WATER TIMES

Published by the Metropolitan Water District

A 6th Grade Educational Publication

EXTRA! EXTRA! READ ALL ABOUT IT!

Scientist Claims that Water Is the Most Important Thing on Earth

Other Experts Agree

By Special Correspondent H. Tuoh

In a shocking revelation, world famous scientist Doctor Wadder Plannet declared today that water is the most important substance on earth, and everyone needs to work together to protect it. People on every continent and in every walk of life stopped in their tracks when they heard this stunning announcement.

The initial response was one of ridicule.

"That's silly!" said Weet Feeldz, a farmer in northern Europe. "Growing my crops to support my family is the most important thing on earth."

"No way," said Deepintha Woods, an Indian lumber merchant. "Wood for making homes and fires is the most important thing."

"That's ridiculous," said X. Hersizer, a fitness expert in Los Angeles. "Staying fit and healthy to live a long life is most important."

"Oh sure, water is important," said Nomar Boms, a peace activist who claims the whole world as his home, "but nothing is more important than world peace."

Doctor Plannet's words have now become clear to these critics, and each one is starting to agree. Without adequate supplies of water, crops and trees will not grow, our bodies cannot stay healthy, and without enough water to keep everyone healthy and comfortable, world peace is unlikely.

People everywhere are starting to become more aware of water.

Walter Vaper, a famous climatologist, explained that water keeps our planet at a livable temperature.

Walter Siikle, the prize-winning earth scientist, commented that evaporation and precipitation keep clean water moving around the globe.

Manuu Fackshure, the billionaire industrialist, noted that water was important to every item her companies produced.

Phar Myr, the renowned agriculturalist, observed that since crops cannot grow without water, we cannot live without it.

Dr. Plannet's close friend and collaborator, Walter Shedd, elaborated on the initial statement saying, "Water keeps us fed, housed, comfortable, and healthy, so we have to be careful to protect our water supplies. In some parts of the world, pollution threatens clean water. In others, water scarcity threatens people's health and prosperity. In other places, people are using water carelessly and threatening future generations. Every human being on earth," he concluded, "must take personal responsibility to care for and protect our precious water supplies."

"Water is the most important substance on earth, and everyone needs to work together to protect it."

what's inside?

Letter to the Editor

Dear Water Times:

I am tired of all this talk about water's importance. Any fool knows that water is infinitely renewable, so we never have to worry about running out of it. Next, you'll probably start telling us that we are running out of air. I think you people are just trying to sell newspapers, and you will stop at nothing to do it.

Sincerely,
Krabb E. Nut

You can write to us at:

Editor, The Water Times
Metropolitan Water District of Southern California
Education Programs
P.O. Box 90054-0153
Los Angeles, CA 90054

ASK HYDRO

Dear Hydro,
I have a question that just keeps nagging at me. If water exists freely in nature, why do we have to pay for it? Shouldn't it be free?
Signed,
Schourt Cited

Dear Schourt Cited,
You are right. Water does exist freely in nature. Delivering healthy clean water to homes is expensive, though. First, we must capture the water from nature. For ground water, wells must be bored and maintained. For surface water, we need reservoirs, aqueducts and pipelines. Then we must treat the water to be sure it is clean and healthful. Finally, we need pipes to deliver it. Everyone should pay a fair share of these costs, so we meter everyone's water use, and metering adds yet another expense. As you can see, the water itself is free, but getting clean water to you costs money.

Yours truly,
Hydro

Playing a Game Saves Mayan Youth from Being Turned into . . . a Frog !

Chaak, the Mayan Rain god

Photo courtesy of Kenneth Mirvis

The red sky and blazing face of the sun god appeared. Oh, dread! A terrible drought was coming. The scorching heat would kill the corn, and the people would die.

The carefree boy Pik taunted Chaak, the rain god (pronounced *chock*), saying, "Why don't you just get to work and make it rain?"

Chaak became angry. "No one orders Chaak around!"

Pik begged for forgiveness, but Chaak said he must earn forgiveness. Pik challenged Chaak to a pok-a-tok, an ancient ball game like a combination of soccer and basketball. If Pik won, Chaak would bring rain to the people. If Pik lost, he would become a frog and croak forever.

Luckily, the Sacred Jaguar, plumed bird Queztal, and the Underwater Caves all felt sorry for Pik, and they too wanted to end the drought. With their help, Pik scored the winning goal. Chaak took Pik up to the sky and told him to empty a great gourd filled with water. Pik tipped the gourd gently so he would not flood the world. Rain fell upon the thirsty earth.

From then on, people called Pik the Rain Player. It always thundered when he entered the ball court, and it showered with his victories in the game.

Mayan myth adapted from the book "Rain Player" by David Wisniewski, Clarion Books, 1991.

Air Cleaning Chemical Results in Water Pollution The MTBE Story

By Paul U. Shun

In a bizarre twist, scientists have learned that a chemical used to help automobile engines burn cleaner actually pollutes the water! Can we afford to trade clean air for clean water?

Southern California is known worldwide for its smog, which is caused in part by the exhaust from millions of cars.

To help fight the smog in the late 1970s, refiners started adding a chemical called MTBE (methyl tertiary butyl ether) to gasoline sold in California. It helped engines run cleaner, so it successfully helped to clean the air. At first, it seemed like a pollution and public health success story.

Soon, though, a water chemist in Santa Monica, California named Miriam Cardenas started measuring small amounts of MTBE in the water coming from the city's wells. She quickly realized that the MTBE was leaking from pipelines and storage tanks and moving through the ground to the water.

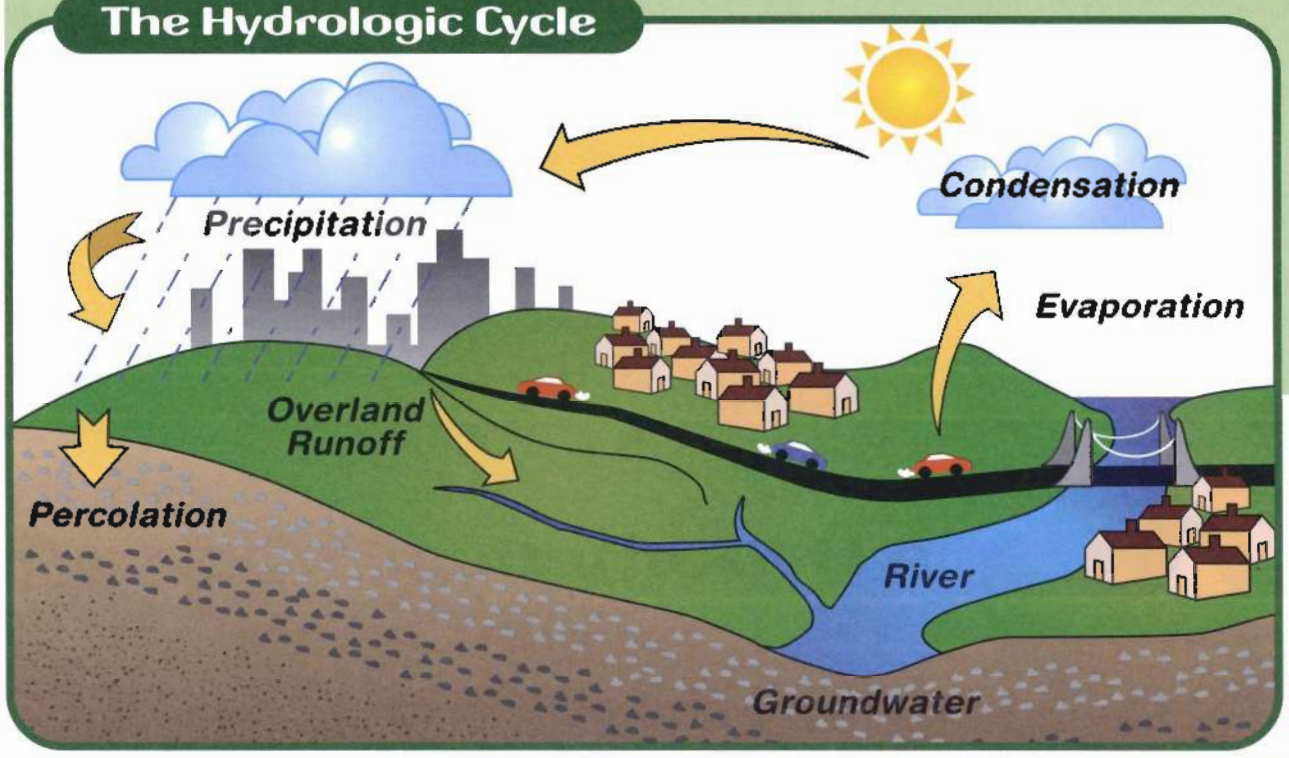
Here was a real problem: The MTBE helped clean the air, but no one knew for sure if it was dangerous to drink (though most people thought it was).

