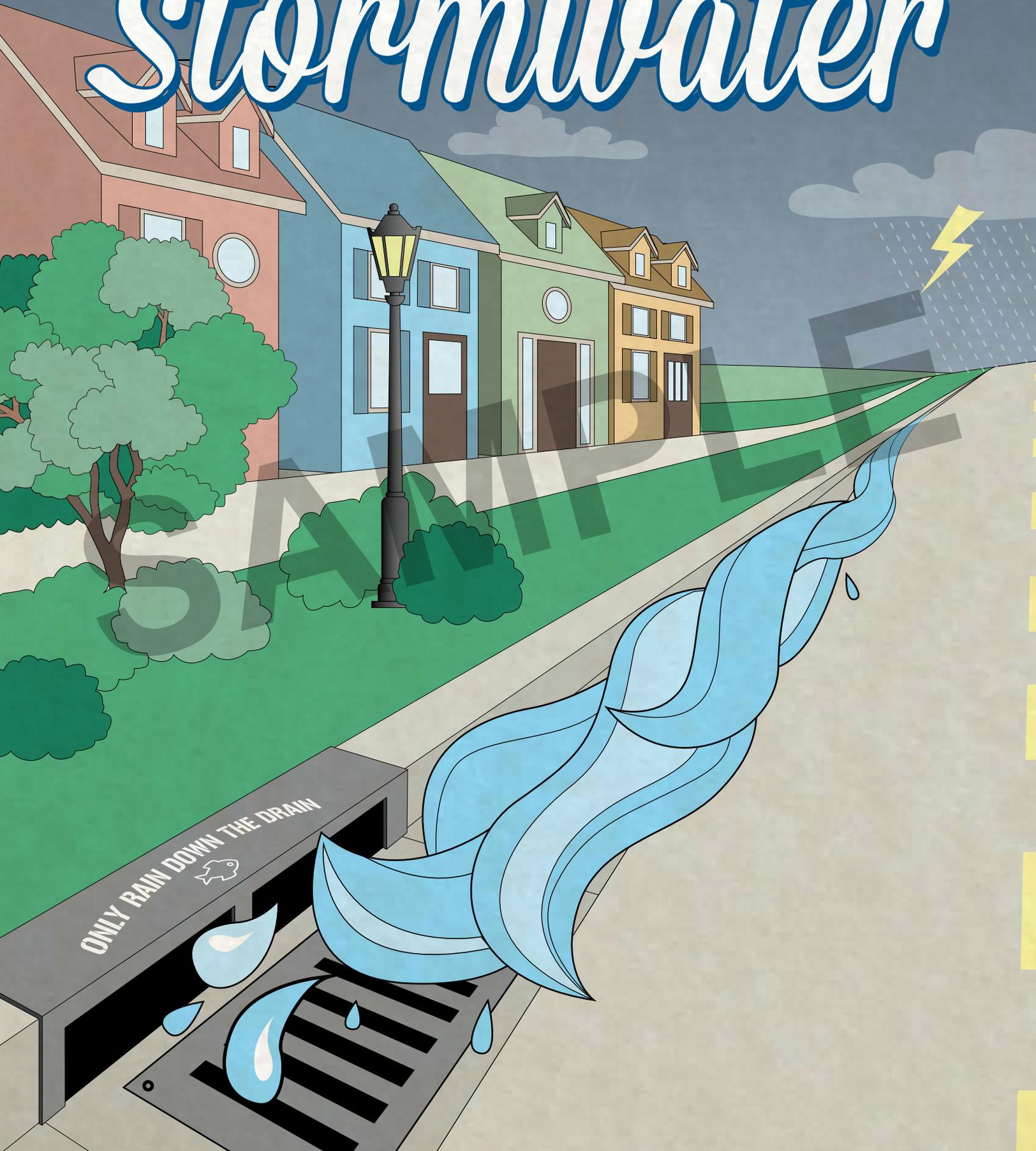


The Surprising Story of Stormwater



This book belongs to:



Follow the Flow

Water is Old! 4

Learn about the water cycle.

Stormwater Flow 6

How do storms affect the water cycle?

MS4s 8

Learn how cities protect their water.

What's So Great about MS4s? 10

They benefit you and the water supply!

You Can Help Too! 12

You are the water's first line of defense.

