# Water

Dedication:

This book is dedicated to the teachers who inspire learning through our connections with water.
*Maria, Sam, and Mary.*

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# Table of Contents

# Water

## What is water?

Water is a unique and special substance. It is responsible for life on this planet! All forms of life depend on water in some way. There are organisms that can live without sunlight, but there are no forms of life yet discovered that can live without water.

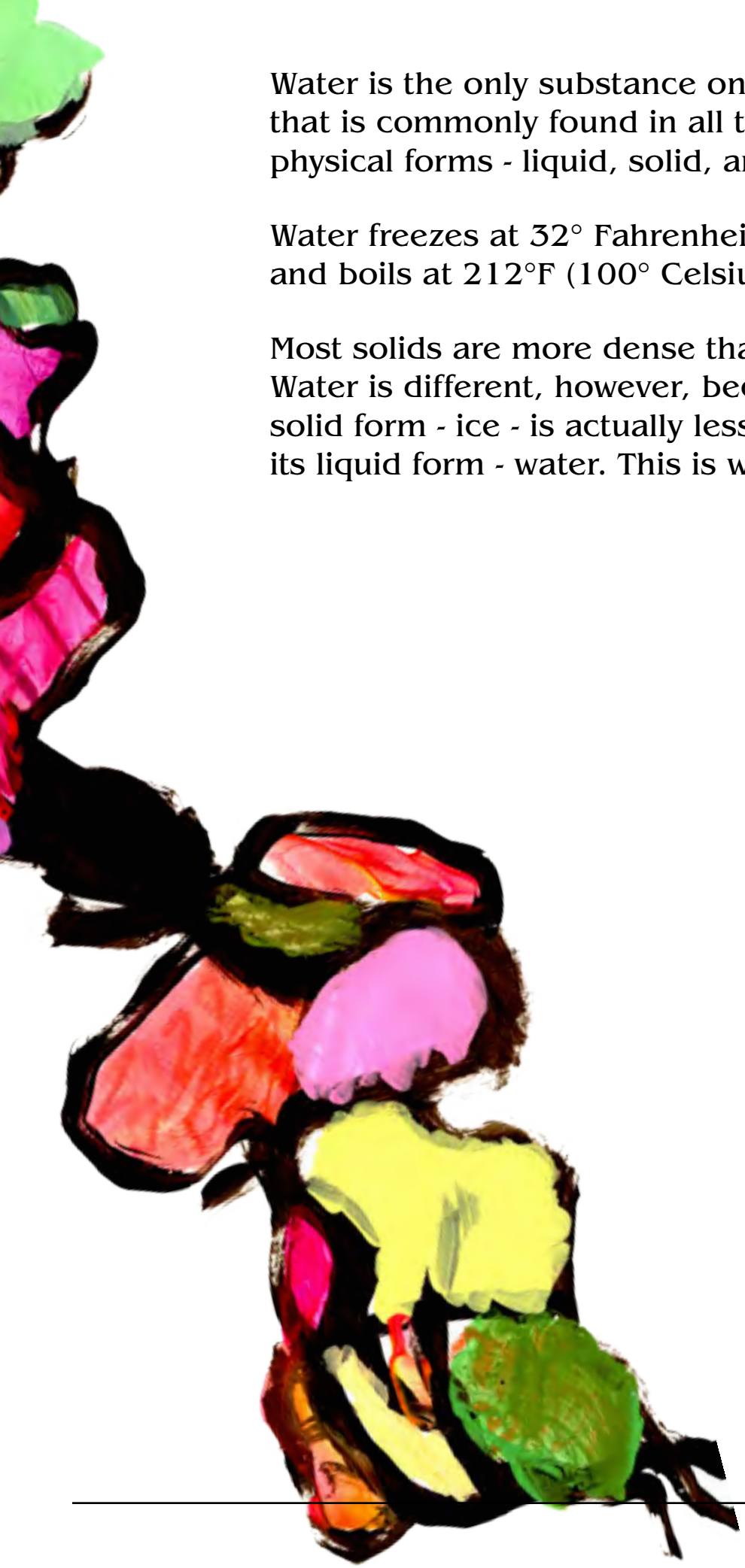
The surface of the Earth is approximately 70% water.

Our bodies are also approximately 70% water - just like the surface of the Earth!

Water is the only substance on Earth that is commonly found in all three physical forms - liquid, solid, and gas.

Water freezes at 32° Fahrenheit (0° Celsius) and boils at 212°F (100° Celsius).

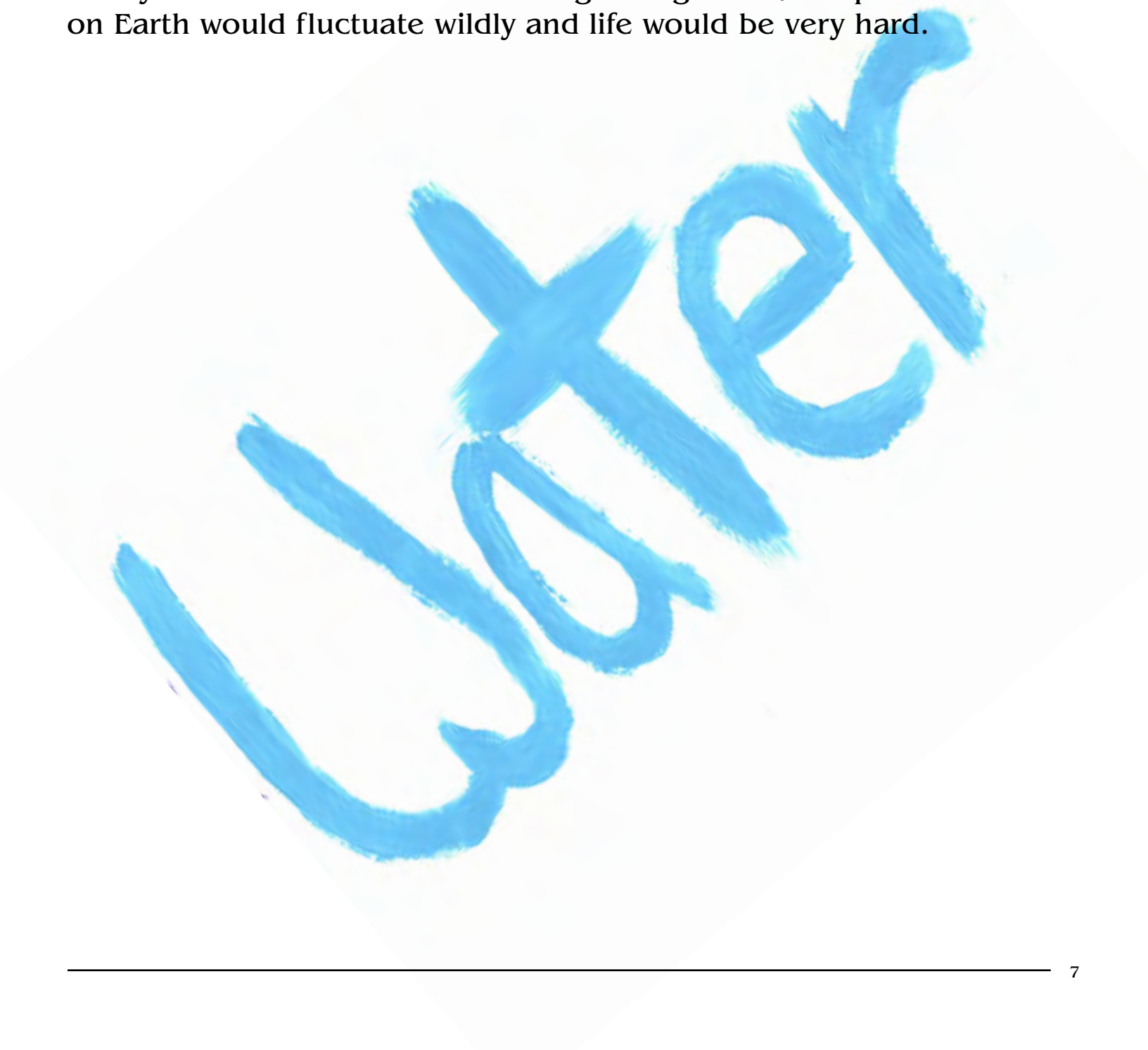
Most solids are more dense than liquids. Water is different, however, because its solid form - ice - is actually less dense than its liquid form - water. This is why ice floats.