Scientists have been studying MTBE to see if it harms human health. Even without knowing the answers for certain, the California Department of Health Services (DHS) has set a limit for MTBE of no more than 13 parts per billion.

1 Conduct Internet and newspaper research on the ongoing effort of some public health organizations to remove MTBE from gasoline and the effort of other organizations to continue the use of MTBE.

2 Create a political cartoon that expresses your personal feelings about ways society should deal with water pollution.

The Hydrologic Cycle



People in the News

Miriam Cardenas, Chemist of the Week

In 1996, Miriam Cardenas had been a lab chemist for the City of Santa Monica for ten years. One day she read something puzzling in a routine lab report. It said there was MTBE present in some of the city's wells. She had never heard of MTBE, so she looked into the matter.

She learned that MTBE had been added to gasoline supplies in California and realized that it might be coming from leaks in underground pipelines and from beneath gas stations. She feared that the chemical might be harmful to people's health, so she immediately moved to have the city's wells shut down.

She was one of the first people to notice MTBE in groundwater. Because of her commitment to protecting the public water supply, she became a leader in the effort to have MTBE removed from gasoline.

Miriam Cardenas earned her Bachelor's of Science Degree from California State University in Long Beach in chemistry and started working in chemistry labs right away. When she is not in her lab, she plays tennis, hikes, camps, kayaks, travels to exotic places, and runs marathons!

Fountain of Health

By Hy Drate

Have you ever stopped to think about all the different ways you use water to stay healthy? Well, now is the time. Take a moment to list ways water protects your health.

Ways I Use Water to Protect My Health

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Water to drink probably topped your list. Water carries nutrients to your cells and flushes waste away, clearing the way for your body's systems to do their jobs. Without fresh water, your body cannot survive more than a few days.

You also bathe in water to keep your body clean. You wash the dishes, do the laundry, and keep your home clean with water. Toilets flush waste down the drain and help prevent illnesses that are common in some parts of the world.

Then there is the calming effect that happens when you gaze at a stream, lake, or ocean shore. Water even contributes to mental health!

Just as having clean water promotes good health, not having clean water causes problems. Public water suppliers test the water regularly to be sure it is safe. For most of human history, though, people have not known how to find problems in water.

London in the mid-1800s

London was a bustling city in the mid-1800s. This photo does not show all of London, though. The poorer sections were not as open and clean looking. Horses left manure along the roads, and disposing of dead horses was a big problem. Edwin Chadwick, a father of public health in 19th-century London, described the sanitary conditions in a typical poor neighborhood:

In many of these streets there are no privies, or, if there are, they are in so filthy a condition as to be absolutely useless... Many of the yards and courts ... are in a horribly filthy state in consequence of dunghills which are situated therein being allowed to grow to an immense size, and the water which drains there from being permitted to flow over the surface.

"Survey into the Sanitary Condition of the Labouring Classes in Great Britain."

A look back in time...

Dr. Snow Saved London

After Mystery Disease Killed Hundreds

By Carl Erah

In 1854, London was in a panic. Five hundred people had died in a span of ten days from a disease doctors called "cholera" (pronounced *kol-'e-rah*). Its victims had terrible nausea, stomachaches, and diarrhea. They could not hold down water or fluids. No one knew how cholera spread or how to stop it, so no one knew who would get sick next.

WORD ROOTS

Epidemic

In Greek, "epi" means "near" or "at," and "dem" means "people." "Epidemic" means "near the people." Any disease that spreads widely among people is called an epidemic. What epidemics threaten the world today? What other words come from the root "epi" and the root "dem"?

One clue to the spread of cholera seemed important: More people living in poor, crowded sections got sick than people in other parts of the city. Those sections of London also tended to smell worse. As a result, most people thought the disease came from poisonous "vapors" in the air.

Dr. John Snow of London doubted the theory that "vapors" caused this "epidemic." He suspected that the cholera poison traveled in food and water. Almost no one took his theory seriously, so he followed the scientific method, gathering information that might help him prove or disprove his "hypothesis."

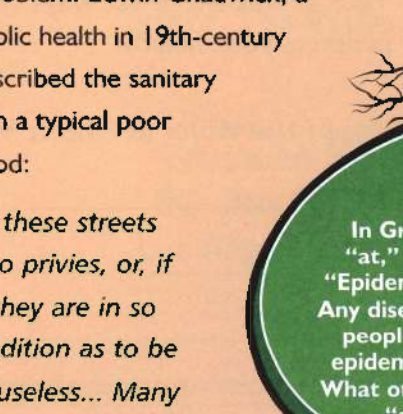
Dr. Snow knew that each neighborhood in London had its own water tank that was filled by private companies hauling water from the Thames River (pronounced *tems*). Some companies filled their tanks with water from upstream, or above, London. Others took water downstream of the city, below the point where London's few sewers emptied untreated waste into the

How do diseases travel?

Some diseases do indeed travel through the air; others travel through water; and others require physical contact. Can you name some diseases that spread in each of these ways?

1. Name some diseases or illnesses.
2. How do people catch these illnesses?
3. How might the microbes that cause these diseases travel, through air, water, or physical contact?

Career Corner



Epidemiologist
(pronounced ep-ə-dee′-me-ologist)

With his detective work on cholera, Dr. Snow created a new medical specialty, epidemiology, the study of how diseases spread. Doctors today continue to use similar methods to discover how other diseases spread. They are called "epidemiologists."

Guesswork

A Hypothetical Exercise

Most people in London believed that cholera spread through air, and people breathed it in. This path of travel is called "inhalation."

Dr. Snow thought that people took whatever was causing the disease into their bodies through their mouths, a path of travel called "ingestion."

Write a hypothesis that would explain how cholera might spread. Begin by studying the map of cholera outbreaks. Does the pattern of the spread of the disease show any connection to the sources of the public's drinking water?

How might Dr. Snow have stated his hypothesis about the cause of the disease?

Be a Water Steward!

Killing microbes keeps people healthy. Keeping microbes and chemicals out of the water in the first place is just as important.

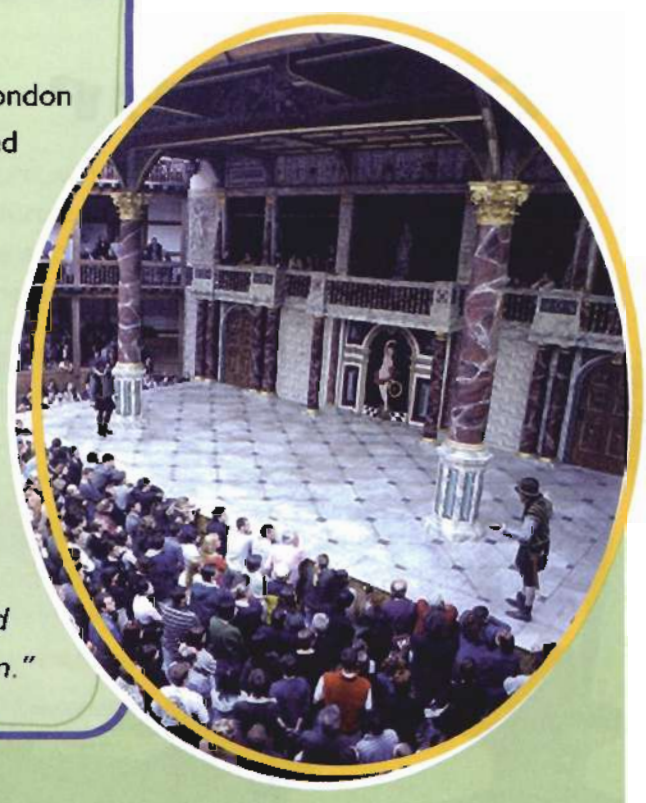
Dust off the director's chair: Work as a class to produce a television commercial that informs others of the importance of keeping water clean and offers ideas for ways people can help.

The Globe Theater and the Groundlings

In the late 16th century, 11,000 people in London died of the Black Plague. The disease seemed to affect people in crowded conditions, so doctors thought the disease traveled through the air.

They closed the theaters, including Shakespeare's Globe Theater, to prevent crowds. Here is a typical notice:

"We think it fit that all manner of concourse and public meetings of the people at plays, bearbaitings, bowlings and other like assemblies for sport be forbidden."

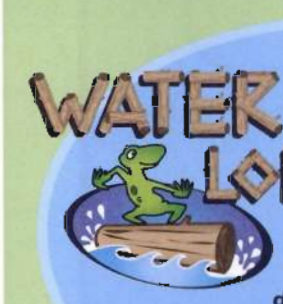


river. The water from downstream of the city had been mixed with the city's sewage, and the water from upstream of the city had not.

Dr. Snow charted the cholera outbreak by marking the locations of reported cholera cases on a map of London. Then he marked the location of the water tanks. *(Your teacher will give you a similar map. Use it to compare the locations of the water tanks to the pattern of the cholera outbreak, and you will see what Dr. Snow saw.)*

Dr. Snow showed city officials his maps and explained how they supported his hypothesis. He convinced them to remove the handle from the pump at the Broad Street tank so people could no longer draw water from this dangerous source. The people grumbled about having to carry their water longer distances, but they also stopped getting sick!

