervious surfaces on site. An infiltration trench, enhanced rain garden and permeable pavers were installed around the livestock buildings in 2016. These practices addressed about one acre of the previously untreated impervious surfaces, reducing annual runoff by about one million gallons. Since 2011, Northeast Iowa Community College's (NICC) Calmar Campus has installed a wide variety of ag and urban conservation practices and serves as a local demonstration site for visitors, students and staff. They also serve as an example for students studying urban stormwater runoff techniques.

DECORAH STORMWATER PROJECT

The University of Iowa Office for Sustainable Communities and students from the University of Iowa College of Engineering worked with the City of Decorah in 2014 to develop a Community Stormwater Plan and to develop and implement a Community Stormwater Utility Fee. Funding collected from the stormwater utility fee is put back into the community to plan, engineer and implement innovative stormwater BMPs that may include rain gardens, bioswales, permeable pavers, and other urban stormwater BMPs. The city also provides a discount to landowners who implement their own urban stormwater practices. A stormwater utility fee is just one example of how a community can afford to implement urban stormwater conservation practices in their community.

WATERSHED MANAGEMENT AUTORITY (WMA) COMMUNITIES

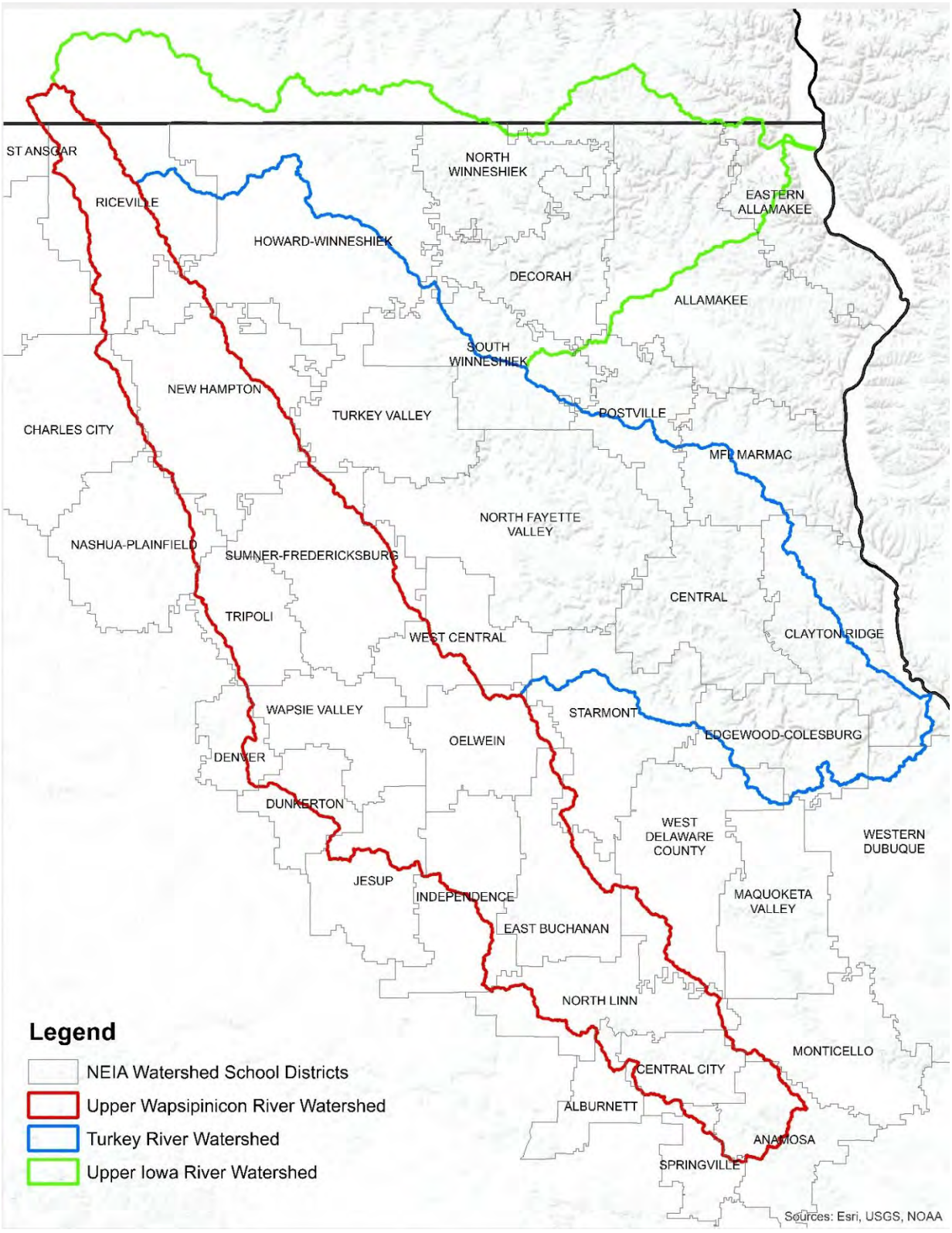
Northeast Iowa contains three WMA's in the region including the Turkey River, Upper Iowa River and Upper Wapsipinicon River. The Turkey River Watershed Resilience Plan was completed in 2015, and includes detailed summaries of urban conservation practices that communities in the watershed are interested in. Communities like Postville, Elkader, West Union, and Elgin are a few that showed interest and have implemented urban conservation practices since the plan was published. A more detailed table showing types of conservation practices each of the Turkey River watershed communities are interested in implementing in shown below. As a part of the planning process for the Upper Iowa and Upper Wapsipinicon River Watershed Resiliency Plans, several communities have performed "Community walkthroughs" with Northeast Iowa RC&D staff. During these "walkthroughs", City representatives pointed out and discussed locations where the current stormwater management is a problem, and an urban conservation practice would improve the area. The Cities of Winthrop, Dunkerton, Waukon, Elma, Riceville, Decorah, and Independence have all participated in these "walkthroughs", and have shown interest in Urban Stormwater Conservation. Many projects have sprouted from these meetings, and several communities are in the process of allocating funding for Urban stormwater management projects. A Map of the Northeast Iowa WMA watersheds is shown below. Which Northeast Iowa Watershed Management Authority is active in your school District?