*Artist rendition of the Willamette River channel network*

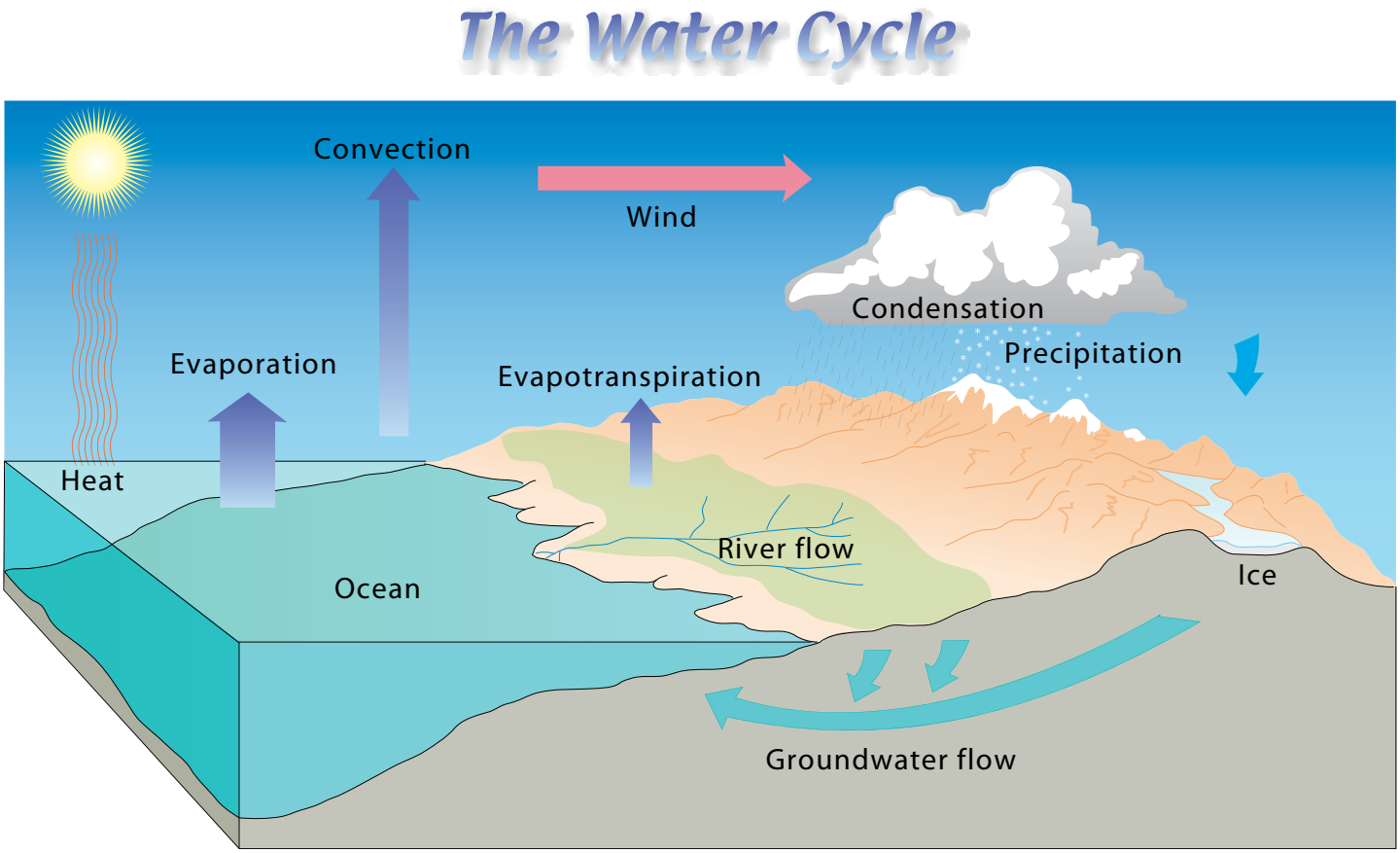
Water has a very high surface tension, which is why it tends to form drops rather than spread out in a thin film. This surface tension allows water to move through the roots of plants and through the tiny blood vessels in our bodies through a process called capillary action.

It takes a lot of energy to heat water up and to cool water down. This is called having a high specific heat index. This also means that the Earth's oceans help regulate temperature on the planet by absorbing heat slowly in the summer and releasing heat slowly in the winter. Without this regulating effect, temperatures on Earth would fluctuate wildly and life would be very hard.



# The water cycle

Water is constantly moving from one form to another, from one location to another. All the water on Earth that exists right now has existed from the beginning of time. It is constantly being recycled from one form to another.