Dr. Snow's maps led to a discovery that caused the whole world to re-think the belief that cholera spreads through the air! He never knew that the "poison" causing the disease was actually bacteria, but he did prove that the disease traveled in water.

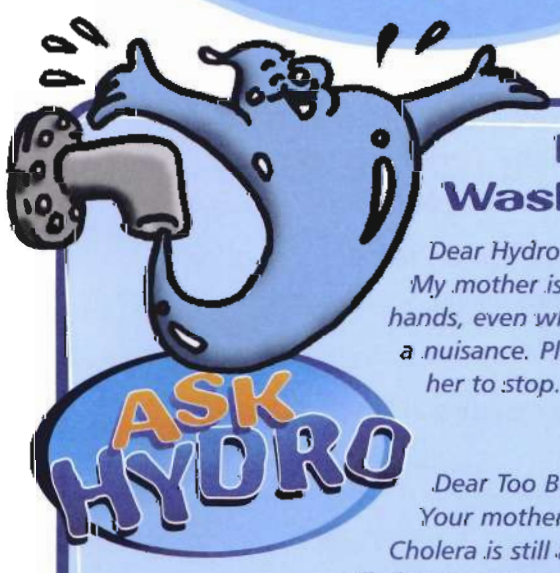


Are we as smart as we think we are?

The people of London drank water from the Thames that had been polluted with raw sewage. What were they thinking!?!

They simply did not know that drinking the water would be unhealthy.

Think of things you do now that people might look back on in 150 years and wonder how you could possibly have been so uninformed.



Mom's Right: Wash Your Hands!

Dear Hydro:
My mother is always nagging me to wash my hands, even when they don't even look dirty. It's a nuisance. Please advise me about how I can get her to stop.

Signed,
Too Busy To Wash

Dear Too Busy,
Your mother is right, and you should take hand washing seriously. Cholera is still around today. We now know that it is caused by a bacterium called Vibrio cholerae. Its happy home is the warm, dark, damp insides of warm-blooded animals (known as intestines). The bacterium travels from one host to another in feces. If that waste gets in the water and people drink it, they can get sick. Today, sewer systems and wastewater treatment help prevent cholera. Many parts of the world do not have these advantages, however, and cholera is still a danger. Even in our culture of plentiful clean water and good hygiene, many other disease-causing microbes hide out in digestive systems and escape when you, your pets, or the animals outside "go to the bathroom." You can't see the microbes if they get on your hands. The very best way to stop the spread of disease is to WASH YOUR HANDS with soap!

Yours truly,
Hydro

The Dose Makes the Poison

By Howmutch S. Toomuch

Paracelsus (pronounced pair-a-SELL-sus) was a German physician born in 1493. In his time, people believed that imbalances in the body caused disease, but Paracelsus thought that outside substances attacked the body! He was one of the very first doctors to use chemical medicines to treat illness.

Paracelsus said a very wise thing: "The dose makes the poison." By that, he meant that any substance can be safe if the dose is small enough, and any substance can be harmful if the dose is too high.

Drinking enough water is essential to good health, but some people have been known to drink so much water that they threw off their body's chemistry and died!

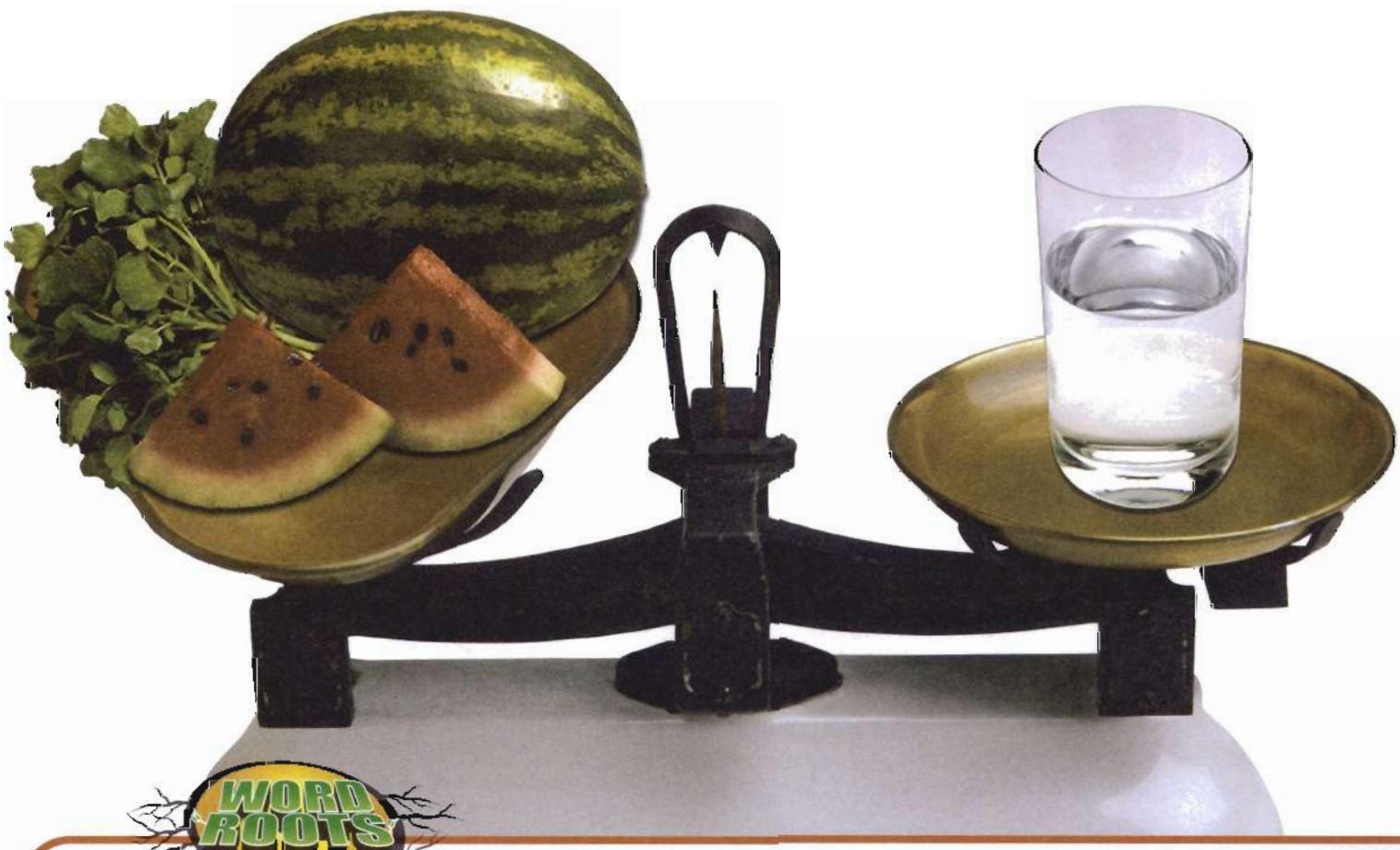
Water scientists measure chemicals in water by their "concentration." Concentration means the amount of a chemical that exists per unit of water. Some chemicals are measured as "parts per thousand," and others are measured by "parts per million," "billion," or even "trillion."

A woman competing in the Boston Marathon in 2002 drank a great deal of water, but she did not replenish her body's salts. The excess water flushed out vital minerals. She became very ill and eventually died from a condition known as "hyponatremia."

Concentrations in Real Life

- There are about 5,000,000,000 people on earth. Get together with four of your friends so five of you are standing together. What is your "concentration" relative to the world's population?
- The Metropolitan Water District provides water to about 18,000,000 people living in Southern California. What is the concentration of your class to the population of the region?
- One drop of water is about one part per million of an average full bathtub.

Worth Its Weight in Water



Watermelon

grows in soil, and it drinks so much water that it becomes heavy with the weight of water. More than one hundred gallons of water go into growing one serving of watermelon, from seed to leafy plant to juicy, delicious slice!

Watercress

is a salad green that grows with its roots in water, like a water lily.

WORD ROOTS

Agriculture

"Agri" means "field" in Latin, and "culture" means "to cultivate" or "nurture," so "agriculture" means "planting and raising a field of crops."

Put on your thinking cap and think about this...

As a class, put on your thinking caps and write down at least five ways that agriculture may have helped civilizations thrive in ancient days.

First Farmers Fine-Tune Focus on Food

By A. Longe Thymageau

Imagine that you are living ten thousand years ago, about 8,000 BCE (before common era). You have no roads, no towns, no stores, and no conveniences of any kind. Your ancestors had lived off the land, always moving to find enough food for the next meal.

You get an urge to settle down in one place. You are sick and tired of this moving, moving, moving. Where would you want to settle? You would want to be someplace with a steady supply of food and water.