TRW Community	Pond, Wetland, or Small Lake	Rain Garden/Empty Lot Project	Rain Barrel Program	Permeable Pavers Strips of P. P.	Rain-scaped Park Revitalization	School Storm Water Runoff Program	Green Roof Project	Native Turf Project/ Native Grasses	Bio-swale Project	Lawn Nutrient Reduction & Grass Mngmt	Downtown Rain-scape	Policy/Ordinance	Business Rain-scape Incentive/ Blvd Project	Bank Stabilization/ Stream Meander	Tree Planting (edible/other)
Arlington		X	X	X				X	X	X					X
Calmar	X	X	X	X	X	X		X	X	X		X	X		X
Clermont	X	X	X	X	X	X	X	X	X	X					
Cresco			X		X			X					X		
Elgin				X											
Elkader	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Farmersburg															
Fayette	X	X	X	X	X		X	X	X	X	X	X	X		X
Fort Atkinson			X	X				X	X					X	
Garnavillo		X							X						
Hawkeye			X	X				X							
Lawler		X	X						X						
Maynard	X		X												
Monona		X	X	X	X	X		X	X	X	X				X
Postville	X		X	X	X	X		X	X	X				X	X
Strawberry Point		X	X						X						
St Lucas	X														
Volga	X	X	X		X			X	X						X
Wadena		X	X					X	X	X					
Waucoma			X		X			X				X	X		X
West Union	X	X	X	X		X	X	X	X	X		X	X		X
Community Project Ideas															

Urban Conservation practices that Turkey River Communities are interested in implementing.

SCHOOL DISTRICTS IN NORTHEAST IOWA WATERSHEDS

What watershed(s) is your school district a part of?



NORTHEAST IOWA WATERSHED MANAGEMENT AUTHORITY ACTIVE MEMBERS

TURKEY RIVER WMA MEMBERS	
Political Subdivision	**Appointed Rep**
City of Arlington	Dustin Schott
City of Clermont	Jim Matt
City of Cresco	Ron Hyberger
City of Elgin	Ron Hills
City of Elkader	Jennifer Cowsert
City of Farmersburg	Ron Dennler
City of Fayette	Jon Biederman
City of Fort Atkinson	Paul Herold
City of Garnavillo	Elizabeth Jaster
City of Hawkeye	John Fels
City of Lawler	Dan Carolan
City of Maynard	Paul Hoeger
City of Monona	Dan Canton
City of Postville	Leigh Rekow
City of Spillville	Michael Klimesh
City of St. Lucas	Kerri Langreck
City of St. Olaf	Darwin Frana
City of Strawberry Point	Allison Osweiler
City of Volga	Kristin Klingman
City of Wadena	Eric Boehm
City of Waucoma	Marlene Klemp
City of West Union	Jon Biederman
Chickasaw County	Dan Carolan
Clayton County	Ray Peterson
Fayette County	Rod Marlatt
Howard County	Jan McGovern
Winneshiek County	Mark Kuhn
Allamakee County SWCD	Jack Knight
Chickasaw County SWCD	Randy Boedker
Clayton County SWCD	Gerry Ommen
Delaware County SWCD	Steve Lueken
Fayette County SWCD	Bill Bennett
Howard County SWCD	Bart Wilson
Winneshiek County SWCD	TBD

UPPER IOWA RIVER WMA MEMBERS	
Political Subdivision	**Appointed Rep**
Allamakee County	Dan Byrnes
Allamakee County SWCD	Jack Knight
City of Decorah	Andy Carlson
Howard County	Jan McGovern
Howard County SWCD	Harlan Hickle
Winneshiek County	Jon Beard
Winneshiek County SWCD	Mark Jensen

UPPER WAPSIPINICON WMA MEMBERS	
Political Subdivision	**Appointed Rep**
City of Dunkerton	Sheila Steffen
City of Elma	Shannon Gebel
City of Frederika	Kip Ladage
City of Independence	All Roder
City of Quasqueton	Elaine Hughes
City of Readlyn	Kip Ladage
City of Tripoli	Greg Eschweiler
City of Winthrop	Shawn Curtis
Black Hawk County	Frank Magsaman
Bremer County	Kip Ladage
Buchanan County	Don Shonka
Chickasaw County	Steve Geerts
Fayette County	Jeanine Tellin
Howard County	Jan McGovern
Linn County	Chuck Ungs
Mitchell County	Shannon Paulus
Black Hawk County SWCD	Jennifer Trent
Bremer County SWCD	Ron Lenth
Chickasaw County SWCD	Kim Leichtman
Buchanan County SWCD	Julie Althaus
Delaware County SWCD	Chris Eiby
Linn County SWCD	Tom Mullen

Section 3.3 Developing Effective Student and Class Projects

BMPs, explained in section 3.1, capture and store stormwater runoff while filtering out sediment, pollutants and debris. These practices can be implemented by students, teachers, and families within the community.

The lesson plans in this section are based on plans developed from EPA funding in *Green Infrastructure as Outdoor Environmental Laboratories: Urban Water Quality Training in Primary and Secondary Schools,* Soil-net.com, the National Gardening Association, and the University of Wisconsin-Madison Arboretum. They are meant to guide you and your students in the development of effective urban stormwater projects. The lessons in this section allow you to incorporate your students in the implementation and planning process. Many of the lessons in this section are required as a part of the Watershed Guardian Program.

STEP 1: DEVELOP A SITE INVENTORY OF THE SCHOOL GROUNDS OR SPECIFIC AREA WITHIN THE COMMUNITY

The site inventory determines areas within your community where water does not drain properly. These areas are often suitable for urban stormwater best management practices that help reduce runoff or improve water quality. Areas where water runs of off roofs, where there is erosion, pools of standing water, or impervious surfaces are some examples of good locations for a stormwater practice. Site inventories could be on school grounds, or on any location within the community.

Northeast Iowa Urban Stormwater Demonstration Site before Project Implementation

Lesson 3.3a Site Inventory

Objective	Students will gain an understanding of site analysis
Grade Level	3-12
Iowa Core Standards	MS–ETS1–1, 21.6–8.ES.1, 21.6–8.ES.2 21.6–8.ES.5, MS–PS1–4, MS–ESS2–4, 3–5–ETS1–1, 3–5–ETS1–2
Time	90 min
Group Size	1-3 Students
Materials	- Handouts - Markers or colored pencils - Clipboard or surface to write on - Map of school grounds (New copies of site inventory map)

PROCEDURE

Warm-Up and Introduction Activity

What is Landscape Architecture?

Answers will vary. Landscape architecture is a multidisciplinary field that combines aspects of biology, civil engineering, horticulture, hydrology, architecture, art, ecology, and much more. It is the design of outdoor spaces such as parks, gardens, streetscapes, residences, etc. There are many different methods and goals. One of the first things a landscape architect has to do in design is complete a site inventory.

What is Site Inventory?

Answers will vary. Site inventory is one of the first stages of the design process that involves identifying, observing and recording different features on the site such as stormwater flow, vegetation, sun and shade patterns, wildlife habitat, and elevation changes.

Introduce vocabulary and discuss the different aspects of a site that Landscape Architects record as part of their site inventory?