Education Prevents Pollution 14

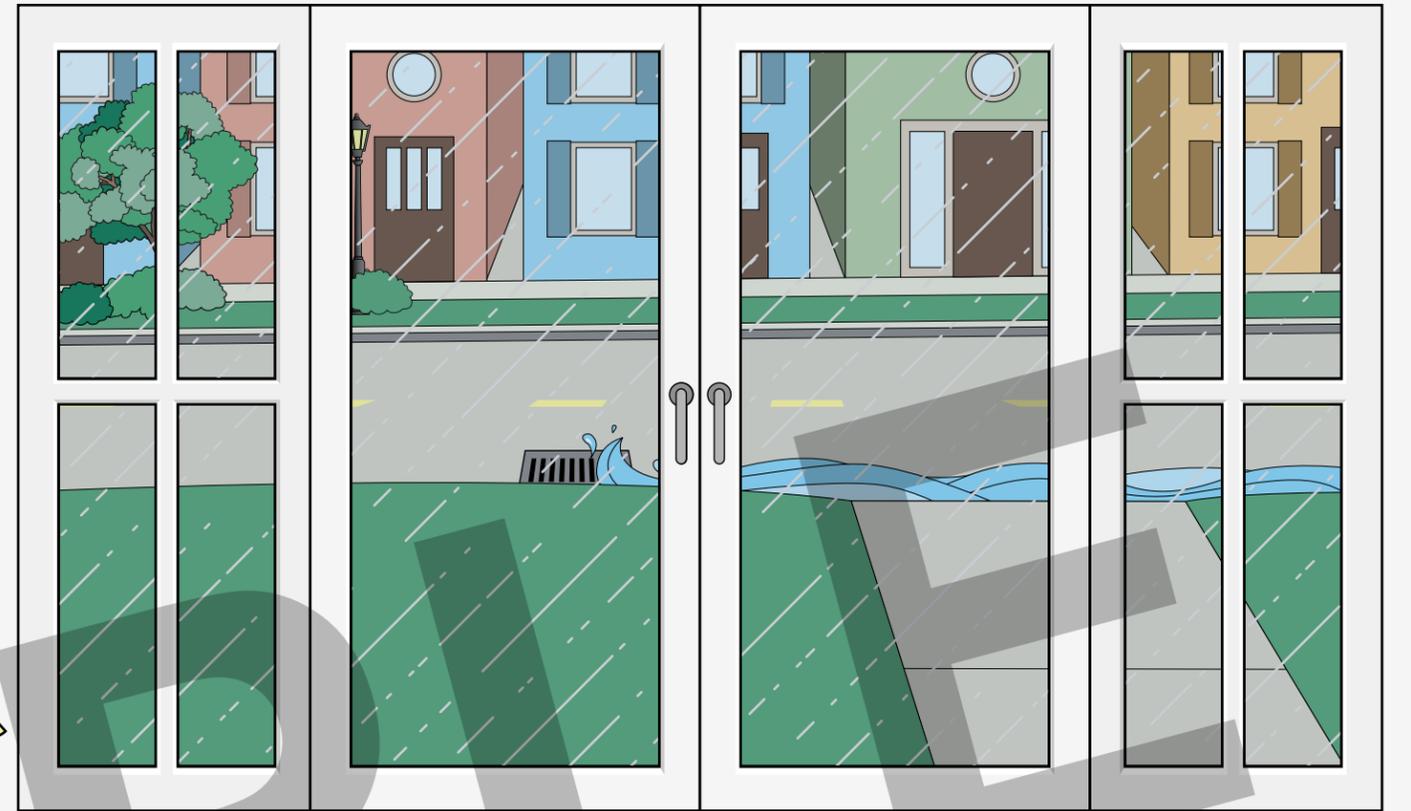
How municipalities protect their water.

Stormwater in My Community 16

Create a diagram of stormwater in your area.

Engineer the Water Works 18

Plan a new sewer system for a city.



Follow the Flow of Water

Welcome to the stormwater flow! Hold on to your galoshes! You're in for a wild and wet adventure!

Every city and town has to deal with stormwater. Stormwater is the water you see rushing down your streets, sidewalks, driveways, and yards after a storm. It could be from an afternoon thundershower or days of on-and-off drizzle. It could be from warm weather after a snowfall that melts snow and ice.

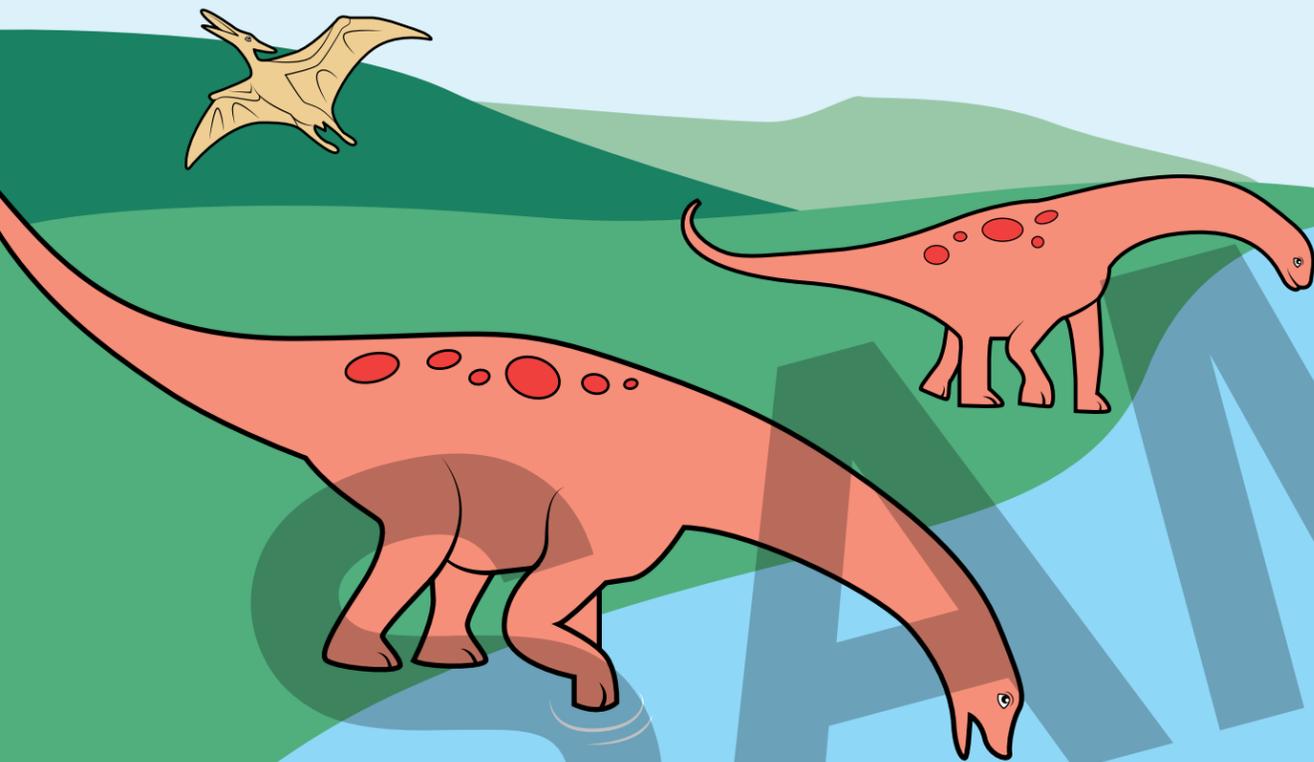
Some places – like much of the East Coast – experience stormwater all year round. In the winter, there's snow and ice that fall, freeze, and melt in a constant cycle. In the summer, there are big storms. In the fall and winter, rainy weather comes and goes. Other places – like Southern California – only see rain during certain times of the year. Since months go by without any rain, that first rainfall every year makes a big splash!