That is why most early civilizations began in river valleys. For centuries, floods caused the rivers to overflow their banks, leaving behind rich soil filled with nutrients. These fertile valleys made perfect places for people to grow crops.

The formation of the earliest civilizations marked the shift from hunting and gathering to cultivating crops. This practice of raising food is called *agriculture*, and it marked the dawn of civilizations. Here are some famous examples of early farming civilizations you have probably read about in history:

- Babylonian and Assyrian cultures in the "Fertile Crescent" – Mesopotamia – between the Tigris and Euphrates rivers in present-day Iraq
- The Huang He or Yellow River culture in northern China
- Indus River culture in India
- Nile River culture in Egypt

Hold the Salt: The End of Civilizations

By Rew N. Theland

Ancient Mesopotamia and the Fertile Crescent (Modern-day Iraq)

All agriculture, whether ancient or modern, depends on water and fertile soil. Sometimes, though, nature does not provide enough water. When that happens, *irrigation* allows farmers to grow crops even in dry climates.

The Mesopotamians were among the first farmers to irrigate their lands. Irrigation allowed their mighty civilization to grow and thrive... but strangely enough, it may also have destroyed them!

Irrigation introduces a hidden problem that people are only now beginning to fully understand. People living in early civilizations did not know that soil contains minerals called *salts*. As water moves across the soil on its way to rivers and streams, it dissolves tiny amounts of those salts, and farmers then use that water to irrigate.

As water moves through the water cycle, it evaporates as pure H_2O, leaving behind the impurities – in this case, the salts, which stay in the fields.

Over many centuries, the salts in the soil become concentrated. That process is called *salination*. Most crops are sensitive to salty soil, so when the concentration of salts becomes too great, the land is no longer able to grow healthy crops.

Many historians believe that salination played an important role in the decline of Mesopotamia. They theorize that salts reduced the fertility of the soil, making the crops more vulnerable to drought and weakening the population.

"I constrained the mighty river to flow according to my will and led its water to fertilize lands that before had been barren and without inhabitants."

Queen Semiramis of Assyria, 2000 BCE

WORD ROOTS

Mesopotamia

In Greek, "mesos" means "middle" or "between," and "potamos" means "river." Mesopotamia is Greek for "between the two rivers," and it refers to the lands between the Tigris and Euphrates. "Hippo" in Greek means "horse." What do you think "hippopotamus" means?

Feeling Low on the Pueblo

Salination may have also caused the downfall of some early pueblo civilizations in the American Southwest. The Hohokam and Anasazi peoples, for example, built cities in their dry lands. How were so many people able to live together in such a dry region? Irrigation. They grew corn and other crops, and they traded with people as far away as Mexico. They thrived. Then, suddenly, they disappeared.

Historians are not sure why. Can you think of some possible reasons?

Write your hypothesis: These pueblo civilizations of the American Southwest might have disappeared because

_____

_____

_____

_____

Source: Marc Reisner, *Cadillac Desert*

Making Ocean Water

A Hands-wet Activity

By Sal Innidy

Why can't people irrigate crops with ocean water? It's too salty!

The general saltiness of water from different sources	
Ocean water:	35 parts per thousand
Colorado River water:	.5 parts per thousand
Distilled water:	0 parts per thousand

The concentration of salt in ocean water is 35 parts per thousand. That means if you evaporated the liquid from 1,000 cups of ocean water, you would be left with 35 cups of salt!

If you evaporated all of the liquid from 1,000 cups of water from the Colorado River, how many cups of salt would be left?

Measuring Concentrations

Would you rather work with grams and meters or pounds and feet? After completing this activity, you might be singing the praises of the metric system!

Your job is to create a concentration of saltwater that has the same level of dissolved salt as the ocean, 35 parts per thousand.

You will try to make the concentration twice, once using the metric system and once using the U.S. customary system. You may work in small groups or as a whole class. You might even want to create teams and hold a race to see who can finish first.

You will need distilled water, a container of salt, and measuring instruments, such as graduated cylinders, measuring cups, and measuring spoons.

How much salt and water will you have to combine to make the water as salty as the water in the ocean, 35 parts per thousand?

HINTS:

Of a total volume of 1,000 units, 35 of those units need to be salt, and the rest need to be water.

Metric

1,000 milliliters	=	1 liter

US Customary

3 teaspoons	=	1 tablespoon
16 tablespoons	=	1 cup
2 cups	=	1 pint
2 pints	=	1 quart

WORD ROOTS

Irrigation

The word "irrigation" comes from the Latin word "irrigare," which means "to water."

Salination

In Latin, "sal" means salt, so "salination" refers to the process of adding salt.

WATER LOG

Time Travel

Pretend you are living in an ancient civilization, and you do not know about the water cycle. Describe what you see happening to the water on the fields. Explain your observations without mentioning the word evaporation.

Now pretend you are from the modern day and are transported back to ancient times. Explain to the people the water cycle and how it affects farming. Use whatever technique you prefer for your explanation: writing, pictures, demonstration, or something else.

HELP WANTED:

Environmental Specialist

The California Department of Water Ways is seeking a certified environmental specialist to work with federal, state, and local agencies to protect the environment and wildlife.

Education Requirements:

Bachelor's Degree in Environmental Science, Geography and/or Engineering

Desirable Traits:

Must have a love for nature and the outdoors; a problem solver; attention to details; strong communication skills

Annual Salary: $50,000

The Water Chain

Kaplink Kaplink Kaplink

Water plays many roles in every piece of food you eat. Plants need water to grow. Animals that provide meat and milk need plants to eat and water to live.

Water's role in food does not stop when crops are watered and animals drink. You use water in cooking, and ice keeps food from spoiling. Water is used to manufacture the farm machines that plant, fertilize, irrigate, and harvest crops. It is used in the processes that put food on the grocery shelves. Water in food is part of a long, long chain.

The Cow that Jack Milked

This is the water

that helped make the steel

that made the machine

that cut the hay

that fed the cow

that gave the milk

that Jack drank.

This is the water

that ran through Jack's veins

and oozed out as sweat

that evaporated from his skin

and rose into the air

and condensed in a cloud

and rained down on fields

that grew the hay

that Jack's milk cow ate.

California's Imperial Valley

Lettuce Tell You a Story

By Sal Adkrops

Did you know that the fields of California's Imperial County, which is not too far from where you are sitting, are some of the most fertile lands in the whole world? People call those fields America's "salad bowl" because they grow so much lettuce, along with other vegetables and crops. The Imperial Valley is one of the most productive farming regions in California. The Valley's produce is worth more than one billion dollars per year.

In ancient times, the valley lay beneath a fresh water lake. After the lake disappeared, the Colorado River sometimes flooded the land, leaving rich sediments behind.

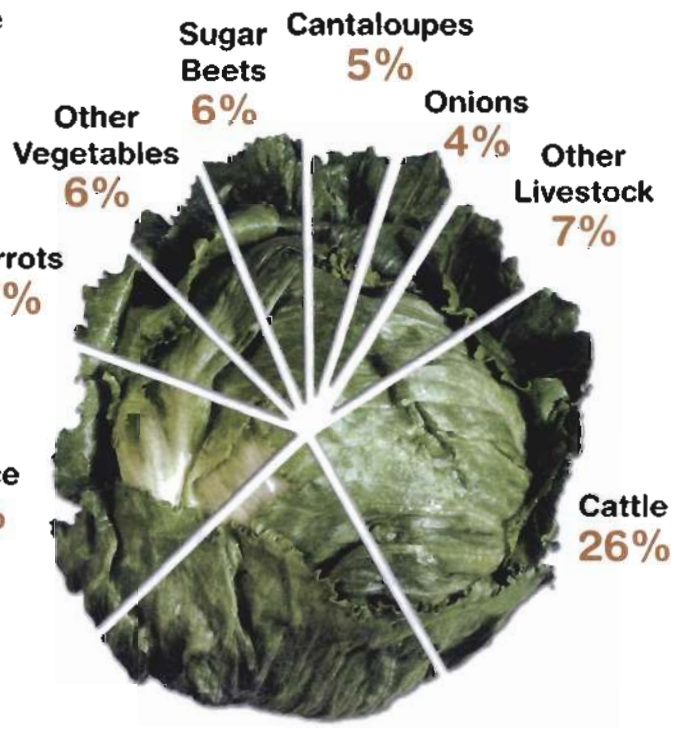
In the late 1800s, people discovered that the soil was perfect for growing crops, if only there were water.

"Aha!" they thought. "Maybe we can divert water from the Colorado River to irrigate our crops."

That's just what they did, and the natural fertility of the soil rewarded them. They grew crops they could sell for a profit, and they named the area the Imperial Valley.

Source: *Imperial County Agricultural Commissioner's Agricultural Crop and Livestock Report, 2002*

Agricultural Output of the Imperial Valley



Food For Thought

The Imperial Valley is hot and dry. How did the soil become so fertile? Where does the water come from to water the crops?