Hand out the Site Inventory Vocabulary Sheet and review it with the students. Discuss the different features they will be recording. These include: plants, moving water or ponding, slopes, high points and low points, erosion, downspouts, impervious surfaces, buildings, sun and shade patterns, and wildlife. Students will be using their site inventories to determine the best locations on the site for different stormwater management facilities

Hand out the Site Inventory Symbols and Samples Sheet.

These are the symbols the students should use to mark their observations on their maps. Usually Landscape Architects record much more than what is listed on the sheet, but the goal of this lesson is to focus on stormwater.

PROCEDURE CONTINUED

Walk around school grounds with students to record observations

Give each student a map of the school grounds to record their findings. If available, give each student a clipboard to use while drawing. Students can work in small groups or individually, but each should produce their own inventory map. If the property is exceptionally large, students can split into groups to record separate areas. Have students focus on stormwater elements first, including ponding, impervious surfaces, and stormwater flow lines.

Color maps and discuss observations

Students should use this time to make their maps readable and colorful. Make sure they use the symbols given on the symbols handout so the maps are consistent between students. Students should talk in small groups and share their maps and observations.

Discuss complete inventory maps with the whole class

Students can pin their maps up on the wall and walk around to review each other's maps. Discuss the different observations that were made. Have students explain what they noticed and how they labeled it. Have students answer the Observations Questions Sheet. Collect inventory maps for future use.

Discuss why Landscape Architects take site inventories and introduce site analysis

This can be a quick discussion and review of the lesson. Landscape Architects do site inventories to become familiar with all of the features on the site in order to make better design decisions.

Expand knowledge of site inventory with activities out of the classroom

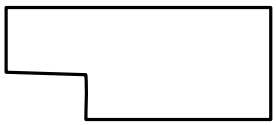
- Students can neaten maps and add in any missing symbols at home
- Students can make a site inventory map of their own yards at home

Helpful Tips:

If necessary, do a preliminary walk around the school property to get familiar with the site. Take note of the things students should record.

Sketch or make copies of a map of the school grounds from google.

Lesson 3.3a Site Inventory: Symbols

Building outline 

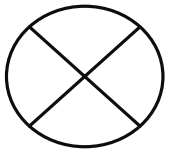
Low Point -LP
High Point +HP

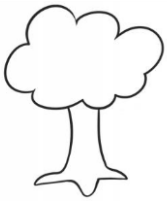
Downspout Opening X

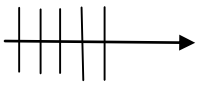
Shady Area 

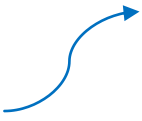
Sunny Area 

Ponding 

Erosion 

Trees and Shrubs 

Steep Slope 

Water Flow 

Impervious Pavement

Lesson 3.3a Site Inventory: Discussion Questions

1. What were some of the observations you made while out of the school grounds?

2. Were there any areas of the property that you think can be used better?

3. Did you observe any drainage issues in the form of puddles, erosion or standing water anywhere on the site?

Lesson 3.3a Site Inventory: Vocabulary

Landscape Architecture: A multi-disciplinary profession that combines architecture, engineering, biology, horticulture, ecology, and design. Professionals design outdoor spaces such as gardens, parks, streetscapes, campuses, and residences.

Site Inventory: One of the first stages of the design process that involves identifying, observing and recording different features on the site such as stormwater flow, vegetation, sun and shade patterns, wildlife, habitat, and elevation changes.

Circulation: The areas and directions in which vehicles, bicycles, and pedestrians travel. A map of the most trafficked areas on a site.

Downspout: A pipe that carries rainwater from a roof gutter. Downspouts are typically vertical and lead water off of a roof to the ground.

Erosion: The slow removal and wearing a way of soil on the earth's surface by water, ice, wind, etc.

Flow Path: A path that stormwater takes when travelling across the landscape.

Focal Point: A point or feature on the site that draws one's attention.

High Point: The highest point of elevation on the site. Every point on the site should be downhill from this point. A relative high point is the highest point in a certain part of the site.

Low Point: The lowest point of elevation on the site. Every point on the site should be uphill from this point. A relative low point is the lowest point in a certain part of the site.

Impervious surface: An impenetrable surface that does not allow water to filter through it. It is typically a man-made surface such as asphalt, concrete, etc.

Pervious surface: A surface made out of material that is porous enough to allow water to filter through it. These surface types can vary, but they include soils and groundcovers, permeable paving, etc.

Ponding: The build-up of water in a certain location due to poor drainage.

Storm drain: A metal grate in the landscape used to collect and divert stormwater into a sewer system.

Lesson 3.3a Site Inventory: Example

RC&D site before Northeast Iowa Urban Stormwater Demonstration Site

STEP 2: PROJECT AREA CHARACTERISTICS

Watershed guardian projects can be based on the site inventory. Have students pick out a couple of locations and best management practices that would make a good fit in your school or community. The following exercises test the current landscape for infiltration rate. This step is not needed if the project chosen is a rain harvest system, permeable pavers, or green roof.

Soil type

Determining the soil type of your potential project area is very important. If you do not have soil that infiltrates well, then most of the best management practices will not function correctly. The best soils for infiltration are those that have a composition made up of mostly sand and silt. If your project area does not have soil that is suitable for your stormwater BMP, then a soil amendment (Explained in section 3.1) is needed to incorporate more sand and silt into the top layer of soil. After a soil amendment is completed, the best management practice can be constructed on top of the newly amended soil.