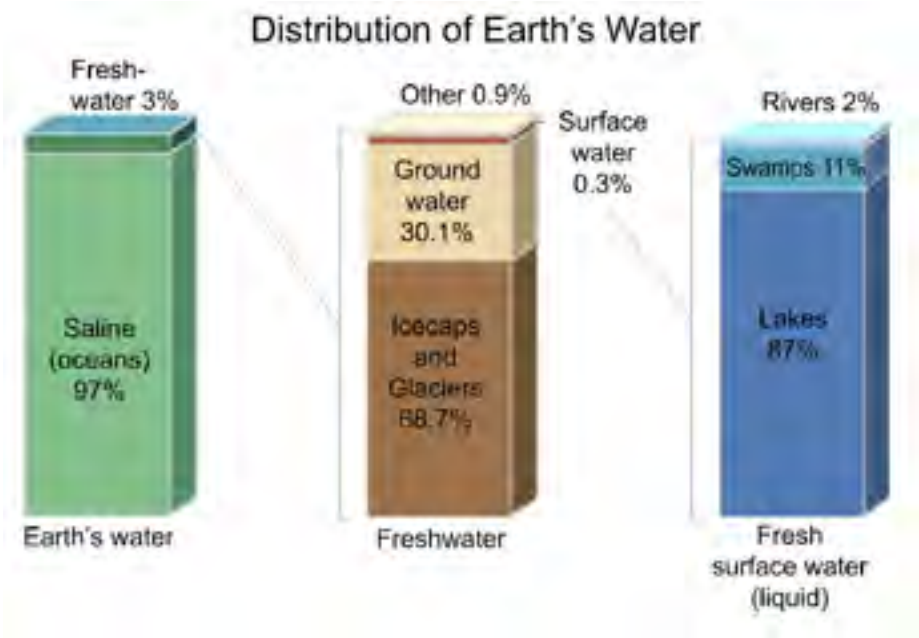



*By: Dave Reinert*

# What kinds of water
## (rivers, lakes, oceans, wetlands, aquifers, etc.)

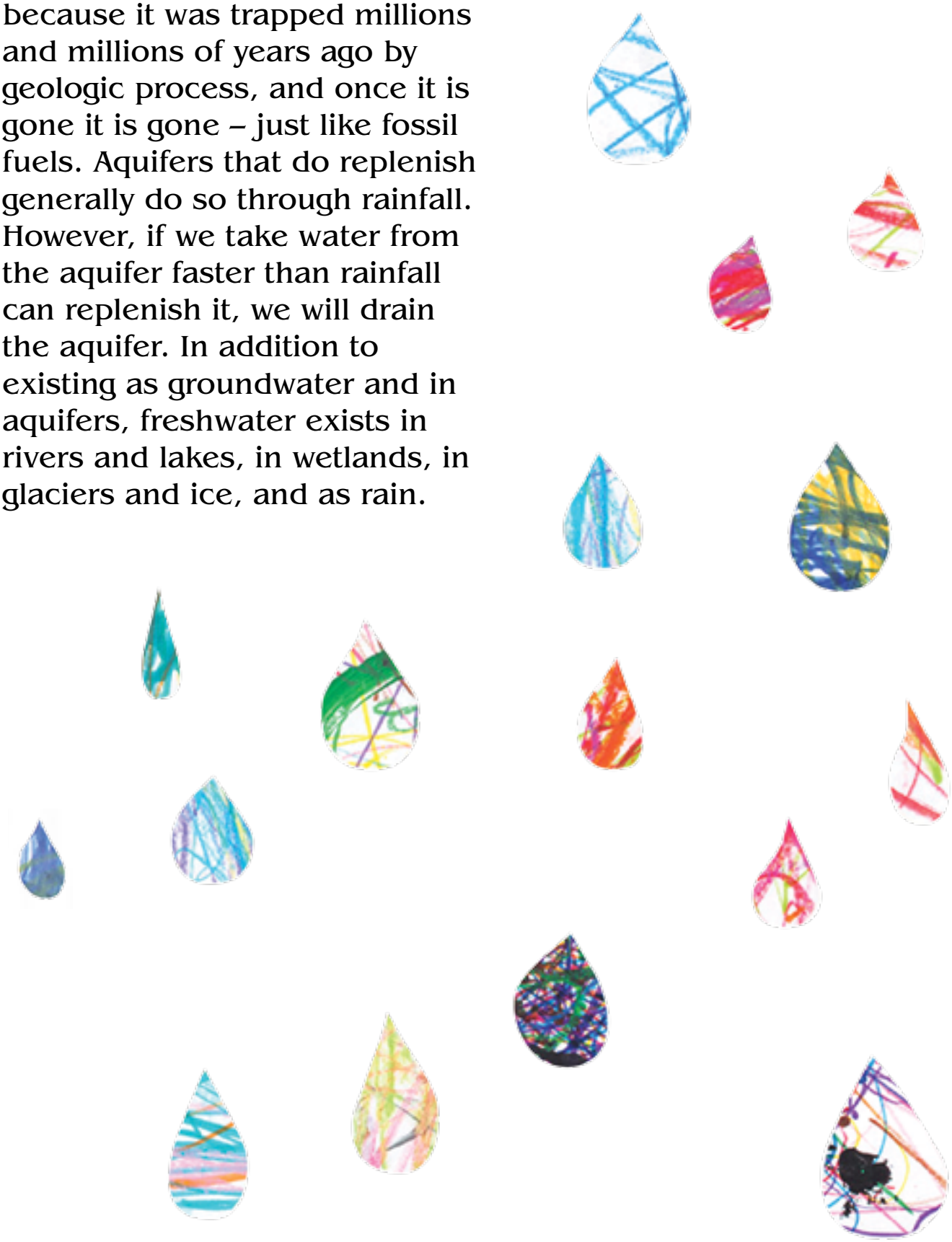
Water exists in many forms, in many different places. Of the Earth's water, about 96.5% is held in the oceans. This water is saline, meaning that it contains dissolved salts. Humans, plants, and other land dwelling organisms cannot live on saline water - they can only live on fresh water. Very little water on Earth exists as fresh water - only about 2.5%. Of this usable fresh water, very little exists in rivers or lakes - most of it exists in glaciers, ice caps, and groundwater. The other 1% is found in various places, like the atmosphere, saline groundwater and lakes, and even our bodies.

Water also exists in many places. Most of the Earth's saline water exists in the oceans. But saline water also exists in some places as groundwater – water that exists in the ground under our feet. Sometimes groundwater is saline, and sometimes it is fresh. Sometimes groundwater exists in slow moving, subsurface rivers – we call these aquifers. Aquifers are often precious sources of water for irrigating fields and growing crops. However, not all of these aquifers replenish themselves, or they replenish very, very slowly.




*Graphic courtesy of USGS*

The water in these aquifers is often called “fossil water” because it was trapped millions and millions of years ago by geologic process, and once it is gone it is gone – just like fossil fuels. Aquifers that do replenish generally do so through rainfall. However, if we take water from the aquifer faster than rainfall can replenish it, we will drain the aquifer. In addition to existing as groundwater and in aquifers, freshwater exists in rivers and lakes, in wetlands, in glaciers and ice, and as rain.



# What we use water for

We need water for nearly everything we do. Water is essential for our daily life, from the water that we drink, to the food we eat, to the clothes on our back. Even turning on a light bulb requires water at some point!  Human beings need to consume approximately 10 cups of water a day simply to stay alive. An adult can survive for weeks without food, but can only survive a few short days without water.

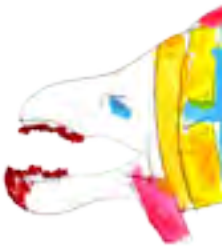
In addition to needing to drink water every day, the food we eat all requires water at some point to grow, whether it is the wheat in our cereal or the beef in our hamburger. Every single thing you eat needs water to become food! Water was also needed to grow the cotton to make your jeans, to process the metal parts in your computer, and even to help generate the electricity to turn on the lights.

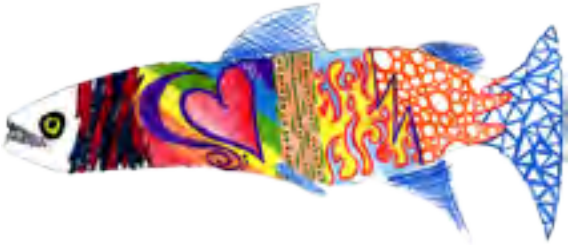
Water is literally everywhere, in everything.

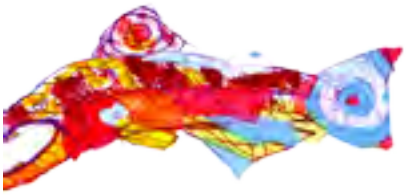
*By: Jennifer Mercedes*

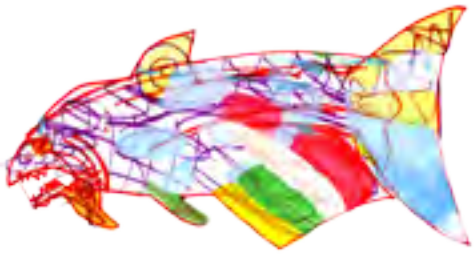
# Aquatic life/The riparian zone

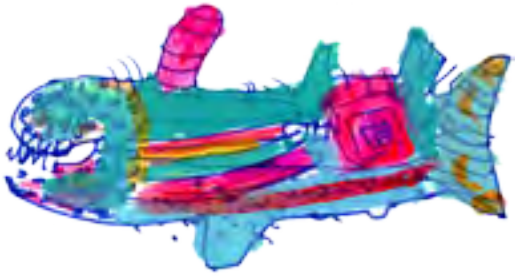
In addition to humans, many plants and animals depend on a healthy supply of water. Approximately 50-80% of life on Earth exists in the oceans. These plants and animals, or "marine organisms" as they are called, depend on oceans that have an abundant supply of nutrients, are free from pollution, and which have a stable temperature – all things which are being threatened by human activities. There are also many plants and animals that live in fresh water, and these are called "aquatic organisms."









Aquatic organisms depend on healthy rivers, streams, and lakes just like marine organisms depend on healthy oceans. However, aquatic organisms also depend on having the right quantity of water at the right time. This can be difficult because land organisms such as humans also need fresh water, and sometimes compete for fresh water with aquatic organisms.


## Salmon Father

"I hope to find her
even when it means death
Life must go on.
Death is part of Living."

*By Linda N. S., Eugene H.S.*

All land organisms, whether they are humans, dogs, cats, sheep, birds, insects, corn, wheat, or anything else that lives on land, need fresh water to survive.


## Salmon Mother

"My life a life that follows home,
my blood my mother's blood
flows in the streams.
If he's not here now,
the blood will stop flowing."

*By Linda N. S., Eugene H.S.*

# The Watershed

## What is a watershed?

A watershed is a geographical area that drains a particular set of rivers, streams, groundwater, and rainfall. Watersheds can be thought of in many different sizes. For example, the Mississippi watershed drains water in 31 states and 2 Canadian provinces, covering a total of 1.2 million square miles. That is quite a big area! But watersheds can also be small. The watershed for a small stream may be only a few square miles. What all watersheds have in common, however, is that they drain to a single source, which can be a lake or reservoir, the mouth of a bay, or another, larger river. Every large watershed is composed of many smaller watersheds, and these smaller watersheds are composed of even smaller ones, right down to a single raindrop. Can you think of what is the biggest watershed of all? (Answer: it's the Earth itself!)