Southern California imports water from other places. In what way does it also export water? ("Import" means to "bring in" and "export" means "carry to other places.")

Imperial Cipherings

Editor's note: The word "ciphering" means to calculate or solve mathematical problems.

1) In 2002, the Imperial Valley had farms on almost 565,000 acres. Those fields produced sales of more than $1,000,000,000.

   On average, how many dollars did each acre of land produce?

   How much would one square mile of that farmland produce? (One square mile = 640 acres.)

   About how many square miles are under cultivation in the Imperial Valley?

2) Alfalfa is grown primarily as a source of food for cattle and other livestock. Roughly what percentage of the farm output of Imperial County goes toward the production of meat and dairy?

Food Journeys

Describe the travels of a drop of water through the food chain.

Amazing but true...

River Moves Mountains

By Bray Krocks and E. Rosian

The Grand Canyon in Arizona is one of the most awesome sights on earth: sheer cliffs a mile high carved by nothing more than the tremendous force of the raging Colorado River. Water can wear away mountains, carve valleys and canyons, create fertile plains, and rearrange shorelines. Its main tools are *erosion* and *sedimentation*.

WORD ROOTS

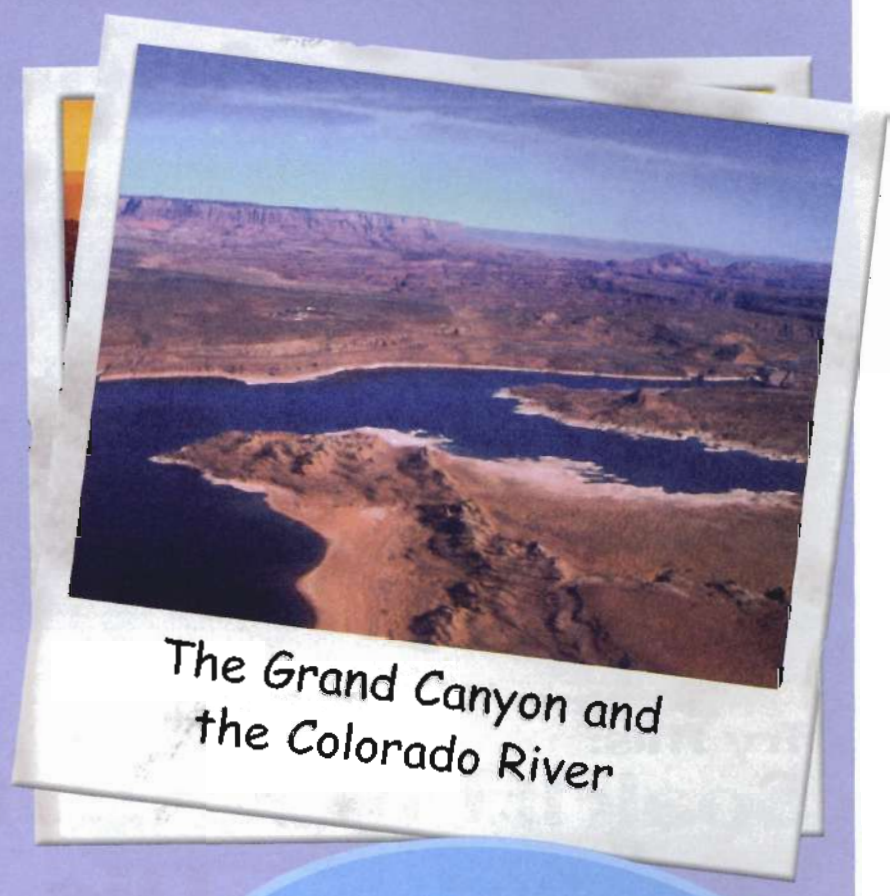
Erosion and Sediment

Erosion comes from the Latin verb "erodere," meaning "to gnaw away." Sediment comes from the Latin verb "sedere," which means "to sit or settle."

All along the Colorado River's 1,450-mile journey, the river wears away the land, breaking rocks and other objects down into fine dirt and sand called *silt*. This breaking down and washing away is known as *erosion*.

Every year, the Colorado River carries tons of silt containing rich nutrients to the Gulf of California. The river's water becomes muddy with the reddish silt. In fact, "Colorado" means "red color" in Spanish.

As the river reaches level ground, the water slows down and drops silt along the riverbanks. Over thousands of years, the silt built up layers and layers of fertile soil. This settling process is called *sedimentation*.



The Grand Canyon and the Colorado River

WATER LOG

Changing the World

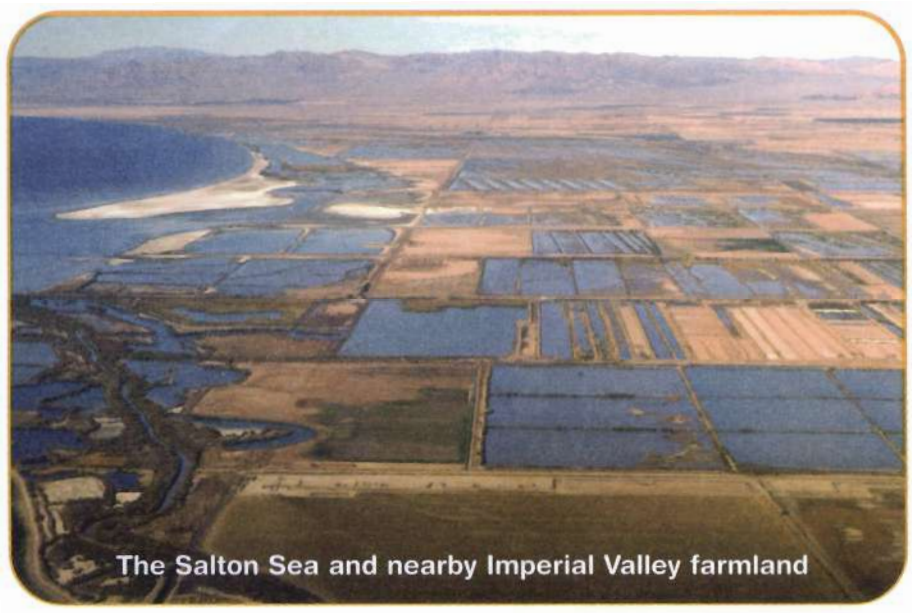
What other natural forces besides water have shaped and reshaped the earth?

What are some human activities that reshape the earth? Find an example of a natural or human-made force that has altered the earth. Take, find or draw a picture of it. Describe how it has changed the earth.

The Silty Salton Sink

By Anne Chent Lanz

During millions of years of wild flooding from the melting mountain snow, the Colorado River changed its course many times. The river would break out of its channel to forge new paths to the sea.



The Salton Sea and nearby Imperial Valley farmland

Sometimes during floods, it poured into a low-lying area in the California desert known as the Salton Sink. During those times, it created a large lake in the desert valley. When the river changed its course again, the lake slowly dried up, leaving its nutrient-rich silt in the dry lakebed.

In the late 1800s, settlers in California realized the soil of the Salton Sink was extremely fertile, so they started farming. They created irrigation channels that followed old pathways of the Colorado River. Then in 1906, a ferociously flooding Colorado River broke those irrigation channels. For the first time in hundreds of years, the Colorado River again filled the Salton Sink, creating the Salton Sea, an inland water body covering 376 square miles.

Today, the mighty Colorado River has been tamed and returned to its main channel. Its waters no longer feed the Salton Sea. If left to nature, the sea would dry up again, but now it is fed by irrigation water from nearby farmlands. The Salton Sea has no outlet to the ocean, so the only way it loses water is through evaporation. As it evaporates, the water leaves its trace salts and minerals behind. Since the Salton Sea has no natural sources of fresh water, it has become salty and is getting saltier every day.

Salton Sea Authority; Salton Sea, California's Everglades, The Redlands Institute

To Be Sea, or Not to Be?

Today, the Salton Sea has created quite an environmental debate.

Should it be treated as a natural lake or an accidental lake? Some say it is an accident because it resulted from breaking irrigation channels. These people argue that the lake should be allowed to dry up.