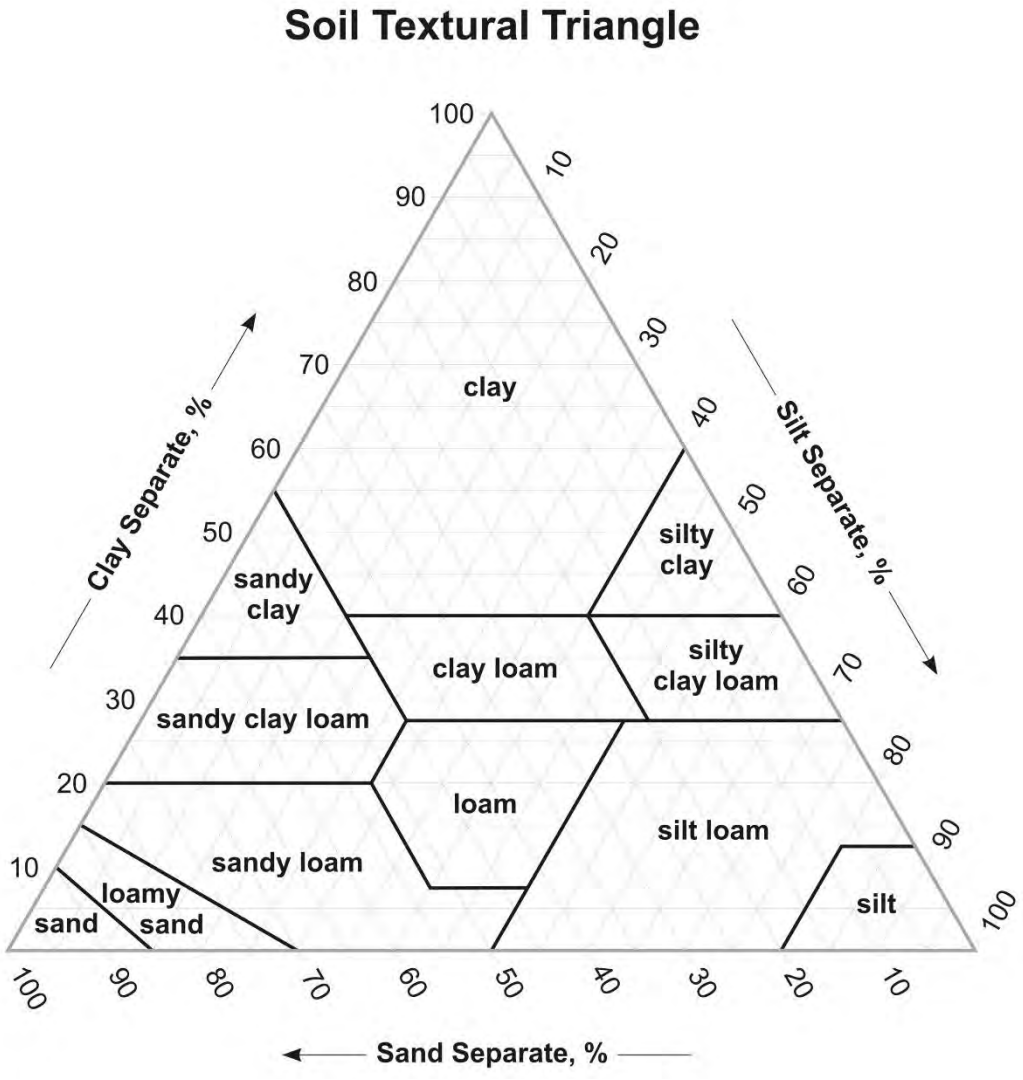


Diagram from the National Resource Conservation Service

Lesson 3.3b Determining Site Soil Type

Objective	Students will test the soil type of their project location
Grade Level	4-8
Iowa Core Standards	MS–ETS1–3, MS–PS2–4, 5–PS1–2, 5–PS1–3, 5–PS1–4, 7.RP.A.2
Time	90 min
Group Size	1-3 Students
Materials	- Small mason jar - Soil samples - Water - Stirring stick - Color pens or pencils

PROCEDURE

- Take a clean mason jar and fill it about one third of the way up with soil from the potential site.
- Multiple samples from the same site should be analyzed.
- Add clear water until the jar of soil is almost full. Look for bubbles before stirring.
- Stir the soil and water mixture thoroughly until there are no large chunks.
- Leave the jar sit undisturbed for one to two hours until the solid contents settle out of the water, and the water becomes clear again.

RESULTS

Sand particles are the largest and weigh the most so these particles will be at the bottom of the jar. Any pebbles or small rocks will also be at the bottom of the jar.

Silt particles are smaller than sand but larger than clay so they appear in the middle of the jar.

If you are able to separate out any clay particles they are the smallest and will be on the top. If your soil is largely clay they you may observe sticky lumps of clay at the bottom of the jar.

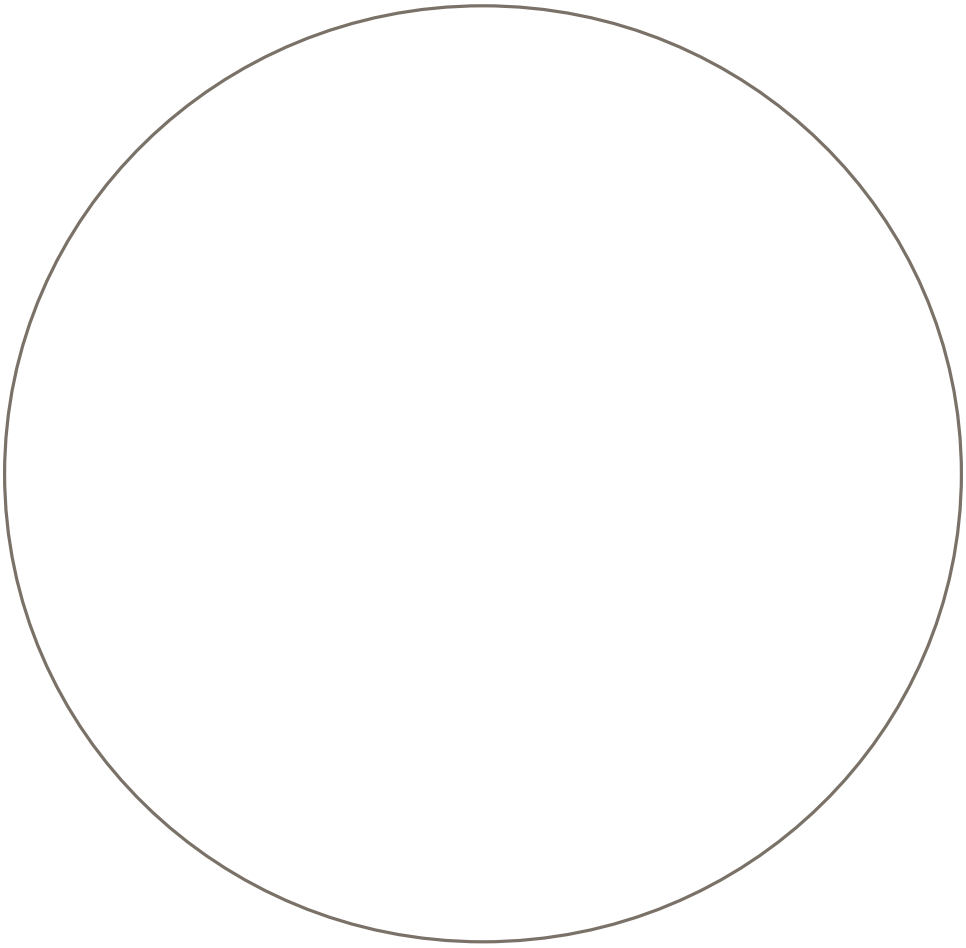
The water layer might be discolored due to broken down organic material that dissolves in water.

At the very top of the jar will be decaying organic matter that is not yet fully decomposed.

DATA ANALYSIS

Have students create a pie chart of their soil sample. Measure the total height of the materials in the jar. Calculate the percentage of each layer in the jar and draw a chart based on the percentages.