No matter where you live, all that water is a big deal. In order to prevent problems – like flooding – cities and towns must deal with the stormwater. And make no doubt about it: YOU are an important player in that flow! Now jump in! Follow the Flow of Stormwater!

Water Is Old!

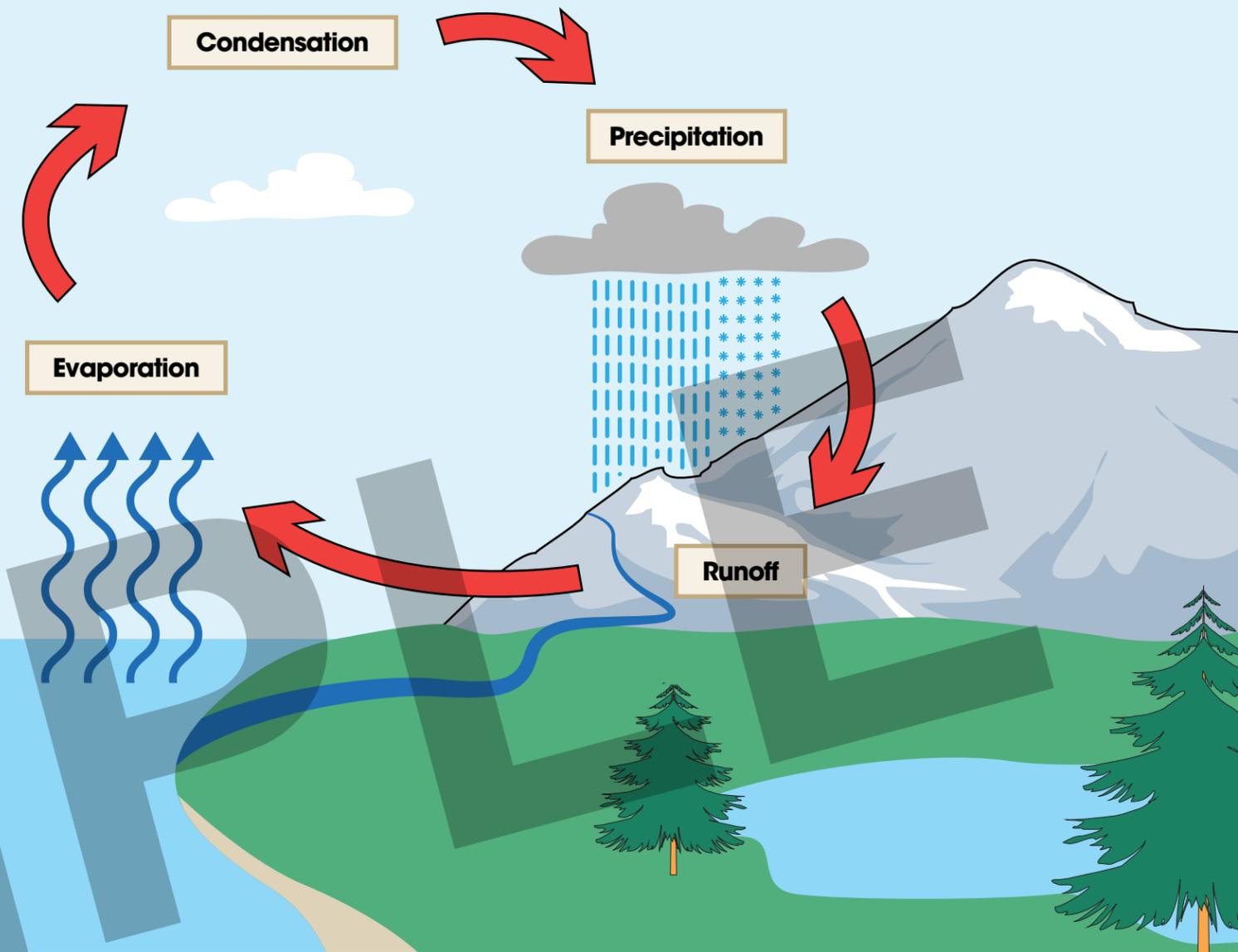
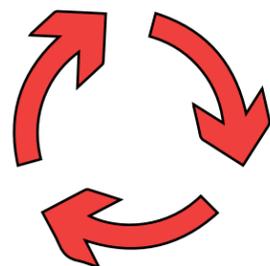
Did you know that the water you use today is the same water the dinosaurs were drinking millions of years ago?

There is only so much water on planet Earth. It gets recycled through the **water cycle**. Rain water isn't stored in the clouds forever. Water in the ocean and lakes isn't there forever, either. Water **evaporates** into the sky, **condenses** to form clouds, and returns as rain, snow, and other forms of **precipitation**. Back on the ground, water becomes **runoff** that flows over and through the ground to get back to large bodies of water.



Imagine That!

There will never be any new water on Earth. The same old water keeps cycling through Earth's natural systems. Everyone and everything needs water to survive. That means it's everyone's job to help keep it clean for the next generation!



Vocabulary

Water cycle: The process that naturally recycles water through Earth's atmosphere and moves water around the planet. Also called the hydrologic cycle.

Evaporate: To change states of matter from a liquid to a gas. In the water cycle, water evaporates from water bodies and land into water vapor in the atmosphere.