*Artist rendition of the Willamette River channel network*

Why is it important to think about watersheds? Well, for starters, we all live within a watershed. Everything we do affects our watershed, whether it is watering our lawn on a summer day, to taking a shower, to choosing food at the grocery store. In addition, everything we put down the drain – from shampoo to detergent to fertilizer – ends up in the watershed as well.

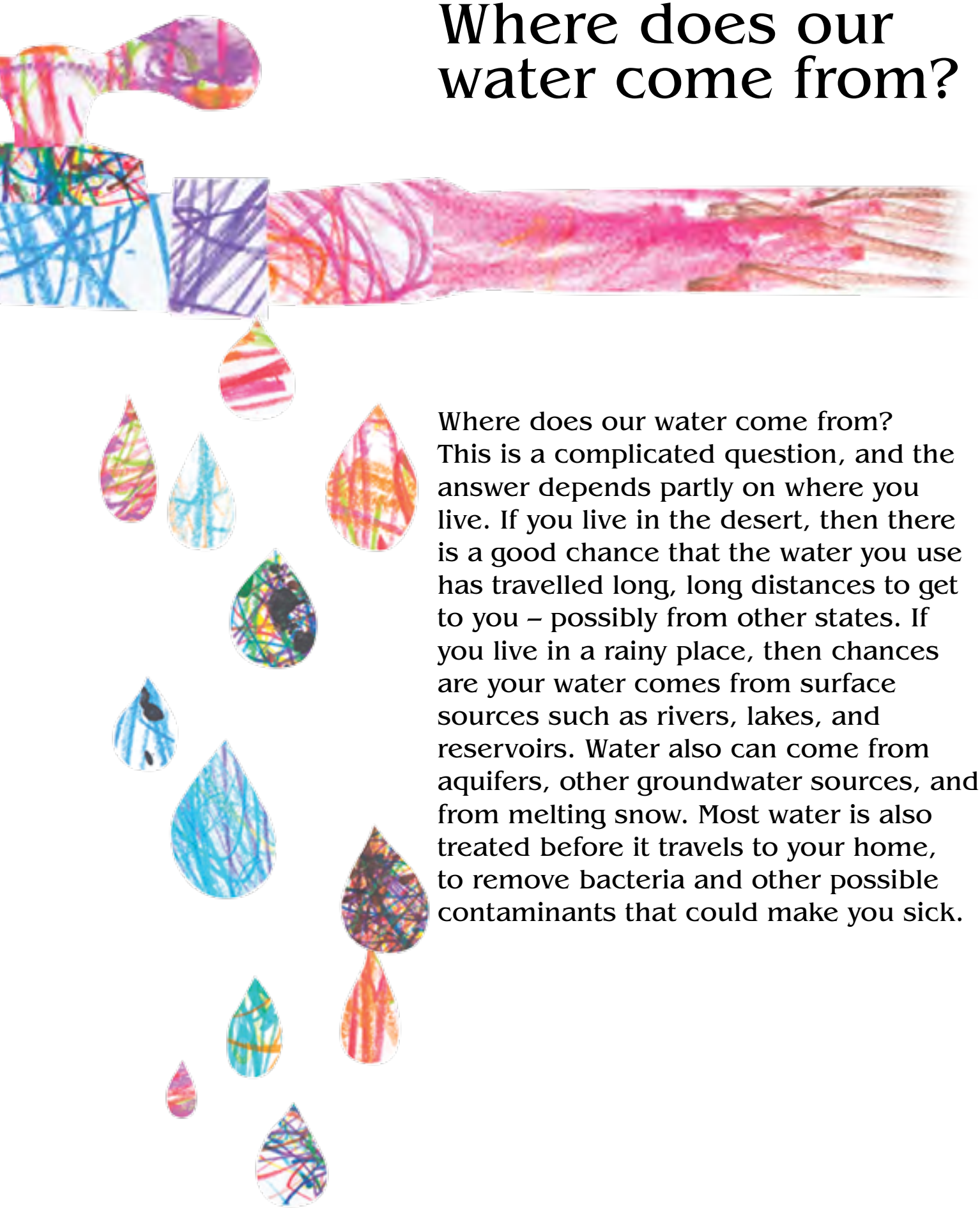

*How rainfall moves into groundwater and streams. Graphic courtesy of USGS.*

# Where does our water go?

By: Jennifer Mercedes

When water goes down the drain, it does not simply disappear. The water that comes into your home is clean and pure, but the water that leaves your home is usually full of contaminants that need to be removed. Most water that leaves your home, called "wastewater" travels to a wastewater processing plant. These facilities treat the water in a series of procedures that makes the water suitable for putting back into the watershed. However, this takes a lot of energy and can be expensive to do. The fewer contaminants we wash down the drain, the less energy we have to spend on cleaning wastewater.

# Where does our water come from?



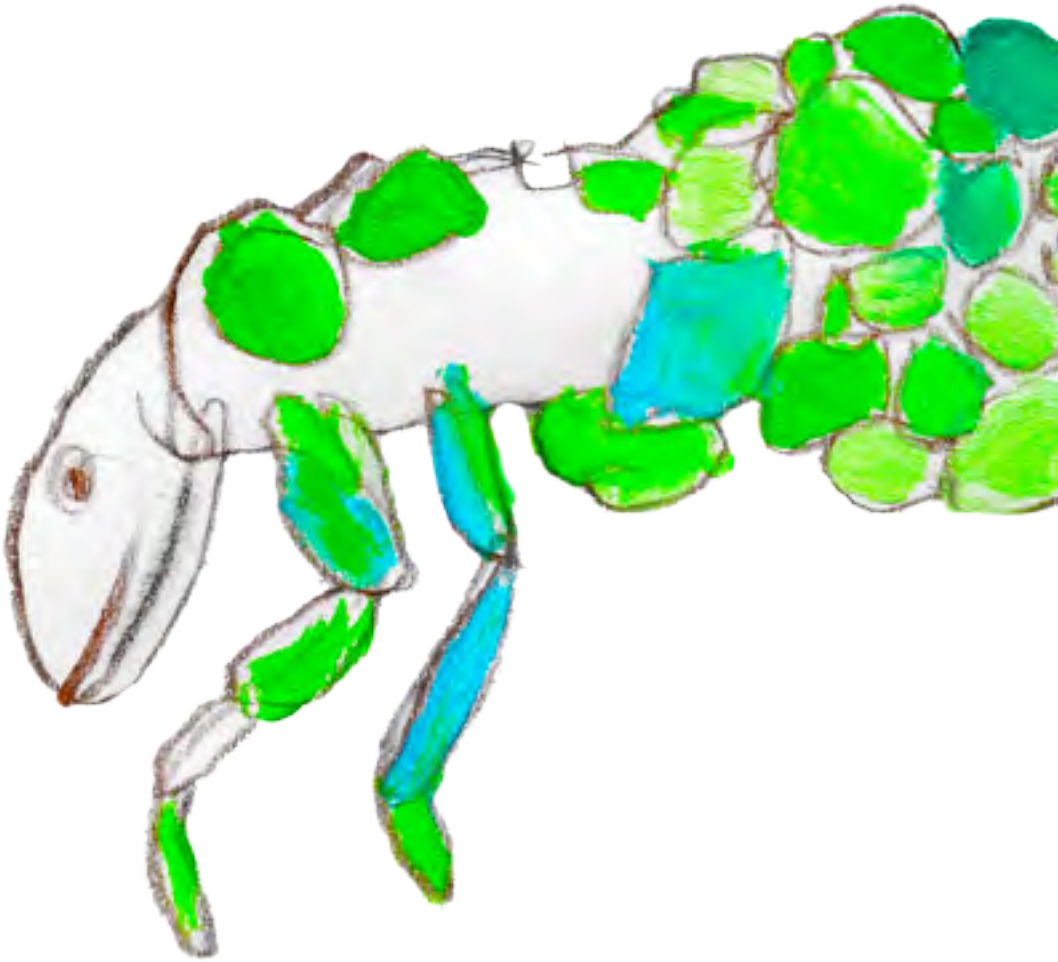
Where does our water come from? This is a complicated question, and the answer depends partly on where you live. If you live in the desert, then there is a good chance that the water you use has travelled long, long distances to get to you – possibly from other states. If you live in a rainy place, then chances are your water comes from surface sources such as rivers, lakes, and reservoirs. Water also can come from aquifers, other groundwater sources, and from melting snow. Most water is also treated before it travels to your home, to remove bacteria and other possible contaminants that could make you sick.