Lesson 3.3b Determining Site Soil Type: Worksheet



Pie chart color key:

Sand
Silt
Clay
Pebbles
Water
Floating Organic Material

Discussion Questions

What soil composition is the best for infiltration?

Based on the results of this experiment, are the current soil type the right composition for the project you have in mind? If not, how do you solve this problem?

Infiltration

soil type directly correlates with infiltration rate, but there are other factors that affect water infiltration like compaction and ground cover. Soil compaction is a form of soil degradation that can increase soil erosion and decreased plant growth. Compacted soils contain smaller pores that limit the movement of water and other materials through the soil. Compacted soils also make it harder for plant roots to move through the soil. Areas with heavy foot or vehicle traffic are subject to have compaction problems. The existing groundcover can also impact infiltration rate. Plant roots break up soil as they move deeper into the subsurface creating large pores and tunnels where water and oxygen can move. Plant roots also provide a food source for microbes and insects that live in the soil. Microbes, insects, and worms live in healthy soils. Without groundcover, plant roots and microbes, soil is more susceptible to compaction.

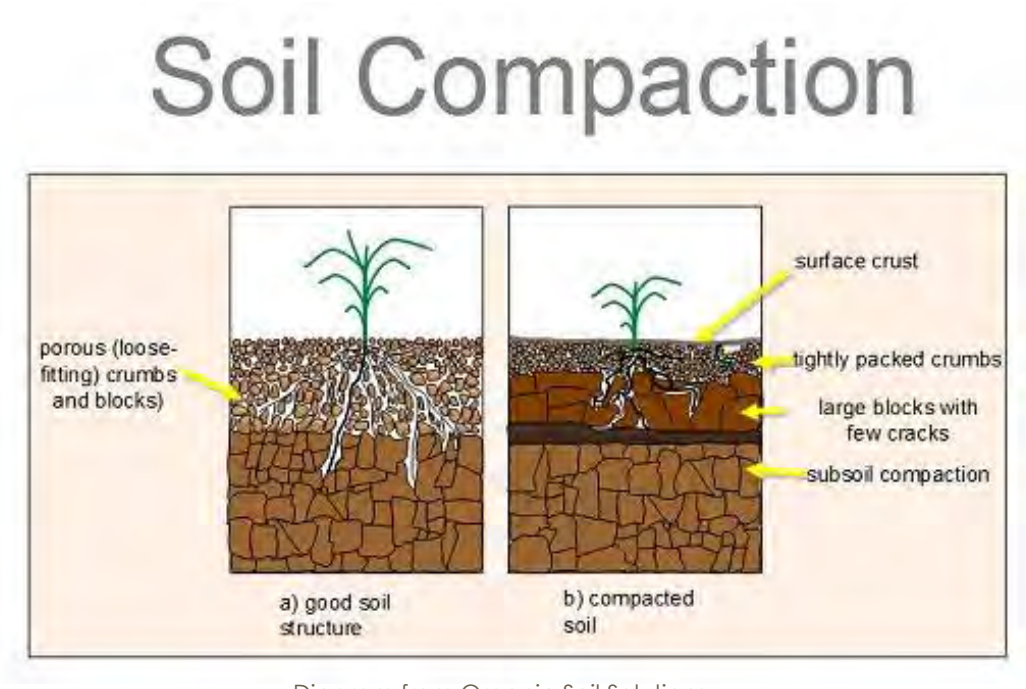


Diagram from Organic Soil Solutions

To test infiltration, dig a 6-inch hole in the center of your proposed project area. Fill the hole with water. If there is water still standing in the hole after 24 hours, then the ground doesn't infiltrate water fast enough for a stormwater BMP and a soil amendment is needed. For larger projects test multiple areas within the project area.

STEP 3: PROJECT SIZE

After you have determined that your location is suitable for your chosen project you need to determine the size of the project. Many BMPs are engineered to hold a certain range of water volume. Projects that are too small for the amount of drainage area causes the project to have little success or can even damage the stormwater practice. On average the size of the rain garden or bio-swale should be about 20% of the drainage area. The next lesson explains how to specifically size a rain garden or bio-swale. But the drainage area should be calculated for all projects.

Lesson 3.3c Calculating Size of Project

Objective	Students will determine the size and drainage area of their proposed project
Grade Level	6-12
Iowa Core Standards	6.G.A.1, 7.G.B.6, 7.EE.B.3, 6.EE.A.2, 6.EE.A.1, HSA.CED.A.4
Time	2 class periods
Group Size	1-3 Students
Materials	- Long measuring tape - Two wooden stakes - String

PROCEDURE

Drainage area of proposed project

- Measure the amount of impervious surface that drains into your proposed project area. Area that drains will be up-hill from project area. Add together multiple areas if the area is not square.

Drainage area (ft2) = Length (ft) X Width (ft)

Slope or necessary Depth of project

- Place a stake at the uphill end for the proposed rain garden and another at the downhill end.
- Level the string between the two stakes with the uphill sting at ground level.
- Measure the length of the string and the height of the string at the low stake.
- Divide the height by the length of the string and multiply the result by 100 to get the slope percentage

Slope = (Height/length) x 100

The slope helps to determine how deep the soil must me in the rain garden to function properly. Use the chart to determine rain garden depth

Slope	Depth
Less than 4%	3-5 inches
Between 5-7%	6-7 inches
Between 8-12%	8 Inches or more

Size Factor

After you have determined the depth of your proposed rain garden and the soil type, you can determine the size factor, which is used in calculating the overall size of a rain garden. Use the table below to determine the size factor.

Majority Soil type	Depth		
	3-5 inches	6-7 inches	8+ inches
Sand	0.19	0.15	0.08
Silt	0.34	0.25	0.16
Clay	0.43	0.32	0.20

Size factor X Drainage Area (ft2) = Rain Garden Area (ft2)

Lesson 3.3c Project Area Worksheet

Name: _____

Project Area Soil Type: %Sand _____%Clay _____%Silt _____

Project Drainage Area: _____
Drainage area (ft2) = Length (ft) X Width (ft)

Project Slope: _____
Slope = (Height/length) x 100

Slope	Depth
Less than 4%	3-5 inches
Between 5-7%	6-7 inches
Between 8-12%	8 Inches or more

Project Depth: _____

Size Factor Table

	Depth		
Soil type	3-5 inches	6-7 inches	8+ inches
Sand	0.19	0.15	0.08
Silt	0.34	0.25	0.16
Clay	0.43	0.32	0.20

Project Area: _____
Size factor X Drainage Area (ft2) = Rain Garden Area (ft2)

Is your project type and area a realistic size for the amount of area available? Why or why not?