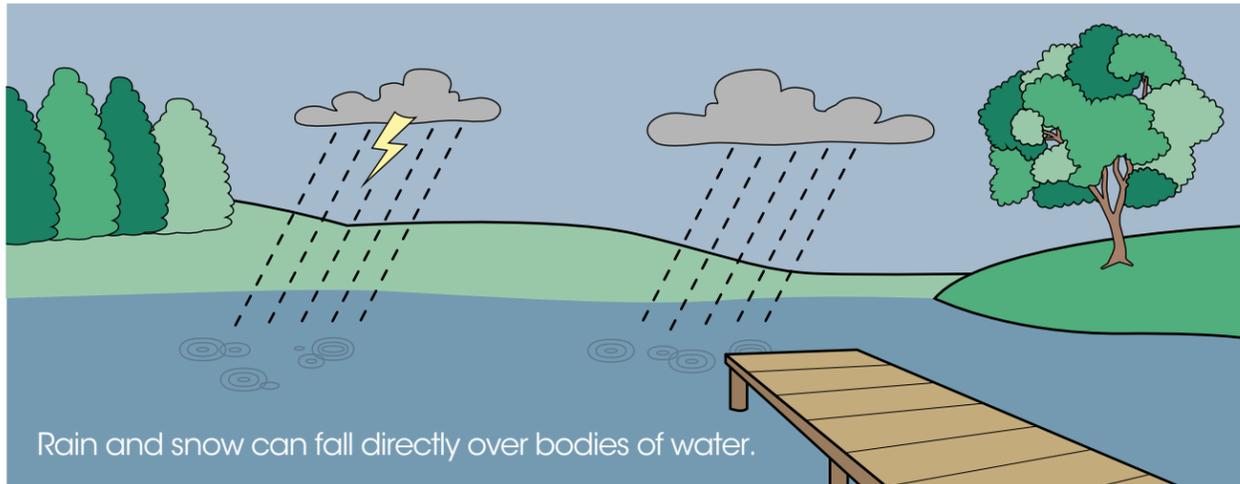
Condense: When water vapor condenses, it turns back into liquid water. In the water cycle, water vapor condenses in the atmosphere to form tiny droplets that make up clouds.

Precipitation: The many different forms of water that fall from the sky. Examples include rain, snow, sleet, and hail.

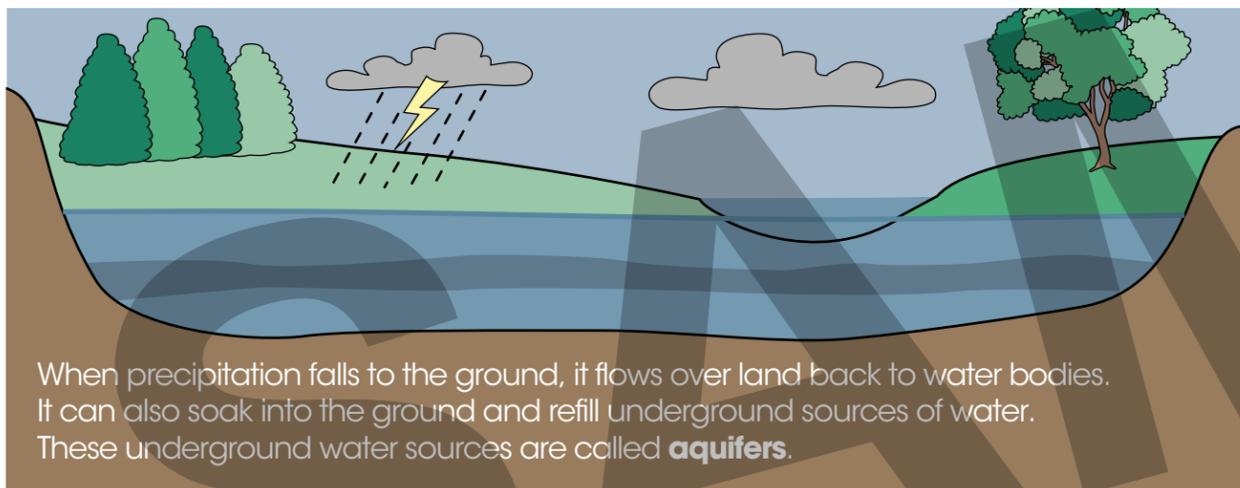
Runoff: Water that flows over or through the ground to reach an ocean, river, lake, or other large body of water.

Stormwater Flow

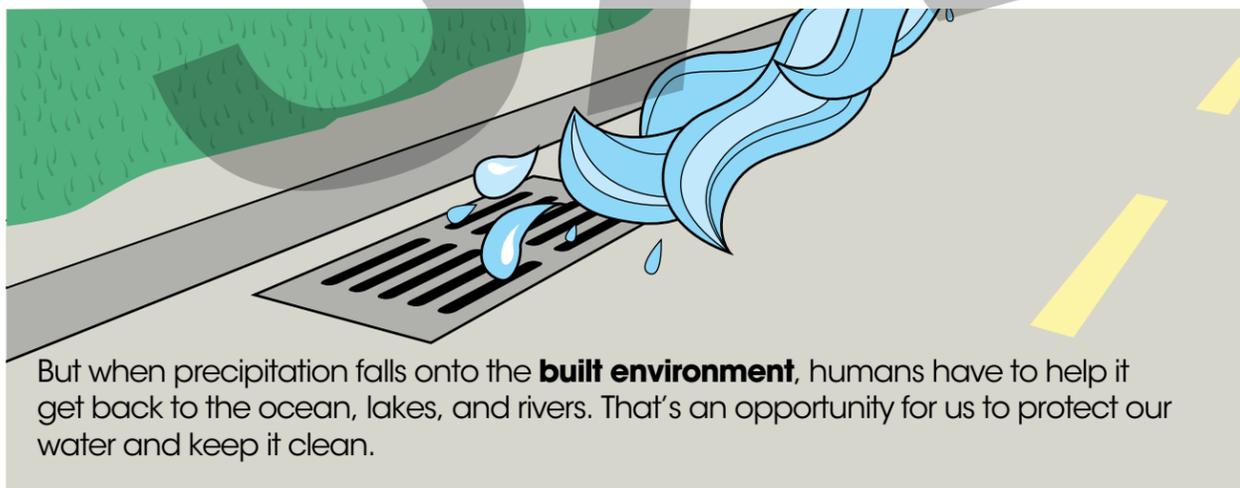
During a storm, precipitation can return to the ocean, lakes, and other bodies of water in three ways.