# WATER QUALI

# How clean is our water?

Everyone likes to drink (or swim in) clean water. But sometimes water is polluted.There are a number of other ways that water sources can become polluted. The most common is runoff from farms and agriculture. Fertilizer can be a good thing for growing crops, but it can be a very bad thing when it gets into the water supply. Fertilizer runoff is one of the biggest sources of water pollution, and it can have widespread effects. Currently, fertilizer runoff is causing a large area in the Gulf of Mexico to become deprived of oxygen – this is called a "hypoxic zone." This happens because the fertilizer runoff causes algae to bloom in large quantities, and this algae uses up all the oxygen in the area, making it very hard for other forms of life to exist.

Water pollution can also take the form of water that is too warm, called “thermal pollution.” Many forms of aquatic and marine life need the water they live in to be within a specific temperature range. Heating the water by only a few degrees can be devastating for these life forms, and can cause a chain reaction in which other forms of life are threatened. Thermal pollution can occur when wastewater is not cooled properly, when rivers and streams are exposed to more sunlight because of deforestation, and when sources of cool water such as groundwater and aquifers are depleted.



Pollution can also occur in the form of stormwater. Stormwater is water that occurs during a precipitation event, such as a rainstorm. Stormwater is not necessarily a bad thing, but when it picks up pollution and contaminants along the way, it can be a problem. In addition, because we are building more and more roads, parking lots, and buildings (called "impervious surfaces" because they cannot absorb stormwater), we are creating more surface runoff – which means that stormwater has more and more chances to become polluted. Impervious surfaces can also create more flooding because they prevent stormwater from being absorbed into the ground and channel it instead into already full rivers and streams.

*Caddisfly*

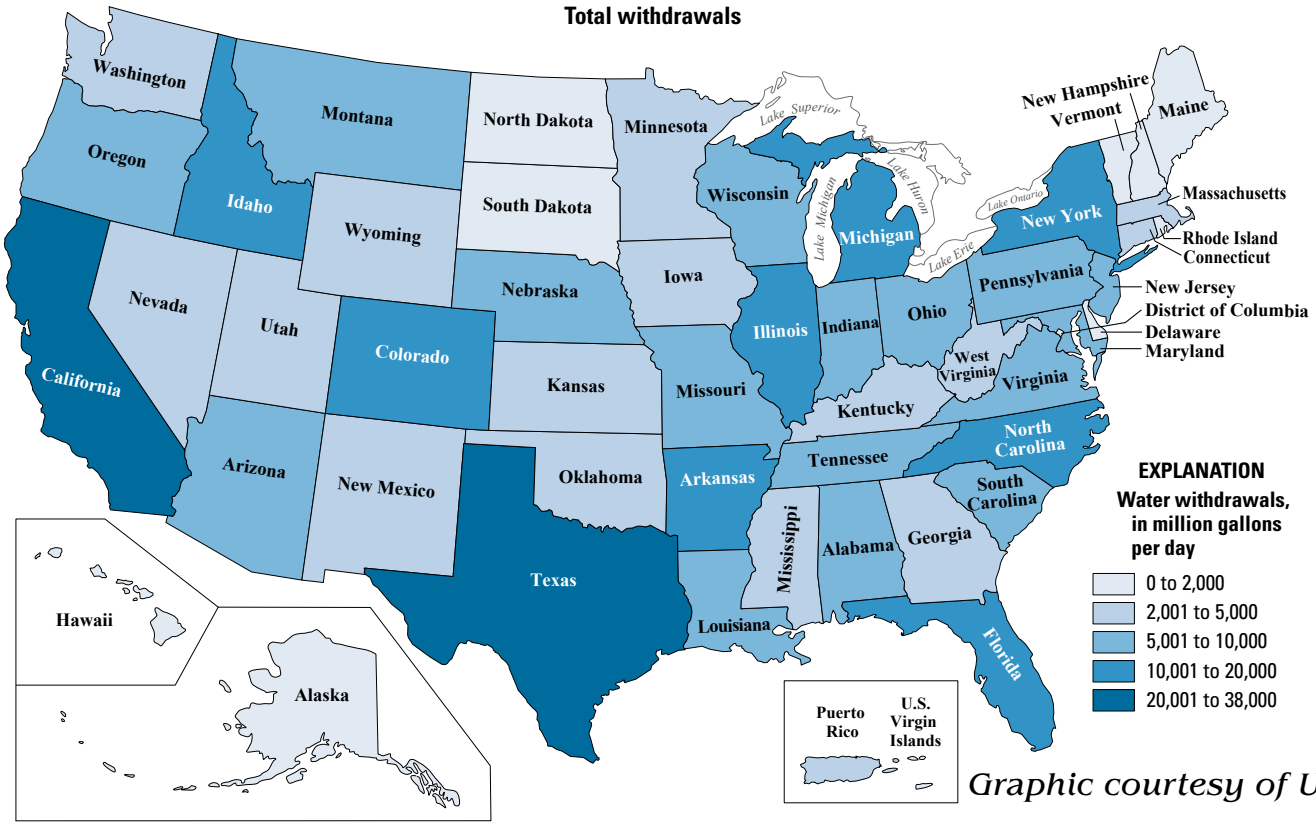
*Caddisflies are among the insect species used as indicators of good water quality. The cases made by caddisflies can be built from the grains of sand or tiy twigs and leaf bits from the botto of the stream.*