STEP 3: SELECTING NATIVE PLANTS

Selecting the right plant species is very important to the function and look of your rain garden. The alternating of wet and dry soils requires that you choose plants that can tolerate this extreme cycle. Native plants that survive in this environment are usually flood tolerant prairie species that grow in flood plains an along rivers and streams. Other consideration for plant selection includes how much light the area gets, the soil type and purpose of the garden. Rain gardens that are focused on pollinators will contain some different species than one that is not.

There are many invasive species that you do not want in your rain garden. Invasive species are defined as species that have become established in an area and out-compete more desirable plants, degrade natural areas, and agricultural land. Some are native to Iowa and some are not. Watch out for those during your research. The best plants are from areas local to where you live in Northeast Iowa. A couple of common invasive species to avoid are pictured below.

Common Invasive species:

(left to right) Wild Parsnip, Crown Vetch, Reed Canary Grass

(left to right) Canada Thistle, Queen Anne's Lace, Leafy Spurge

CRITERIA FOR SELECTING NATIVE RAIN GARDEN SPECIES

- Sunlight availability
  - Sun: area receive a minimum of 6-8 hours of sun per day during the growing season
  - Partial Shade: Area receives 3-6 hours of sun per day
  - Shade: Areas receive less than 3 hours of direct sun per day.
- Grass/sedge to forb (wildflower) ratio
  - Natural structure of naive prairie is 30%-60% grass. Grass provides structural support for forbs.
- Phenology
  - A variety of blooming periods of flowers from mid-April through October
  - Beneficial for pollinator species to have access to pollen for as long as possible.
- Plant Size
  - Large raingardens often have taller plants with larger spreads, while smaller rain gardens have smaller plants.
  - Makes rain garden more visually appealing.

COMMON RAIN GARDEN NATIVE PLANT TYPES

Prairie Blazing Star

Black eyed Susan

Mountain Mint

Pale Purple Coneflower

Butterfly Milkweed

Ohio Spiderwort

Smooth Blue Aster

Lesson 3.3d Rain Garden/Bio-swale Design

Objective	Students will determine plant spaces and a design for their rain garden
Grade Level	4-12
Iowa Core Standards	7.G.A.1, 21.3–5.TL.1, 4–LS1–1, 4–ESS3–2, 3–5–ETS1–1, 3–5–ETS1–2, RI.4.7, 6.RP.A.1, MS–ETS1–1,
Time	2 class periods
Group Size	1-3 Students
Materials	• Plant identification books, nursery catalogs, internet or other native plant resource • Graph paper

PROCEDURE

As a group review the rain garden site characteristics and identify criteria that fit your rain garden site and goals for your project.

- Divide into teams or 3-4 people and have each team be responsible for a growing period
  - April/May, June, July, August, September/October
- Have each team research and create a list of 5-10 plants they want to implement into their rain garden based on their growing season
- Compile all species selected on a master list

Develop a Species List

- As a class begin to determine quantities for each species.
- First divide the grasses/sedges from the wildflowers. Using your grass to forb ratio determine how many plants you need for each group.
  - Total number of herbaceous plants = number of square feet of your rain garden.
- Create a new species list with the number of each plant needed.

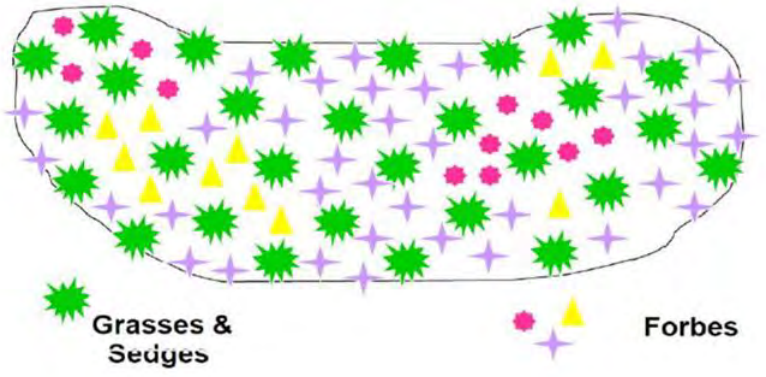
Design your rain garden

- Have the students get into their groups again or 3-4 students.
- Give them a large piece of graph paper and have them design their own rain garden using the sizing criteria and plant species you have come up with.

(For older students have them draw their design to scale)

- One square on the piece or graph paper equals one square foot.
- Develop a code for each species, and use colored pencils to indicate the flower color.
- Make sure that designs have the correct ratio of grass to forbs.
- After students are done drawing their design have each group present their design to the class.

Example of a Design



Lesson 3.3d Rain Garden Design: Species collection

NAME: _____ PROJECT LOCATION: _____

Rain Garden Size: _____

Circle the site characteristics that describe your site.

Soil type: Sand Silt Clay

Percent slope: Less than 4% 5%-7% 8%-12%

Light: Full Sun Partial Shade Shade

Plant Criteria

Number of plants needed (1plant/square foot): _____

Number of Forbs: _____ Number of Grasses: _____

Circle the Phenology that your group is in charge of finding plants for

Phenology: Spring (April-May) Early Summer (June) Summer (July) Late Summer (August) Fall (September-October)

List 5-10 Plant species with the above criteria

STEP 4: IMPLEMENTATION OF THE STORMWATER BEST MANAGEMENT PRACTICE.

Checkout the eligibility requirements for the Northeast Iowa Stormwater Education Program Watershed Guardian Grant Guidelines located in the next section of the Teacher's packet, or online at www.northeastiowarcd.org/projects/stormwater. For other funding sources, more information, or implementation assistance contact Tori Nimrod, the Education Coordinator at Northeast Iowa RC&D, at stormwater@northeastiowarcd.org or (563) 864-7112.

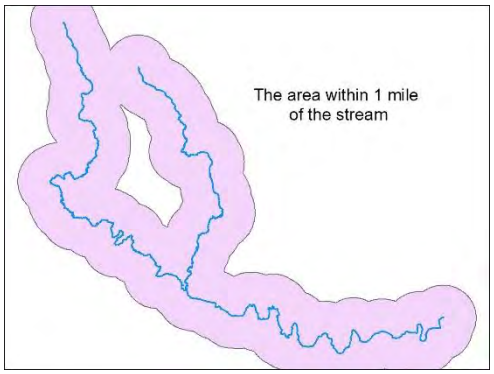
Upper Iowa River in Allamakee County. Photo by Larry Reis.