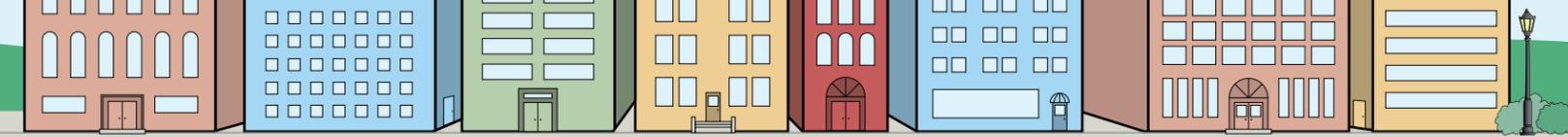
Rain and snow can fall directly over bodies of water.



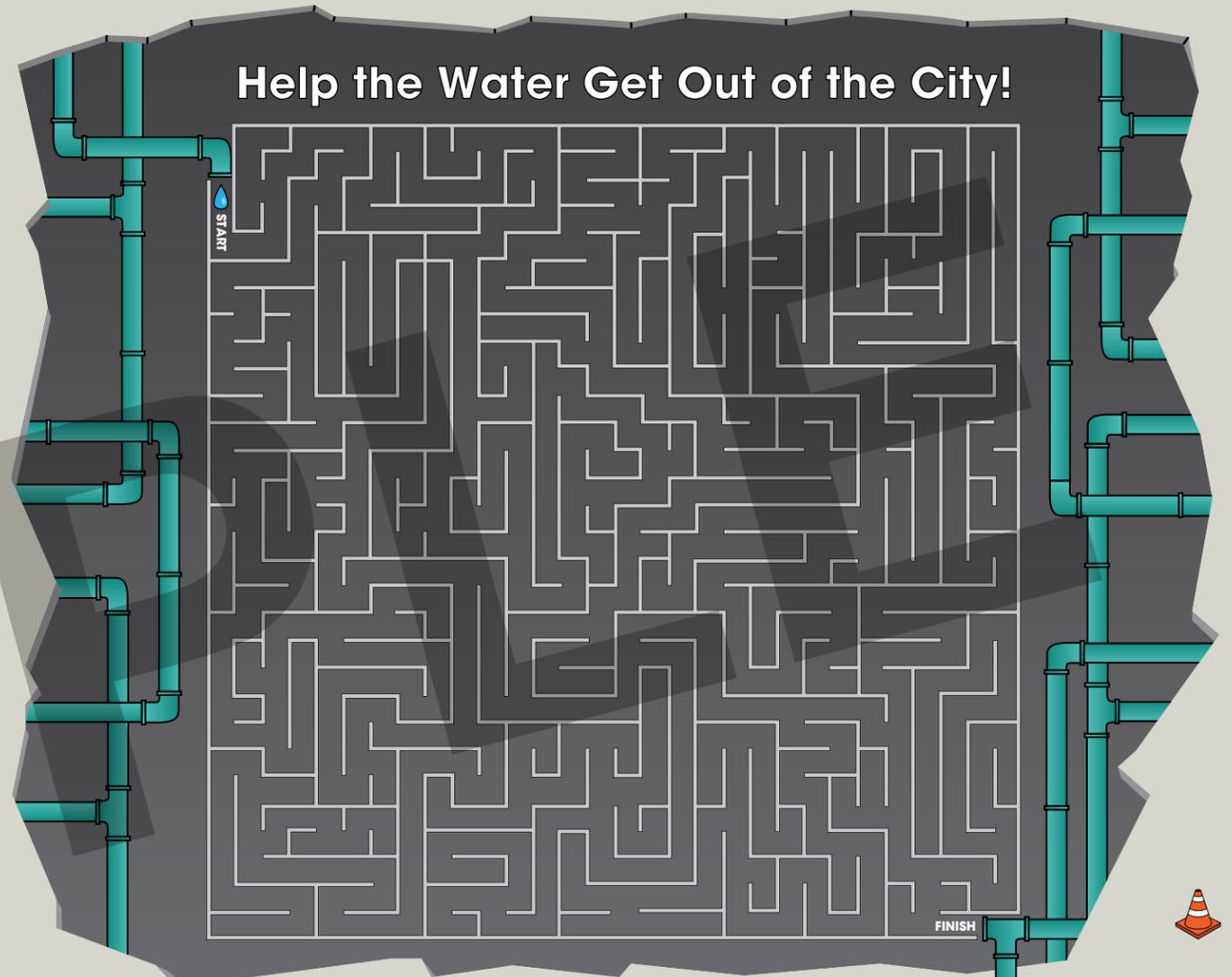
When precipitation falls to the ground, it flows over land back to water bodies. It can also soak into the ground and refill underground sources of water. These underground water sources are called **aquifers**.



But when precipitation falls onto the **built environment**, humans have to help it get back to the ocean, lakes, and rivers. That's an opportunity for us to protect our water and keep it clean.



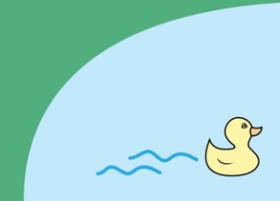
Help the Water Get Out of the City!



Vocabulary

Aquifer: Underground body of water. Often serves as a source of water for human use and for plants.

Built Environment: Buildings, roads, landscapes, and other human-made features that have been constructed or have changed the natural surroundings.



MS4s

Many cities and towns have a sewer system in place just for stormwater. **Stormwater** is water from rain. It is also the water that flows over the ground when snow and ice melt. One common sewer system is called an **MS4**, or municipal separate storm sewer system. Take a look at how these separate sewer systems work.

1. First the water flows off roofs and paved surfaces. These are called **impervious surfaces**. Water can't soak through impervious surfaces, but it can soak through **permeable surfaces** like gardens, grass, fields, and forest floors.

2. As the water enters the street and other impervious surfaces, it flows into drains and ditches. Maybe you've seen some of these drains in your neighborhood.

Did you know... engineers are starting to build permeable roads and parking lots! We now have the technology to create surfaces that are hard enough for even the heaviest vehicles to drive on and still allow water to soak through and return to underground aquifers.