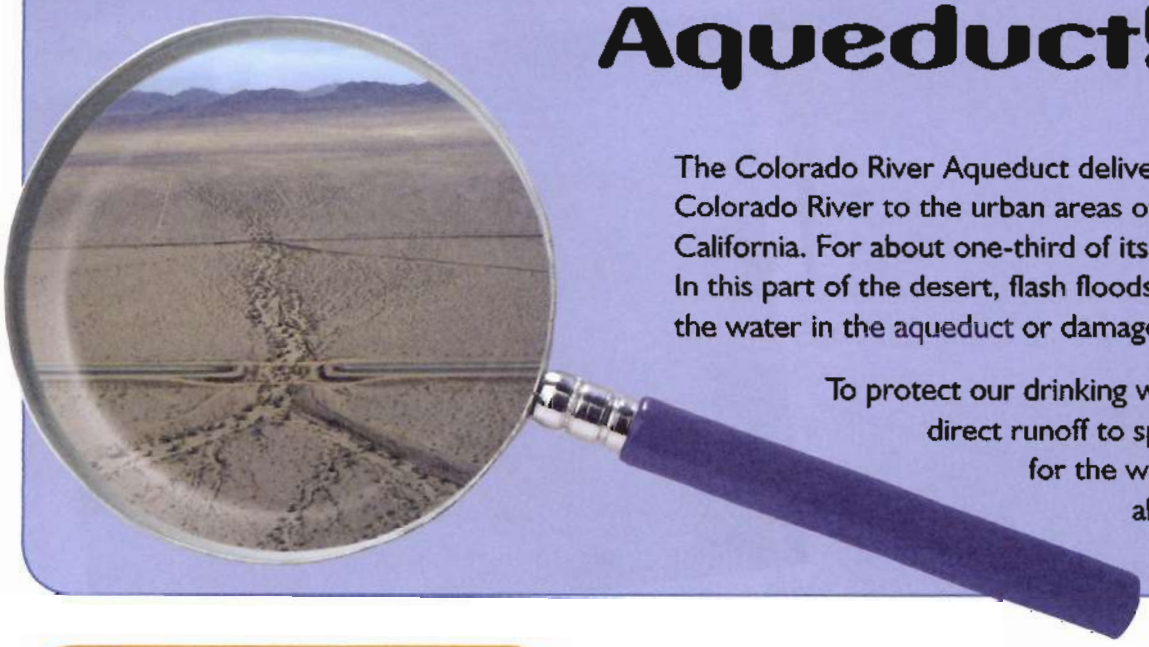
Others say the Salton Sea is natural because the 1906 event was just another in a long string of floods that changed the flow of the river. These people think we should keep the lake full.

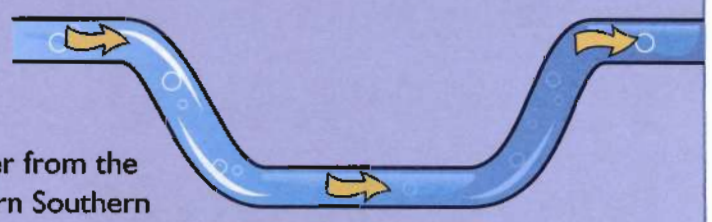
If we let the sea evaporate, the birds and other wildlife that make it their home would lose their habitat. Meanwhile, the irrigation water that feeds the sea contains fertilizers and other chemicals, which also threaten the health of these animals.

Maybe one day your generation will help decide the fate of the Salton Sea.

Write a one-page persuasive paper making an argument for leaving the lake to the forces of nature or using human ingenuity to protect it.

The Case of the Disappearing Aqueduct!



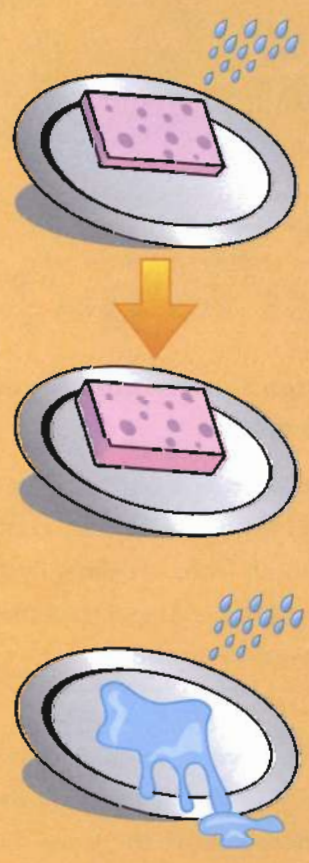


The Colorado River Aqueduct delivers water from the Colorado River to the urban areas of western Southern California. For about one-third of its 242-mile length, the aqueduct runs as an open channel. In this part of the desert, flash floods are common, and the flooding rainwater could pollute the water in the aqueduct or damage the aqueduct itself.

To protect our drinking water and the aqueduct, engineers built small dikes to direct runoff to specific locations, and then they built underground tunnels for the water, which are called "inverted siphons." These siphons allow the water to flow beneath parts of the desert.

Try This:
Soak It Up

Place a sponge on a plate that is tilted at an angle. Sprinkle or spray water on the sponge and observe what happens to the "runoff" water. Now remove the sponge and spray water on the plate.



What happens to the runoff?

How might these results relate to rainwater hitting rooftops, roads, or parking lots?

How do they relate to water running across land before and after a huge fire?

People often compare soil covered with vegetation to a sponge. The soil can soak up rainfall, hold the moisture a long time, and release it slowly. Bare land acts more like a flat plate, with the water running right off.

Don't Dis Deltas

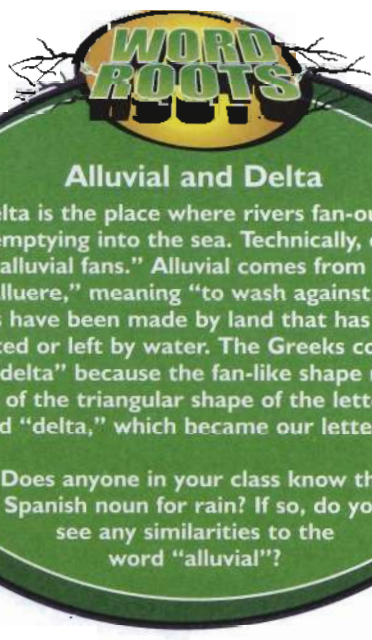
They are too important

By M.T. Inthesee

The Colorado River slows down and spreads as it nears the end of its journey and meets the Gulf of California. As it slows down, it creates a fan-shaped or triangular layer of silt called a delta. You have probably studied some of the world's greatest deltas, including the Nile Delta, the Tigris-Euphrates Delta, the Yellow River Delta, and the Mississippi Delta.

California has another famous delta, known simply as "the Delta." It is a region in the central part of the state, just south of Sacramento, where the Sacramento and San Joaquin rivers come together. One of the most fragile and important regions in California, the Delta attracts 120 fish species and several species of endangered plants and animals. The water that passes through the Delta provides irrigation for 45% of the nation's produce and drinking water for more than 20 million people.

A bird's-eye view of a portion of California's Delta. You might have showered in or drunk some of the water in this picture!



Alluvial and Delta

A delta is the place where rivers fan-out just before emptying into the sea. Technically, deltas are called "alluvial fans." Alluvial comes from the Latin word "alluere," meaning "to wash against." Alluvial fans have been made by land that has been deposited or left by water. The Greeks coined the word "delta" because the fan-like shape reminded them of the triangular shape of the letter they called "delta," which became our letter "D."

Does anyone in your class know the Spanish noun for rain? If so, do you see any similarities to the word "alluvial"?

Nowhere and Everywhere at the Same Time

The traveler and writer Aldo Leopold used personification to describe the Colorado River delta at the Gulf of California in the early 1900s:

"The river was nowhere and everywhere, for he [the river] could not decide which of a hundred green lagoons offered the most pleasant and least speedy path to the Gulf. So he traveled them all, and so did we."

— Aldo Leopold, ***Sand County Almanac***

Write a poem that uses personification to describe a body of water, such as a stream, river, delta, or watershed.

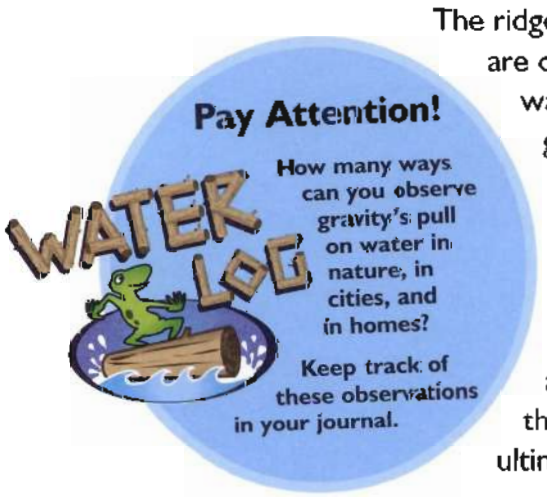
Draining a Watershed

By Flo S. Downe

Water always runs downhill. Why? Gravity!

In nature, water runs from high points, such as mountain ridges, to low points, such as valleys or the shore. The land that water runs across is called the *drainage basin*. Water flows from hills and mountains into the lowlands. Together, these hills and valleys make up a *watershed*.