# Conserving water

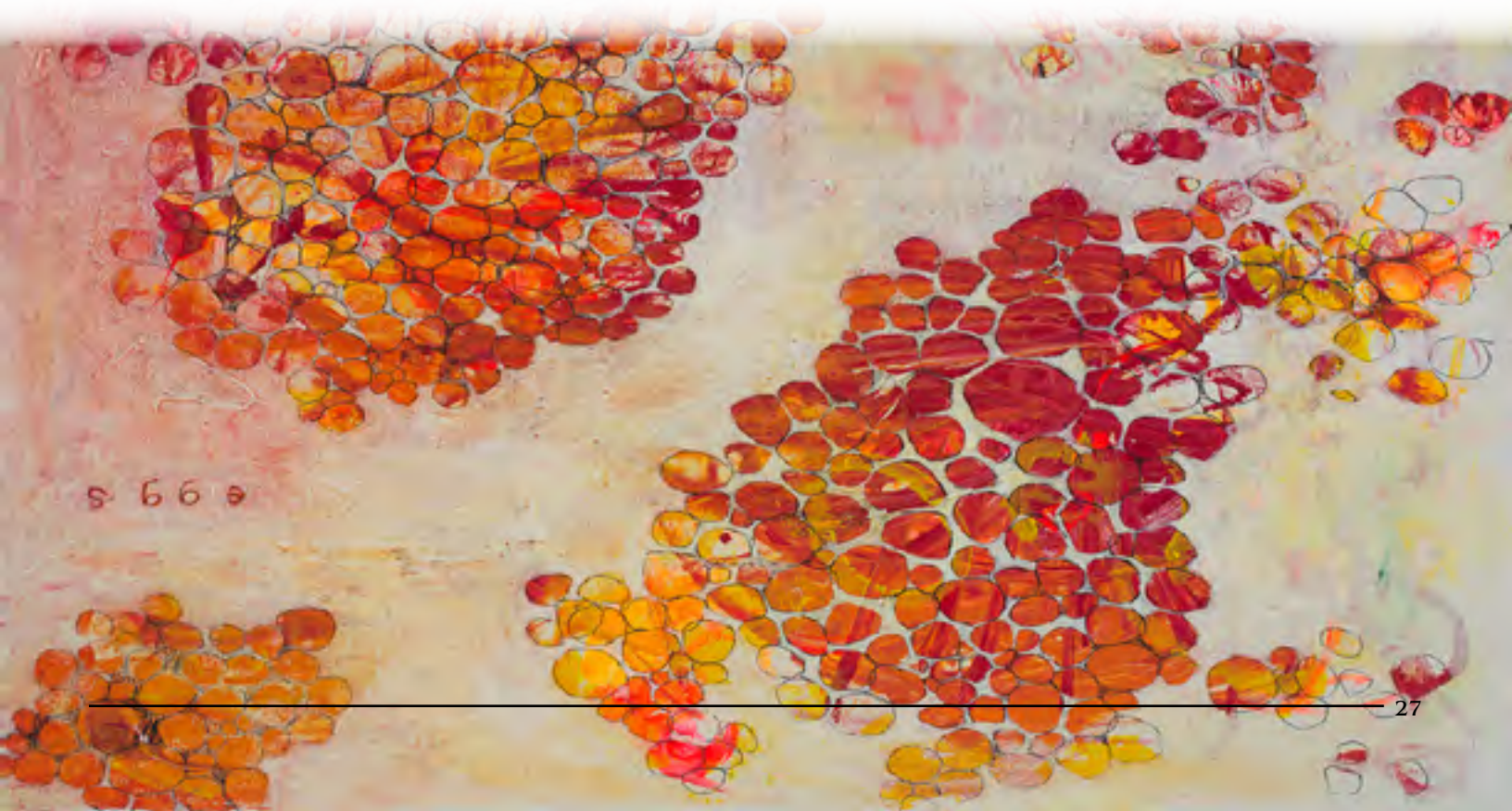
All the water we will ever have is what currently exists in the world. Water is continually being recycled through the water cycle, yet it is possible to use water, especially freshwater, at a faster rate than it is replenished. For this reason, it is important to think about water conservation.

*Artist's concept of salmon eggs in a gravel bed. By Jennifer Mercedes*

Map of water withdrawl in the USA. Find your state on the map. Knowing what you know about water use, what do you think you could do to conserve water in your life?




*Graphic courtesy of USGS*




*Imagery by Daniel E. Coe, courtesy of Oregon Department of Geology and Mineral Industries*

# The Future of Water

## The global watershed

The Earth is one giant watershed, but that does not mean that everyone has the same access to water. Many people do not even have access to clean water for drinking or bathing. Many other people face water shortages, drought, and scarce food supply. For many others, water is very expensive.

It also takes a lot of water to make energy, whether than energy is from oil, hydroelectric dams, solar power, or others – it takes water to make energy.
It also takes energy to make water, or more specifically, to treat and transport water. Water and energy are linked. The more we use of one, the less we have of the other.

# Climate change

Global climate change is the term used to describe a number of changes happening as a result of human activities. While global climate change is also sometimes called global warming, it does not necessarily mean that every place will get warmer. Rather, it means that the overall temperature of the Earth – the average of all the temperatures in every place – is increasing. However, even though the average temperature of the Earth is increasing, global climate change will mean different things depending on where you live. Some places will get more rain and may experience floods and intense storms, while other places may get very little rain and experience long droughts. It is likely

*By: Jennifer Mercedes*

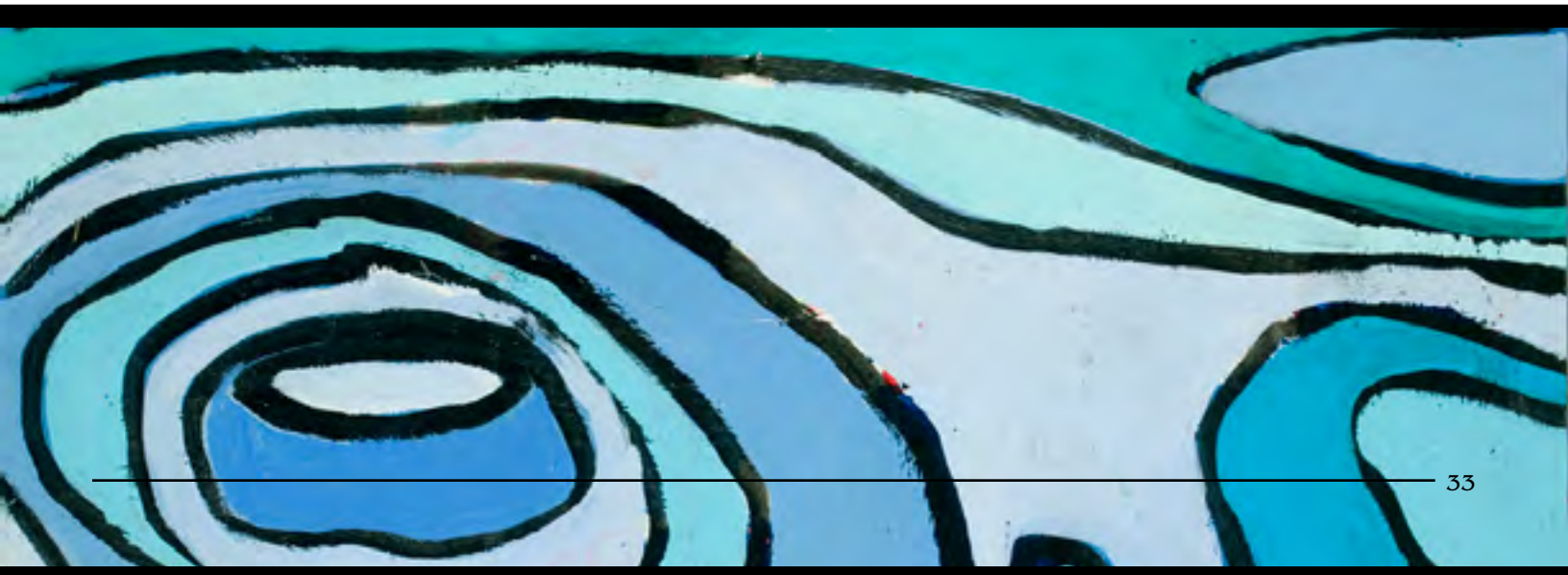
that heat waves will occur more often and be more severe. Weather patterns may shift dramatically. Global climate change may also mean dramatic changes for glaciers and oceans. A warming of just a degree or two will cause many of the world's glaciers to shrink or disappear entirely, and in fact many of these effects can be seen already. Large scale melting of glaciers, ice caps, and ice sheets will cause the Earth's oceans to rise, because much of the water that was stored on land will be released into the sea. Small changes in the average temperature of the Earth – even as small as a degree or two – can have huge impacts on human health, the weather, and the ecosystems we depend on.

Why is this happening? Global climate change is a direct result of human activities. When we burn fossil fuels, such as the gas in our cars or coal for energy, we release carbon dioxide and other gasses into the atmosphere. These gasses are called greenhouse gasses because they create a layer around the Earth that prevents heat from escaping back into space – much like how the glass of a greenhouse traps heat inside. Other human activities, such as the cutting down of forests, also contribute to global climate change because forests can absorb carbon dioxide.

As climate change becomes a bigger problem in the coming years, so will the challenges we will face. Rising sea levels may mean that many people may have to move away from coastal cities; changes in weather and how much freshwater we have available to us may dramatically impact how and where we grow our food; and we may need to develop energy sources that do not further contribute to global climate change. Can you think of some effects that climate change might have on your life?

However, by making choices today to reduce greenhouse gasses and develop cleaner energy sources, as well as to prepare for the changes that are already happening, we may be able to minimize the impact of global climate change. Carbon dioxide and other greenhouse gases can persist in the atmosphere for a century or more; therefore, the choices we make today will have an impact on our children and grandchildren. Getting involved every day at school, at home, and in your community can make a difference! By choosing to walk or ride a bike instead of driving, by purchasing locally grown food, and using less energy around the house, your can do your part to help reduce greenhouse gasses. Can you think of other ways to help?