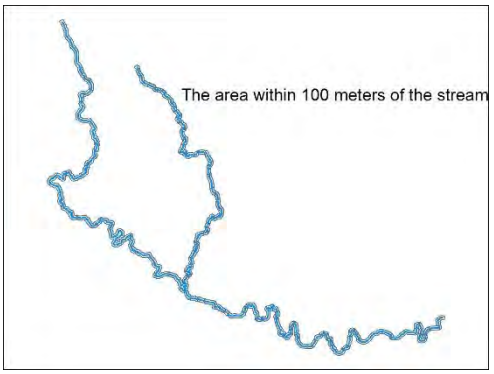
Post-Test

Name:_____

JUNIOR WATERSHED GUARDIAN

1. Which map shows the land area of a watershed? The blue line represents a stream or river. **Circle the best choice**





2. Which of the following are considered part of the environment?
    a. Forests
    b. People
    c. Buildings
    d. All of these
3. The act or result of putting harmful substances into the air, water, or soil is:
    a. Erosion
    b. A bad idea
    c. Pollution
    d. Eutrophication
4. Fish, cattails, frogs, water lilies, dragonflies, and all other living things in a pond make up.
    a. a population
    b. a community
    c. an ecosystem
    d. a biosphere
5. What is the name given to the distinctive landscape in Northeast Iowa that has been formed with limestone?
    a. Loess
    b. Sinkhole
    c. Karst
    d. Prairie
6. The most common Iowa aquatic pollutant is?
    a. Soil sediment
    b. Animal waste
    c. Untreated human waste
    d. Plastics and other trash

SENIOR WATERSHED GUARDIAN

7. Water pollution that is discharged through a pipe or conduit
    a. Non-point source pollution
    b. Point source pollution

8. Term used to describe the cloudiness of a body of water caused by sediment suspended in the water.
    a. Turbidity
    b. Anoxic
    c. Potable
    d. Anaerobic

9. A surface that cannot soak up water or allow water to pass
    a. Permeable
    b. Impervious
    c. Perched
    d. Buffered

10. What are the three stages of the water cycle?
    a. evaporation, condensation, precipitation
    b. condensation, precipitation, hibernation
    c. precipitation, dehydration, evaporation
    d. transpiration, dehydration, condensation

EXPERT WATERSHED GUARDIAN

11. List two ways that a rain garden improve water quality.

12. List four pollutants carried into waterways by runoff from streets, sidewalks or parking lots.

13. An increase in the amount of impervious surfaces in a watershed could lead to
    a. Increased eutrophication
    b. Increased stormwater runoff
    c. Increased nutrient loading
    d. All of the above

Post-Test Answer Key

JUNIOR WATERSHED GUARDIAN

14. Which map shows the land area of a watershed? The blue line represents a stream or river. **Circle the best choice**

15. Which of the following are considered part of the environment?
    a. Forests
    b. People
    c. Buildings
    d. All of these

16. The act or result of putting harmful substances into the air, water, or soil is:
    a. Erosion
    b. A bad idea
    c. Pollution
    d. Eutrophication

17. Fish, cattails, frogs, water lilies, dragonflies, and all other living things in a pond make up.
    a. a population
    b. a community
    c. an ecosystem
    d. a biosphere

18. What is the name given to the distinctive landscape in Northeast Iowa that has been formed with limestone?
    a. Loess
    b. Sinkhole
    c. Karst
    d. Prairie

19. The most common Iowa aquatic pollutant is?
    a. Soil sediment
    b. Animal waste
    c. Untreated human waste
    d. Plastics and other trash

SENIOR WATERSHED GUARDIAN

20. Water pollution that is discharged through a pipe or conduit directly into a body of water is an example of
    a. Non-point source pollution
    b. Point source pollution

21. Term used to describe the cloudiness of a body of water caused by sediment suspended in the water.
    a. Turbidity
    b. Anoxic
    c. Potable
    d. Anaerobic

22. A surface that cannot soak up water or allow water to pass
    a. Permeable
    b. Impervious
    c. Perched
    d. Buffered

23. What are the three stages of the water cycle?
    a. evaporation, condensation, precipitation
    b. condensation, precipitation, hibernation
    c. precipitation, dehydration, evaporation
    d. transpiration, dehydration, condensation

EXPERT WATERSHED GUARDIAN

24. List two ways that a rain garden benefits water quality.
    Plants filter water as it infiltrates into the ground, Temporary holds water to allow sediment and other pollutants to settle.

25. List four pollutants carried into waterways by runoff from streets, sidewalks and parking lots.
    Salts, antifreeze, sand, oil, fertilizer, glass, etc.

26. An increase in the amount of impervious surfaces in a watershed could lead to
    a. Increased eutrophication
    b. Increased stormwater runoff
    c. Increased nutrient loading
    d. All of the above

Appendix

A. *Supporting Project Development Materials*
B. Other Implementation Materials
C. Grant Guidelines
D. Other Funding Sources

Appendix A

NEARBY NATIVE PLANT SUPPLIERS

*Certified Source-identified seed available

***Ion Exchange**
1878 Old Mission Road
Harpers Ferry, IA 52146
(563)419-0837
hbright@ionxchange.com
Iowa ecotype seed: NE IA
NATURAL SELECTIONS™ grower

Seed Savers Exchange
3094 North Winn Road
Decorah, IA 52101
(563)382-5990
Seedsavers.org
Seed orders, select plants at nursery

***Tallgrass Prairie Center-UNI**
2412 W. 27th St.
Cedar Falls, IA 50614
(319)273-3836
Fax: 319-268-0668
Gregory.houseal@uni.edu
www.tallgrassprairiecenter.org/natural-selections
Administraters the NATURAL SELECTIONS™ Program

***Shooting Star Native Seeds**
20740 County Road 33
Spring Grove, MN 55974
(507)498-3953
mark@shootingstarnativeseed.com
www.shootingstarnativeseed.com
Iowa ecotype seed zone: N, C, S
NATURAL SELECTIONS™ grower

***Iowa Pheasants Forever-Native Seed** Program
2880 Thunder Rd.
Hopkinton, IA 52237
(563)926-2357
Cell: (319)240-4075
moconnor@pheasantsforever.org
www.iowaph.org/page/1100/Native_Seed_Program.html
Iowa ecotype seed zone: N, C, S

Appendix B: Other Implementation Materials

Iowa Stormwater Manual
http://www.iowadnr.gov/Environmental-Protection/Water-Quality/NPDES-Storm-Water/Storm-Water-Manual

Iowa Rain Garden Design and Installation Manual
http://www.rainscapingiowa.org/documents/filelibrary/rain_gardens/RainGardens_776AA55A160E5.pdf

Appendix C: Northeast Iowa Stormwater Education Program
Watershed Guardian Grant Guidelines

The Northeast Iowa Stormwater Education Program is excited to support school classes in implementing stormwater management projects. Eligible classes may apply for two types of awards: ***Junior Watershed Guardian Grants*** will award up to $500, and ***ExStream Watershed Guardian Grants*** will award up to $5,000.