Hmm...
Some streets and sidewalks – impervious surfaces! – can be pretty dirty. What can I do to keep the water clean that flows through these MS4s?

3. Underneath homes and streets is a network of larger pipes that make up the sewer system. Stormwater enters bigger and bigger pipes from the street.

4. Eventually, the sewer system brings the stormwater to a local water source.

Vocabulary

Stormwater: Flowing water from rain or meltwater from snow and ice.

MS4: Municipal Separate Storm Sewer System. A system of pipes and drains used to carry stormwater away from towns to prevent flooding. It's separate from any other sewer systems.

Impervious Surfaces: Hard surfaces that do not allow water or other liquids to soak in or pass through. Impervious surfaces are sealed off and impenetrable. Examples include roofs, roads, parking lots, and sidewalks.

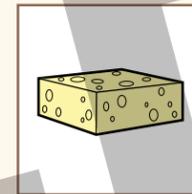
Permeable Surfaces: Surfaces that allow water and other liquids to soak in or pass through, like water trickling through a sponge or sieve. Examples include fields, gardens, and forest floors. Some human-made surfaces can be permeable, too.

Explore the Surface!

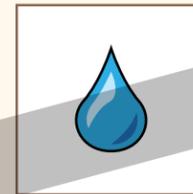
Materials:



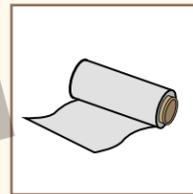
Large Cup or Glass



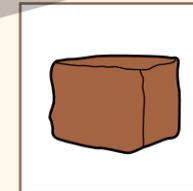
Standard Kitchen Sponge



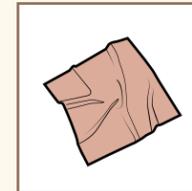
Water



Plastic Wrap



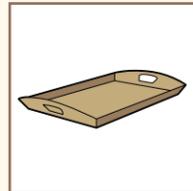
Clay



Cloth



Small Stones



Tray

Procedure

1. Perform this activity on a tray or in a tub or sink.
2. Wet the sponge and then wring out most of the water. Place the sponge vertically inside the cup. The sponge should fit snugly near the top of the cup.
3. Pour water slowly over the sponge. What happens to the water? Where does it go? Is the sponge permeable or impervious?
4. Drain the water out of the sponge. Wring out the sponge again and then put it back inside the cup.
5. Plan a design to make the surface impervious using the other materials available. Test your design.
6. What worked well to keep the water from soaking into the sponge? What didn't work well?

What's So Great About MS4s?

MS4s prevent flooding of streets, sidewalks, and even homes and businesses by allowing stormwater to flow away.

They prevent **erosion** and destruction of green spaces and landscaping. If stormwater remained on the ground, it could carry away a lot of necessary **topsoil** and could harm many plants that can't survive underwater.

Below ground, MS4s safely and efficiently guide stormwater back to local bodies of water. MS4s are like humans' contribution to the water cycle!

Many MS4s start protecting the water bodies right at the surface. Have you noticed grates, or slotted covers, over storm drains? No one wants to lose a soccer ball down a storm drain. And no one wants to get a bicycle tire stuck in a big hole either! But there is another reason for the grates, too. Unfortunately, trash and litter sometimes end up on streets and sidewalks. When heavy rain or snowmelt occurs, it can pick up the trash and carry it away. Storm drain grates keep some litter out of the sewer system and out of rivers, lakes, and coastal waters. Remember - there is a limited supply of water on planet Earth. It shouldn't be polluted!

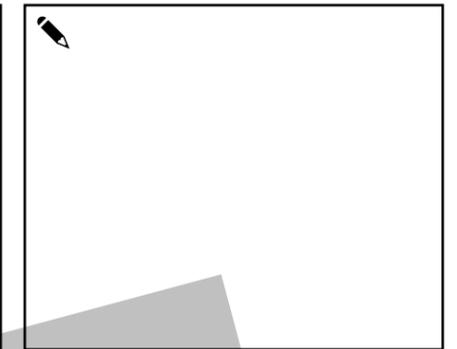
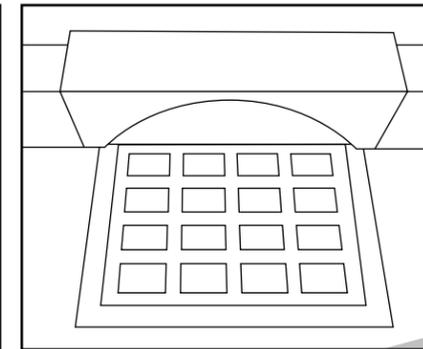
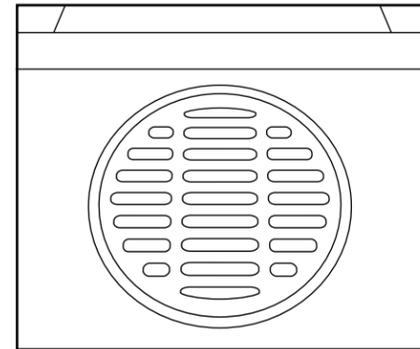


Vocabulary

Erosion: The wearing away of rock and dirt by wind and water.

Topsoil: The top layer of soil in an ecosystem that helps anchor plants, allows new seeds to grow, and provides many nutrients for plants to survive.

Add a splash of color to these different types of storm drains and then design your own!



What did you notice about these storm drains? Write your observations about the drains here.

Create a Funny Stormwater Story

Step 1. Fill out the list of words below.