*By: Jennifer Mercedes*



# Future scenarios

What will the future look like? Scientists often try to picture what the future looks like by creating what they call future scenarios. Future scenarios ideas about what the future might be like based on the choices we make today. So, for example, if we decided today to cut down all the trees in the world, what would the world be like in the future? A less dramatic example might be, if we decided to cut down all the trees along the banks of a river, what would happen to the river?

Scientists study future scenarios because it helps us learn about how our choices are connected to each other. In the example of cutting down trees along a river, this might mean that the river receives less shade and is therefore warmer, which would mean that fish and other life forms that need cold water to live would die, which would mean that the whole food chain of the river would be dramatically changed. Can you think of any other ways that the decision to cut down trees along a river might affect the future?

This is just one future scenario.
Some others to think about are:

- What would the future look like if we kept doing everything as we are doing it now?
- What would the future look like if we used up all the water in our aquifers?
- What would the future look like if we used fossil fuels to make freshwater from salt water?
- What would we do if we all stopped using fossil fuels? What kind of energy would we use?
- How much land should we set aside for forests? For farms? For houses?
- What would the future look like if water was available to everyone for free? If water was expensive?

The future needs scientists that will ask these and other questions. It is your turn now – what are the questions that need to be asked? What decisions do we need to make to have a better future? How will we get there? It's up to you!

# Book Activities

# Activity: Make the Water Cycle

Materials:

- A large metal or plastic bowl
- A sheet of clear plastic wrap
- A dry ceramic mug (like a coffee mug)
- A long piece of string or large rubber band
- Water

Instructions:

Fill water into the bowl until it is about ¼ full. Put the bowl in a sunny place outside. Place the mug in the center of the bowl, being careful to keep the inside of the mug dry. Cover the top of the bowl tightly with the plastic wrap. Tie the string around the bowl to hold the plastic wrap in place. Over time, observe what happens. Eventually a mist will develop on the plastic wrap, which will form drops that will "rain" into the mug.

Draw a picture of the set-up and label the components.

Prediction: What do you think will happen?

Outcome: What did happen?

Explanation:

The heat from the sun evaporated the water in the bowl, which became trapped by the plastic wrap. Eventually, the water vapor condensed into droplets that became heavy and fell back into the bowl. This is a miniature version of the water cycle, representing the processes of evaporation, condensation, and rain.

Reflection: Why is the water cycle important?

# Activity: Use Capillary Action to Make Water Move

Materials:

- A glass of water
- An empty glass
- Paper towels

Instructions:

Place the glass full of water next to the empty glass. Twist a couple of paper towels together until it forms a rope long enough to reach to the bottom of both glasses. Place one end of the paper towel rope in the empty glass, and place the other end in the glass of water. Observe what happens. Be patient, it will take some time!

Draw a picture of the set-up and label the components.

Prediction: What do you think will happen?

Outcome: What did happen?

Explanation:

Water has some unique properties that allow water molecules to “stick” together. This means that water can travel through substances such as a paper towel, the stem of a plant, or the tiny blood vessels in your body through a process called capillary action.

Reflection: Can you think of any other instances where you have observed capillary action at work, without realizing it?

# Activity: Make a Rain Gauge

Materials:

- A plastic (soft drink) bottle (12 or 16 oz)
- Sharpie or other permanent marker
- A ruler
- Duct tape

Instructions:

Cut off the top of the plastic bottle, about 2 inches from the very top. This should create an even cylinder, with a wide opening at the top. Use a ruler and the sharpie to make a scale on the bottle, starting from the bottom. Make sure to mark off at least every ¼ inch. Put your rain gauge outside where it can collect water when it starts raining. Using duct tape, secure it to a surface so that it does not blow away. After a rainstorm, check your rain gauge to see how much it has rained.

Draw a picture of the set-up and label the components.

Prediction: How much rain do you think will fall?

Outcome: What was the actual rainfall amount?

Explanation:

As rain falls, it collects in the rain gauge, and you can measure rainfall by keeping track of the gauge over time. Try measuring the gauge before and after a storm, and comparing the rainfall levels. If you want, you can keep track of the gauge over time and compare it to other weather events, such as temperature and wind speed.

Reflection: Was the level in the gauge more or less than what you had predicted? What does this tell you about rainfall in your region?

# Activity: Build a River

Materials:

- Sand - 8 cups
- Gravel - 4 - 1/2 cups
- 1 gallon of water
- Dishpan
- Something to elevate the dishpan, such as bricks or books

Instructions:

Mix the sand and gravel together in the dishpan, and spread them level. Slightly elevate one end of the dishpan. Fill the pitcher or watering can with water, and slowly pour the water onto the elevated end of the dishpan. Observe as the water runs through the gravel and sand.

Draw a picture of the set-up and label the components.

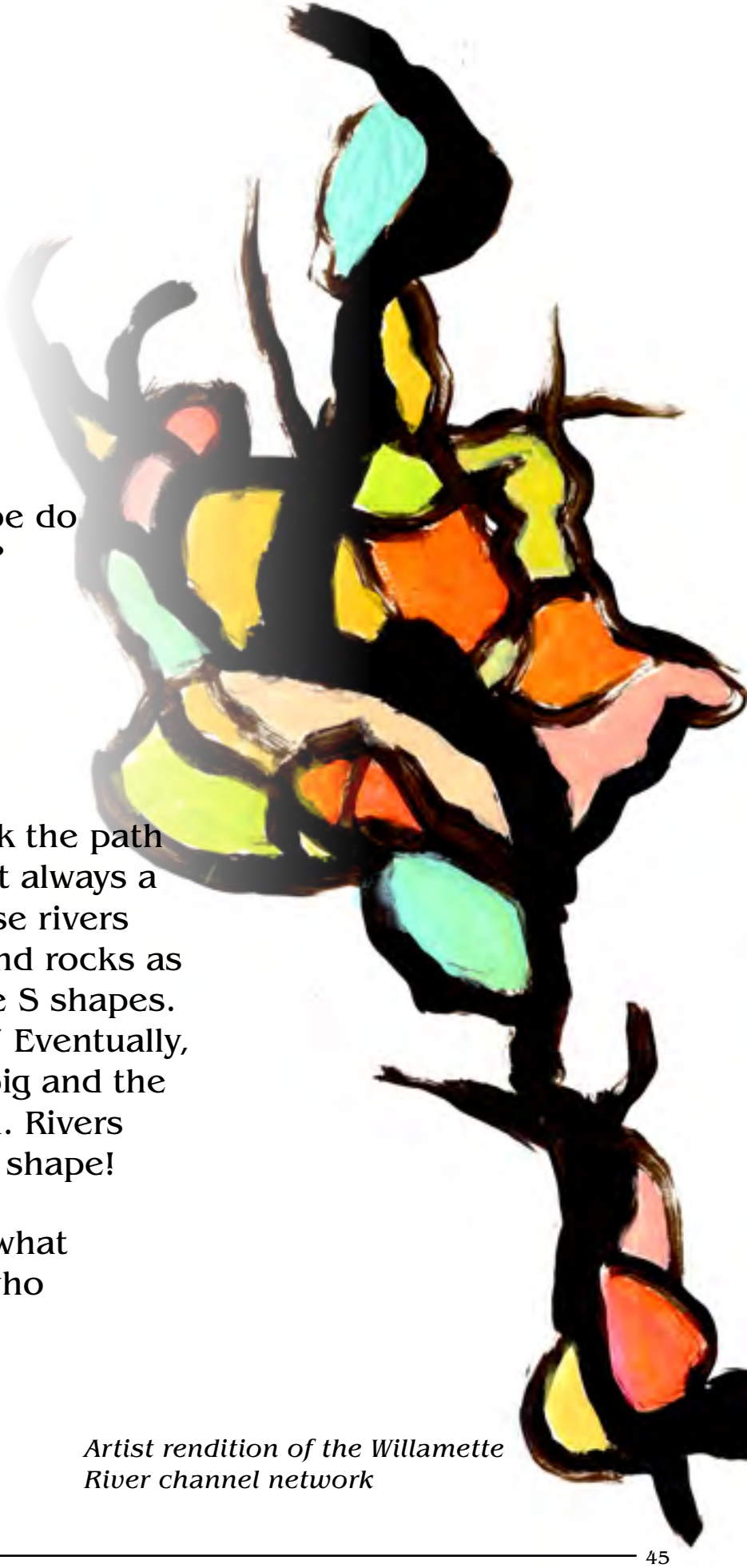
Prediction: What kind of shape do you think the river will make?