JUNIOR WATERSHED GUARDIAN GRANT

Awards up to $500 - Available to classes on completion of field trip

Eligibility: Junior Watershed Guardian grants are available to all classes from school districts in project area counties that visit the Northeast Iowa Urban Stormwater Demonstration Site in Postville for a learning field trip, and complete lessons in section 3 of the Northeast Iowa Stormwater Education Project Watershed Guardian Teacher's Packet. Multiple applications from the same school/district will be considered, as long as they are submitted by different classes with different teachers.

Project Area counties: Allamakee, Buchanan, Clayton, Chickasaw, Fayette, Howard, and Winneshiek.

Purpose: Junior Watershed Guardian grants are intended to support classes in implementing stormwater best management practices at their schools and in their communities. Teachers are encouraged to engage students in project selection and development, as well as implementation. The Education Coordinator will be available to help classes identify possible projects, and answer questions on applications and project implementation.

The Junior Watershed Guardian Grant is intended to help classes hit the ground running, applying classroom learning to real-world stormwater management scenarios. Examples of possible projects include creating rain gardens on school property, developing school-to-home rain barrel programs, and starting a community tree planting project.

Projects may be sited on school property, city property, or on private property within the urban community.

Project Size: The Junior Watershed Guardian Grant awards of up to $500 could be used as the sole source of funding for smaller projects, such as a school butterfly garden, or could fund a portion of a larger project alongside funding from other sources. Projects including vegetative plantings, must incorporate native species only. The project budget should also specify how Northeast Iowa Stormwater Education Program funds will be spent, and identify other sources of support.

Application and Award Timeline: The Education Coordinator will regularly review Junior Watershed Guardian Grant applications, and grants will be awarded within a

month of submission. Junior Watershed Guardian grants will be available for up to 20 projects, and will be awarded on a first-come, first-served basis.

Application Requirements: Applicants need to submit a site plan, project description, budget, timeline, student involvement plan and project learning evaluation. Detailed instructions are included on the application form, which can be found on the website at www.northeastiowarcd.org/projects/stormwater. Applications should be submitted by email to stormwater@northeastiowarcd.org or mailed to Northeast Iowa RC&D Att: Watershed Guardian Grant Program, PO Box 916, Postville, IA 52162.

Reporting: Grantees will be required to submit a final report at the completion of their Junior Watershed Guardian Project. The report should include pictures of the student's involvement in the implementation of the project. If the project is not completed within a year, grantees will be required to submit an annual report.

Questions? Contact Tori Nimrod, the Education Coordinator, at stormwater@northeastiowarcd.org or call 563-864-7112.

EXSTREAM WATERSHED GUARDIAN GRANT PROGRAM

Competitive grant program – Awards up to $5,000 - Available to classes on completion of field trip and section 3 of Watershed Guardian Teacher's Packet.

Eligibility: All classes from school districts in project area counties that visit the Northeast Iowa Stormwater Demonstration Site in Postville for a learning field trip, and who complete lessons in section 3 of the Watershed Guardian Teacher's Packet are eligible to apply for an ExStream Watershed Guardian Grant. Multiple applications from the same school/district will be considered, as long as they are submitted by different classes with different teachers.

Project Area counties: Allamakee, Buchanan, Clayton, Chickasaw, Fayette, Howard, and Winneshiek.

Purpose: The ExStream Watershed Guardian Grant is a competitive grant program intended to support classes in implementing stormwater best management practices at their schools and in their communities. Teachers are encouraged to engage students in project selection and development, as well as implementation. The Education Coordinator will be available to help classes identify possible projects, answer questions on applications, and project implementation.

ExStream Watershed Guardian Grant aims to empower students to apply classroom knowledge to the creation of stormwater management solutions in their own communities. Projects should measurably improve stormwater management at the school or in the surrounding community. Projects including vegetative plantings, must incorporate native species only. Example of possible projects include: wetlands, rain gardens, and bio-swales. Projects may be sited on school property, city property, or on private property within the community.

Project Size: The ExStream Watershed Guardian Grant is a competitive grant program that will support projects in a select number of Northeast Iowa with awards up to $5,000. Match funds are not required. If classes seek funding from other sources the project budget should specify how Northeast Iowa Stormwater Education Program funds will be spent, and identify other sources of support.

Application and Award Timeline: Applications for the ExStream Watershed Guardian Grant will be reviewed quarterly. Application deadlines are: Oct 31, 2018, Jan 31 2019, April 30, 2018. Applications will be reviewed by a committee of education and stormwater experts, and awards will be announced within 60 days of the application deadline.

Application Requirements: Applicants need to submit a site plan, project description, budget, timeline, student involvement plan and project learning evaluation. Detailed instructions are included on the application form, which can be found on the website at www.northeastiowarcd.org/projects/stormwater. Applications should be submitted by email to stormwater@northeastiowarcd.org or mailed to Northeast Iowa RC&D Att: Watershed Guardian Grant Program, PO Box 916, Postville, IA 52162.

Reporting: Grantees will be required to submit a final report at the completion of their ExStream Watershed Guardian Project. Report should include pictures of the student's involvement in the implementation of the project. If the project is not completed within a year, grantees will be required to submit an annual report.

If you have any Questions or would like to apply, download the grant applications and supporting materials at
www.northeastiowarcd.org/projects/stormwater
or Contact the Education Coordinator at
stormwater@northeastiowarcd.org or call 563-864-7112.

Appendix D

EDUCATION GRANT RESOURCES

Nature works Everywhere Grant Description
https://www.natureworkseverywhere.org/grants
https://www.natureworkseverywhere.org/asset/grants/2019_Detailed_Grant_Description.pdf

Whole Kids Foundation School Garden Grant
https://www.wholekidsfoundation.org/schools/programs/school-garden-grant-program

Fruit Tree Planting Foundation
http://www.ftpf.org/apply.htm

Carton 2 Garden
https://kidsgardening.org/garden-grants/

School Yard Garden Grants
https://monarchlab.org/?/education-and-gardening/gardening-for-monarchs/garden-grants

The Cornell Lab of Ornithology Mini-Grants
https://celebrateurbanbirds.org/community/minigrants/

Toshiba Grants
https://www.toshiba.com/taf/

AIAA Foundation Classroom Grant Program
https://www.aiaa.org/Secondary.aspx?id=4184&terms=grants

Project Learning Tree Greenworks Grants
https://www.plt.org/resources/greenworks-grants/

Lowe's Toolbox for Education
http://toolboxforeducation.com/hta

Walmart Foundation Community Grant Program
http://giving.walmart.com/apply-for-grants/local-giving

Target Field Trip Grants
https://corporate.target.com/corporate-responsibility/community/philanthropy/field-trip-grants

Captain Planet Foundation Grants
http://captainplanetf.wpengine.com/wp-content/uploads/CPF_Grant_Guidelines_112717.pdf

American Honda Foundation
http://www.honda.com/community/applying-for-a-grant

Community Foundation Grants
https://www.cfneia.org/