1. Pick an animal (make the word plural): _____
2. Pick an adjective: _____
3. Pick a participle (an -ing adjective): _____
4. Name a type of shelter or living structure: _____
5. Pick another adjective: _____
6. Pick a personal accessory: _____
7. Pick an action verb (ending in -ing): _____
8. Pick one of the five senses: _____
9. One last adjective: _____

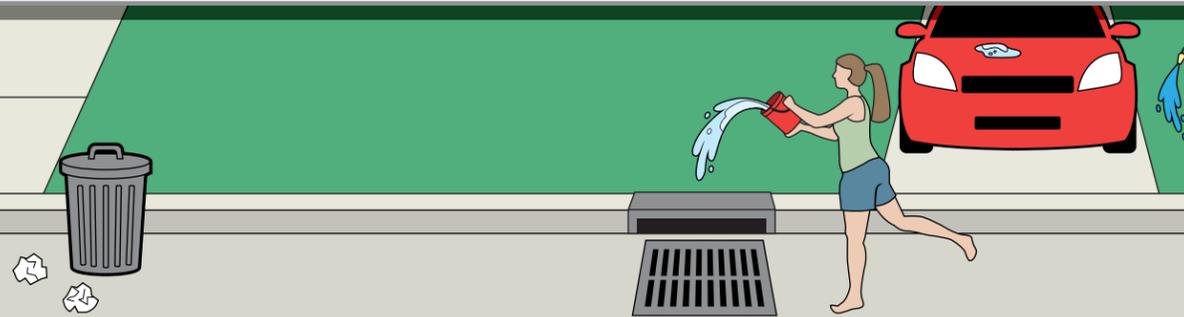


Step 2. Transfer your words into this story and read the hilarious result!

Yesterday it started raining cats and 1. _____! As the storm continued, I watched the water form into huge, 2. _____ puddles. After just a few minutes, my street had turned into a 3. _____ river. I thought for sure that the water would rise and carry my 4. _____ away. But instead, I noticed the water entering our town's 5. _____ storm drains. I pulled out my x-ray 6. _____ to see where the water went on the other side of those drains. Lo and behold! The water was 7. _____ through pipes and sewers away from my city! I couldn't believe my x-ray 8. _____. Those storm drains I see every day were keeping my 9. _____ city safe.

You Can Help Too!

There are other pollutants that fit through the grates. You can help keep these materials from going down the drains and out of our precious water supply. **Circle all the things in this image that are polluting the water - and don't have to be!**



Fine particles of soot from car engines and smoke stacks can coat surfaces and get washed down the drain. Walk, bike, carpool, and take public transportation whenever possible to help reduce these particles.

Help your family maintain efficient cars. Motor oil and other fluids from old or broken vehicles can leak onto the road, run down the storm drain, and pollute nearby waterways. Encourage frequent check-ups and tune-ups of family vehicles. Any mechanical work should be done in a professional garage and fluids should be disposed of properly.



Make sure that small pieces of trash that can fit down the sewer drains, like straws, gum wrappers, and bottle caps, make it into trash and recycling bins. Better yet, choose reusable items instead of **single-use items** so they stay out of bins and landfills altogether! Why buy water bottles over and over again? Instead, purchase a sturdy plastic or metal bottle and keep refilling it. You can also say no to straws, carry a to-go container with you, and stash a reusable spork in your bag. With a little planning, you can reduce the amount of trash heading down the drain or into the landfill.

Only rain down the drain! Any other liquids should be disposed of elsewhere. For example, wash your car at a professional carwash that will treat the wash water. Many places recycle and reuse the wash water. Wash pets in the tub or at a pet store. Dirty, soapy water from car or pet washing can pollute local waterways. But wash water inside the house goes into a different sewer system and gets treated. Harmful pollutants are removed from dirty household water so they don't pollute our water supply. Bring any other household waste - like paint or used cooking oil - to your local waste facility for safe and proper disposal. Oil and paint down a storm drain can easily pollute nearby water sources. (And oil and paint down home drains can clog up the system!)

Vocabulary

Single-use items: Products that can only be used once and then must be discarded. Examples include plastic water bottles, plastic straws, and carry-out food containers.

Word Find

Find the pollutants and catch them before they are washed down the drain!

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O | U | B | O | S | R | B | I | V | G | N | E | F | N | S | L |
| S | I | A | H | S | S | I | N | G | L | E | U | S | E | H | I |
| W | P | L | S | E | M | I | S | S | I | O | N | S | O | J | T |
| D | A | U | V | N | I | F | J | L | V | D | C | G | L | H | T |
| X | L | S | H | D | P | O | L | L | U | T | A | N | T | S | E |
| K | R | U | H | L | C | H | P | B | W | O | X | V | H | G | R |
| R | W | C | P | W | U | B | O | U | Y | O | E | A | B | B | I |
| Q | M | N | A | O | A | S | F | I | R | S | M | O | W | T | A |
| R | Q | S | I | F | H | T | I | M | Q | R | N | P | R | R | G |
| M | J | O | N | N | K | A | E | J | T | X | W | T | O | A | X |
| H | R | T | T | J | R | S | H | R | E | Z | Q | G | N | D | M |

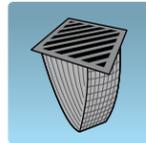
- Pollutants
- Single Use
- Emissions
- Soot
- Paint
- Oil
- Litter
- Wash Water

Education Prevents Pollution

Fortunately, cities and towns are on top of their pollution-prevention game. Here are some ways that municipalities reduce the amount of pollutants that enter the system.



Treating the stormwater runoff to remove pollutants and litter.



Using filters at storm drains to catch litter before it goes into the sewer.



Establishing laws to regulate waste disposal.

Education is a huge piece of the pollution-prevention game. Many **municipalities** educate people about storm drain systems and water pollution prevention. They can do this in schools, on field trips, and in public spaces (and in fun, coloring activity booklets!). Have you ever noticed signs around a storm drain, like the ones shown here? These signs educate people about the water system and how to keep it clean.



You can help your municipality. Make sure you and your family dispose of household liquid waste properly. Don't litter and safely pick up litter you see. Keep yard waste – like raked leaves, picked weeds, and garden trimmings – away from storm drains so they don't clog them. Make sure your waste and recycling bins have lids that close properly so pieces of trash don't end up on the street.

Design a sign to remind people not to put trash or pollutants into the sewer system.

There may even be volunteer opportunities in your community. Some towns have beach and street cleanup events. Others have Adopt-a-Highway programs. Some municipalities ask for volunteers to apply stencils or decorations to drains to help remind people to care for the environment.