Outcome: What shape did the river make?

Explanation:

Flowing water will always seek the path of least resistance. This is not always a straight line, however. Because rivers encounter friction with soil and rocks as they flow, they actually create S shapes. These are called "meanders." Eventually, a meander will become too big and the river will cut itself a new path. Rivers are constantly changing their shape!

Reflection: Can you think of what this might mean for people who live on the banks of rivers?



*Artist rendition of the Willamette River channel network*

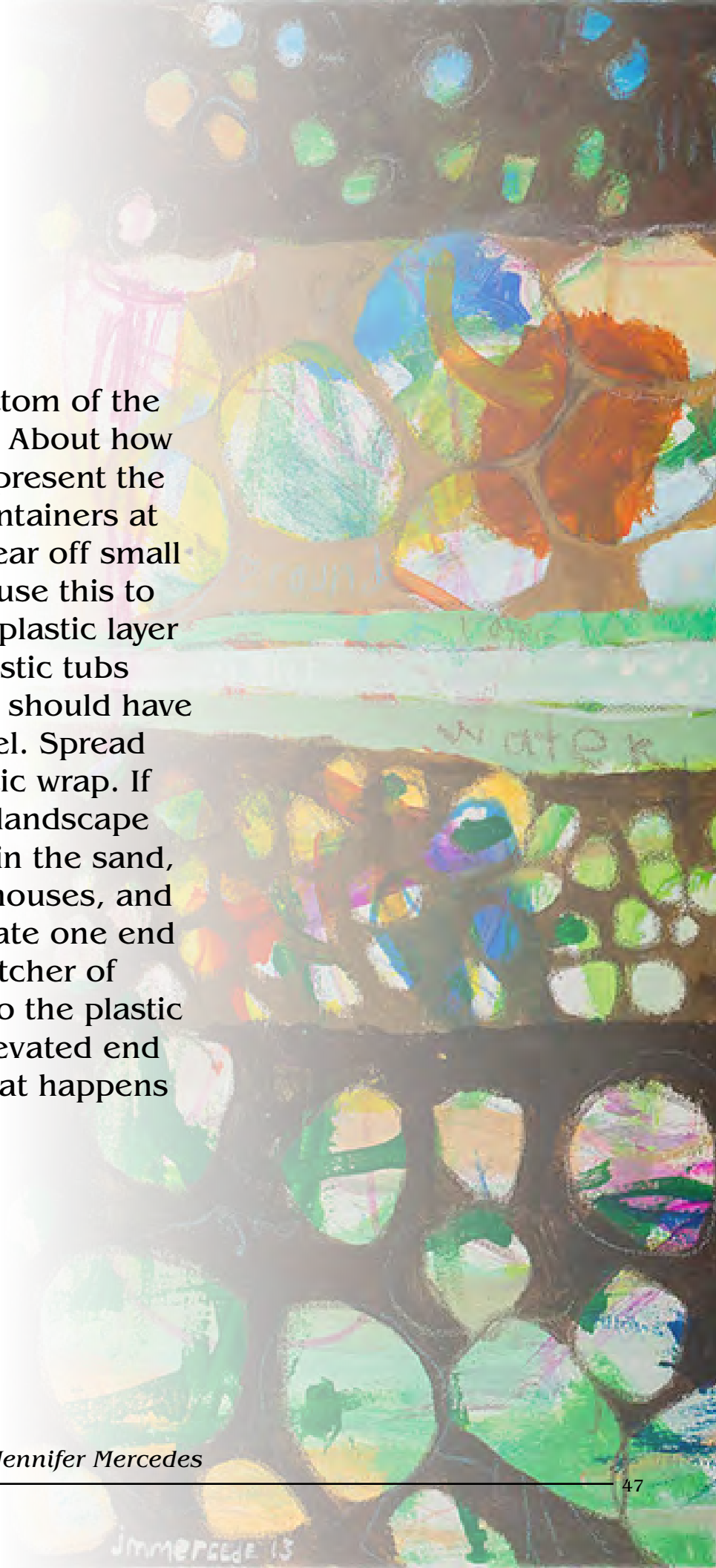
# Activity: Build an Aquifer

Materials:

- 2 small plastic containers (yogurt or butter tub) with holes punched in the bottom
- Dishpan
- Gravel how much?
- Plastic wrap
- Sand
- A pitcher of water
- Something to elevate the dishpan, such as books or bricks

Instructions:

Spread the gravel at the bottom of the dishpan, smoothing it level. About how many cm deep? This will represent the aquifer. Place the plastic containers at opposite ends of the tub. Tear off small sheets of plastic wrap, and use this to cover the gravel, creating a plastic layer above it, but leaving the plastic tubs uncovered. The plastic tubs should have direct contact with the gravel. Spread the sand on top of the plastic wrap. If you want, you can create a landscape by making hills and valleys in the sand, or by placing plastic trees, houses, and people on top. Slightly elevate one end of the dishpan. Using the pitcher of water, slowly pour water into the plastic tub that is located at the elevated end of the dishpan. Observe what happens




*Artist's concept of an aquifer. By: Jennifer Mercedes*

Draw a picture of the set-up and label the components.

Prediction: How long do you think it will take for the water to be absorbed into the aquifer? How much water do you think it will take? How long do you think it will take?

Outcome: What happened?

Explanation:

Groundwater is different from aquifers. Groundwater is simply the water that exists in the ground all around us. There can be a lot of it, or not very much, depending on the climate and soils where you live. Aquifers are underground layers of water that exist in water-permeable rock, sand, gravel, or silt, from which groundwater can be extracted. Some aquifers are unconfined, meaning water seeps into them from the ground surface directly above. Other aquifers are confined, meaning an impermeable layer exists that prevents water from seeping down from the surface.

Reflection: What kind of aquifer is the one you built? If you were to replace the lower tub with a pump that pumped the water out at a fast rate, what would happen to the aquifer?

*By: Jennifer Mercedes*

# Activity: Create a Water Filter

Materials:

- 2-liter soda bottle
- A variety of materials to use in the filter, such as paper towels, gravel, sand, cotton balls (be creative!)
- Chocolate syrup
- Cooking oil
- 2 Tbs of salt
- Tiny pieces of Styrofoam (can be torn from a Styrofoam cup)
- A pitcher of water

Instructions:

Cut the 2-liter soda bottle in half. Remove the cap, and place the top half of the soda bottle inverted in the bottom half, so that it resembles a funnel. The top half will hold your water filter, while the bottom half will hold the filtered water. Create a water filter by layering the filter materials in the top half of the filter. Put some thought into the types of materials you choose, what you think they will remove from the water, and the order in which you place them in the filter. Make dirty water by adding cooking oil, salt, chocolate syrup, and Styrofoam to the pitcher of water.
Slowly pour the dirty water into the funnel. Observe what the filtered water looks like. Take apart your filter materials, and observe what each one did or did not remove from the water.

Draw a picture of the set-up and label the components.

Prediction: What kind of filter materials do you think will work best?

Outcome: What kind of filter materials did work the best?

Explanation: The water that you and I drink, that we shower in, or that we flush down our toilets has actually gone through an extensive series of treatments to make it safe. Some things are easy to remove from water, such as large particles. Other things, like dissolved substances, are much harder to remove. Everything that goes down the drain, or washes down a sewer, or that falls from the sky as precipitation eventually ends up in our waterways.

Reflection: Were you successful in filtering your water? Was your filtered water something you would want to drink? Has this made you think differently about what you put down the drain?