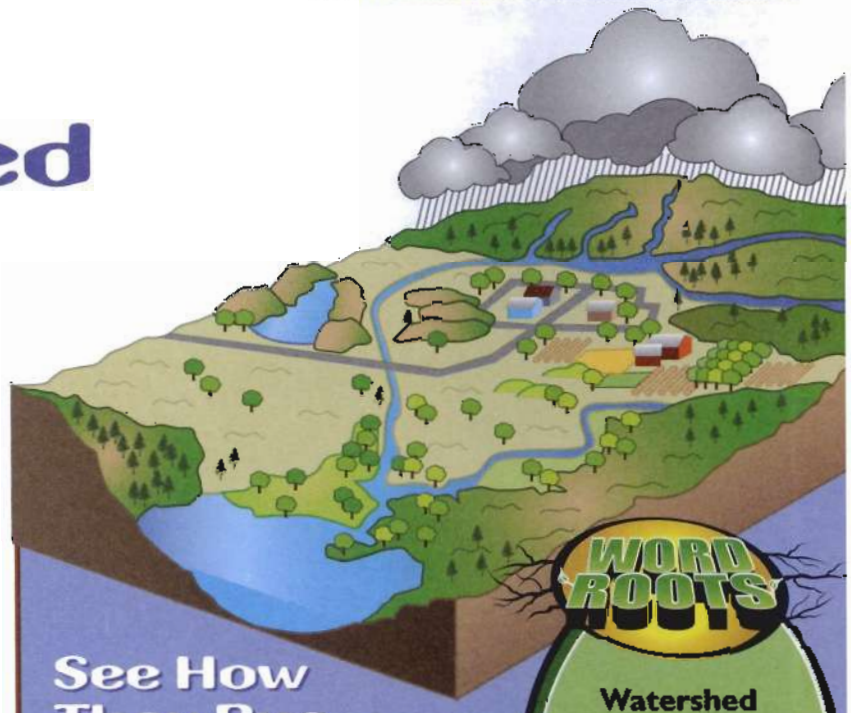
The ridges that define the boundaries of a watershed are called *divides* because they divide the flow of water: water falling on one side of the divide goes in one direction, and water falling on the other side goes in another direction. For example, rain falling on the east side of the great Continental Divide atop the Rocky Mountains flows into the Mississippi River. From there, it flows into the Gulf of Mexico and the Atlantic Ocean. Water that falls on the west side of the Continental Divide ultimately flows to the Pacific Ocean.



Pay Attention!

How many ways can you observe gravity's pull on water in nature, in cities, and in homes?

Keep track of these observations in your journal.



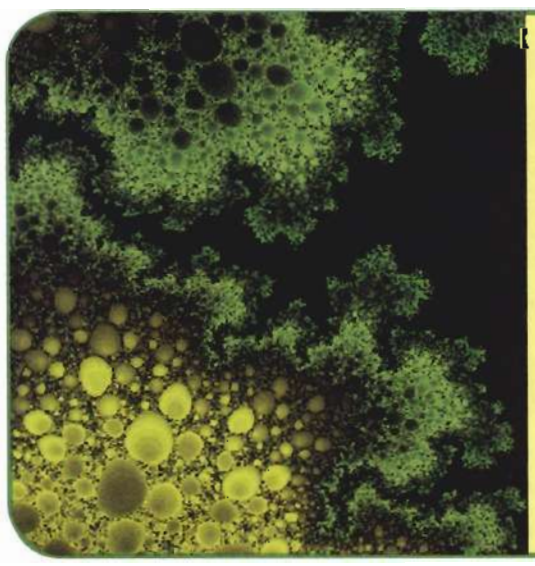
See How They Run...

When rain falls on hillsides, the water runs across the land. It collects in channels called rills, which grow into creeks, streams and rivers. Rivers, in turn, eventually flow into lakes, seas or oceans. Look around your community and observe this pattern in both large and small scales in nature.

WORD ROOTS

Watershed

Watershed comes from the German word "wasserscheide." "Wasser" means water, and "scheide" means to divide or part.



Here is a photo in need of a caption. Does this picture remind you of what you've read? Can you create a caption for it?

_____

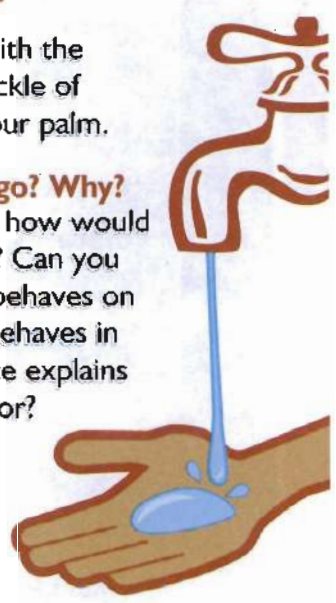
_____

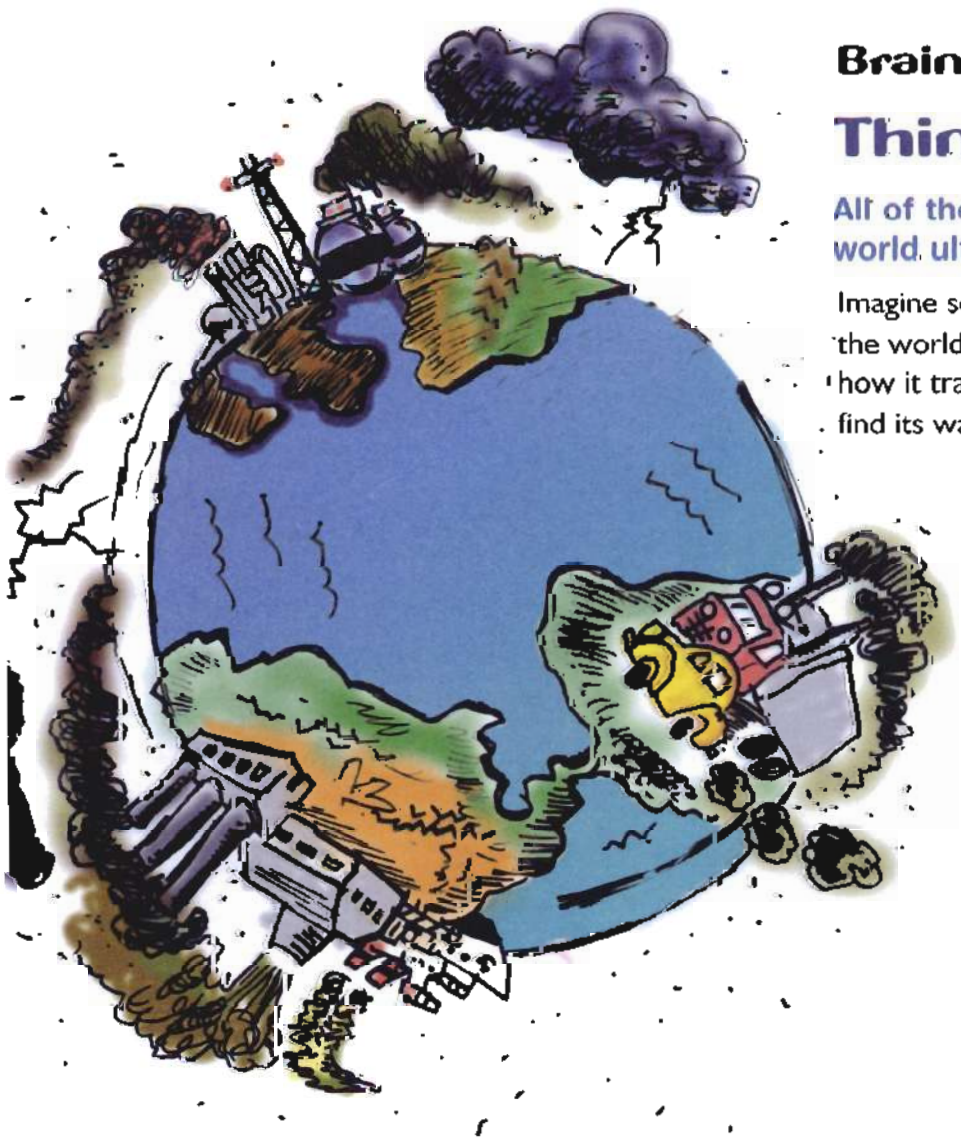
_____

Try This Handy Experiment:

Cup one of your hands with the palm facing up. Pour a trickle of water onto the heel of your palm.

Where does the water go? Why?
If it follows certain paths, how would you describe those paths? Can you compare the way water behaves on your hand to the way it behaves in nature? What natural force explains water's pattern of behavior?





Brain Stretcher:

Think about this one for a while...

All of the pollution created anywhere in the world ultimately becomes water pollution.

Imagine some type of pollution anywhere in the world, including land and air. Think of how it travels. How will it eventually find its way to water?

California

Getting to know

Who Am I?

INSTRUCTIONS: On this map, you see a number of blank boxes near geographic features, such as mountains, rivers, lakes, aqueducts, reservoirs, and cities. Follow the clues below to identify the features, and then put the proper number in the box. If you cannot figure out an answer right away, skip it and come back later.

1 I am the part of Mexico that continues south from California's southern border. I am one of the world's largest peninsulas, and my northernmost city is Tijuana.

_____

2 I flow southward from the Delta, near Sacramento, carrying water to the people and farms of Central and Southern California. I end my journey in Riverside County at Lake Perris.