Stormwater Facts

How much have you learned about stormwater so far? Test yourself to show what you know!

1. True or False? The water cycle is a system that recycles water from our sinks and toilets so we can drink it.

False. The water cycle naturally recycles water and moves it around the planet.

2. Fill in the Blank. Four processes that are part of the water cycle are evaporation, _____, _____, and _____.

condensation, precipitation, and runoff.

3. Short Answer. What does MS4 stand for? _____.

Municipal Separate Storm Sewer System.

4. Multiple Choice. Which of the following things would you want to keep out of a sewer system so they don't pollute a nearby water body? Check all that apply.

- | | | | | | | | |
|--------------------------|------------|--------------------------|--------|--------------------------|-----------|--------------------------|------------|
| <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | |
| | Rain Water | | Litter | | Snow Melt | | Wash Water |
| <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | | <input type="checkbox"/> | |
| | Motor Oil | | Paint | | Leaves | | Ice Melt |

Litter, Wash Water, Motor Oil, Paint.

5. Make a rhyme. Some stencils on stormwater drains say "Only rain in the drain!" Can you create a short and catchy slogan to remind people that only stormwater should flow down drains? _____.

Vocabulary

Municipality: A city or town that governs a certain region and population.

Stormwater in My Community

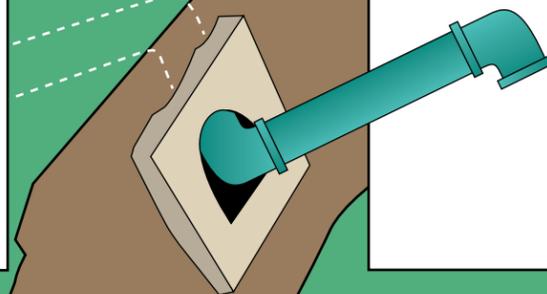
Create a flowchart with illustrations that show what happens to stormwater in your town.

✎ When rain falls in my town, it falls on this type of built environment:

✎ It also falls on these landscapes and natural environments:

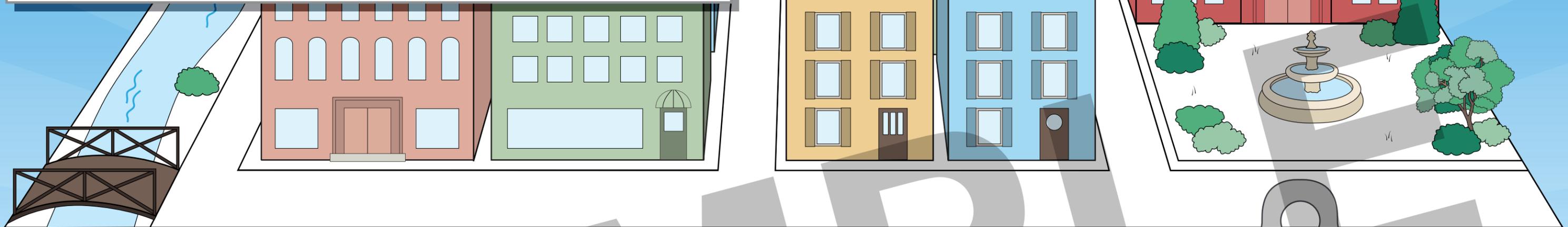
✎ Our streets and drains are next:

✎ Our nearest body of water that the water could drain to is:

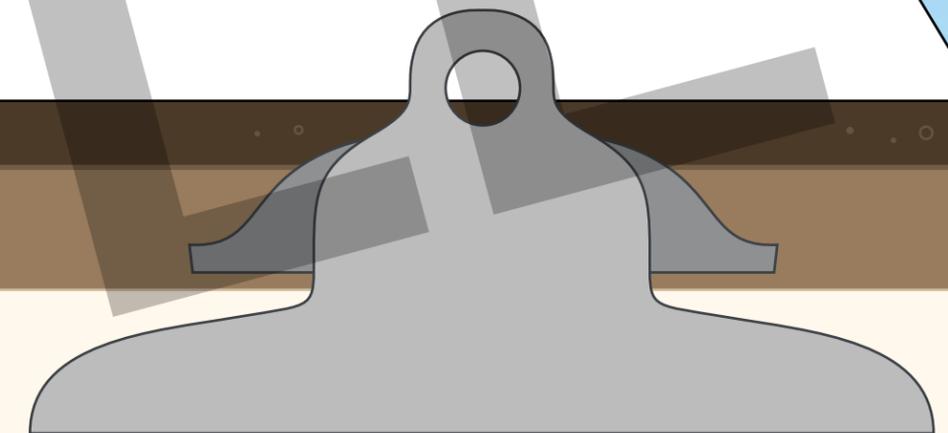


Engineer the Water Works

Imagine you are a municipal engineer. Plans are being drawn for a new community downtown. There will be a park, homes, a school, as well as businesses lining the street. The community is near a small river. The city officials have asked you to develop an MS4 for the new community. They've also asked you to help them understand how the water flows through the city. **Follow your Planning Guidelines to complete the city's blueprint.**



SAMPLE



Planning Guidelines

- Color any impervious surfaces black, grey, or brown.
- Color any permeable surfaces green, light blue, or yellow.
- Add drains and drain covers on streets, sidewalks, and landscapes as needed.
- Create a system of pipes for the MS4 beneath the city. Connect the system of pipes to each other, to the nearby river, and to the drains at the surface. Avoid dead ends and pipes without a route to the river.
- Use dark blue to show the path of stormwater from a rainstorm. Remember to include all the places the rain will fall and paths it will take before it gets into the MS4.
- Present your plan to a partner. Receive feedback and make improvements.

Resources

For more information check out these great sites!

Soak Up the Rain

<https://www.epa.gov/soakuptherain>

Polluted Runoff: Nonpoint Source Pollution

<https://www.epa.gov/nps>

National Pollutant Discharge Elimination System (NPDES)

<https://www.epa.gov/npdes>

USGS Water Science School

<https://water.usgs.gov/edu/runoff.html>

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