_____

3 I am in the heart of California. I am 450 miles long, bounded by the Klamath Mountains to the north, the Tehachapi Mountains to the south, the Sierra Nevada Mountains to the east, and the Coastal Range to the west. I am an alluvial plain, and I am the largest block of irrigated farmland west of the Rocky Mountains. I am home to nearly half of California's farmland, and I doubt you can name a crop that is not grown in my soil. Some of my most common crops are fruits, nuts, citrus, vegetables of every kind, rice, cotton, and wheat. I am also home to dairy cattle, beef cattle, sheep, and chickens.

_____

4 I flow from the Colorado River, which is the border between California and Arizona, to Lake Mathews in Riverside County. I am 242 miles long, and when full, I can carry 1.3 million acre-feet of water to the people of Southern California each year.

_____

5 Just completed in 2000, I am in Riverside County, south of the Colorado River Aqueduct but much smaller than the Salton Sea. I am the newest of the Metropolitan Water District's surface water storage reservoirs, and I am filled with fun-to-catch fish. I am also Metropolitan's largest reservoir. I provide emergency water supplies if aqueducts ever fail. I am also the newest water recreation area in Southern California, and I am home to the new Center for Water Education, which is dedicated to water and the region's fascinating history.

_____

6 I am located in the southernmost portion of California, south of the Salton Sea and just north of Mexico. Silt deposited by the Colorado River over a period of many centuries made my lands fertile. I am known as "America's salad bowl" because my farms grow so much lettuce and other salad crops.

_____

7 From the time I was built in the 1930s until Diamond Valley Lake was built in 2000, I was Metropolitan's largest reservoir. I hold the water that comes through the Colorado River Aqueduct until it goes off to a treatment plant. I am completely protected to help make sure my water stays clean and pure. No one is even allowed to swim, boat or fish in my water.

_____

KLAMATH MOUNTAINS
Lake Shasta
Sacramento River
Lake Oroville
Feather River
Lake Tahoe
American River
Sacramento
Pacific Ocean
The Delta
San Francisco
San Francisco Bay
CENTRAL VAL
San Joaquin River
California Aqueu
COASTAL MOUNTAINS
N
1" = 45 miles
1 cm = 28.5 km
45 miles

8 Fed by the Feather River, I am located about 70 miles north of Sacramento. I am owned by the State of California and operated by the Department of Water Resources. My water flows into the Delta, and from there through the California Aqueduct to the people living near California's border with the Pacific Ocean.

...getting to know all about you

9 Known for my clarity, beauty, and mountain scenery, I am a lake partly in California and partly in Nevada. I was formed more than two million years ago when the mountains around me uplifted and the basin that holds my water dropped. At an elevation of 6,225 feet, my surface is almost a mile and a quarter above sea level. My greatest depth is 1,645 feet, which makes me the second-deepest freshwater lake in North America, next only to Crater Lake in Oregon. Sadly, the clarity of my water has declined over the past 100 years, but even now, you can see a white dinner plate 75 feet below my surface. If you spread all of my water evenly across California, I would cover the state to a depth of 14 inches!

10 By population, I am the second-largest city in the U.S. and the seventh-largest in the world. Situated near the Pacific coast in the heart of Southern California, I am one of the most multi-cultural cities in the world and home to the film industry. I am also known for my miles and miles of freeways and my mild climate.

11 I am bordered by the Tehachapi Mountains to the north, and the San Gabriel Mountains to the south and west. (The San Gabriel Mountains are the ones that form the northern and eastern edges of the Los Angeles basin.) On average, I receive only six inches of rain per year. I am home to Death Valley, which is the lowest, hottest place on earth. In July and August each year, my daytime temperatures reach about 120°F.

12 I am located in the eastern Sierra Nevada Mountains, 340 miles north of Los Angeles and close to the Nevada state line. At one million years old, I am one of the oldest continually existing lakes in North America. During the Pleistocene Ice Age, I overflowed, filling the Owens River Gorge and draining into the Owens Valley. Today, I receive water from rain and snow in the mountains. I am also home to 30 volcanic domes that erupted as recently as 650 years ago, and I am considered "tectonically active." Like the Salton Sea in the south, I am a "terminal lake," meaning that I have no outlet to the sea. I support an ecosystem of brine shrimp and brine flies, but no fish. I'll bet you can't guess the origin of my name! A Native American tribe called the Yokuts lived along my shores. Their word for "flies" was monoi. My shores were covered with millions of fly pupae that the Yokuts ate and used for trade. My name came from the "fly people" because flies were their source of food and wealth.

13 The water that runs through me comes from the Owens River and provides water to the City of Los Angeles. The water flows a distance of 233 miles. I was completed in 1913. My western end is just northwest of Los Angeles.

14 I form the entire western border of California.

15 Located in the central part of the state, I am the capital of California. Even though I am an inland city, the Delta and nearby rivers provide 1,000 miles of waterways.

16 At 382 miles long, I am the longest river in California. I start in the far north of the state, near Lake Shasta, which is the largest and northernmost water reservoir in California. I flow through the northern part of the Central Valley. I then meet up with the American River and flow into the Delta. From the Delta, the American River and I flow into the northern part of San Francisco Bay.

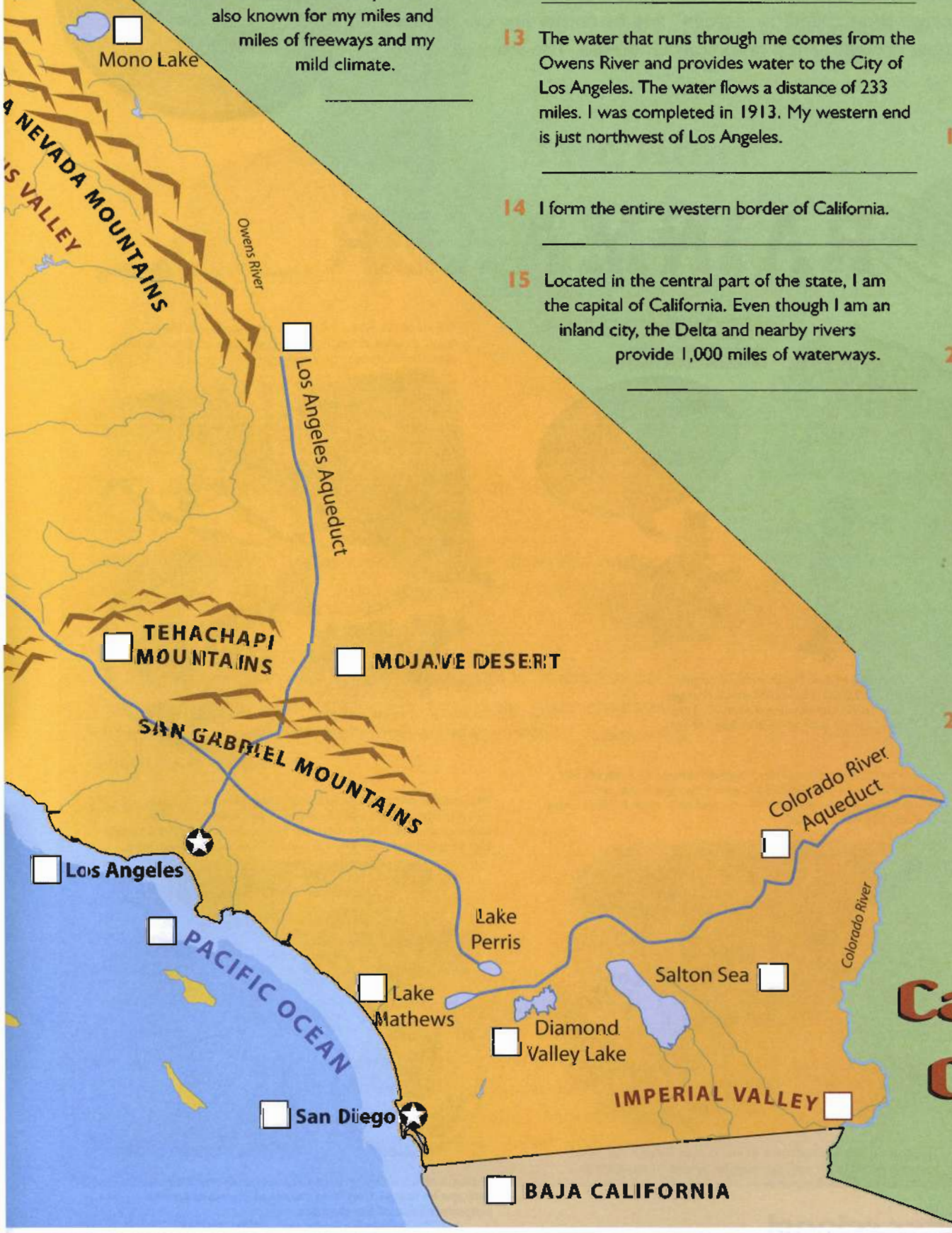
17 The largest lake in California, I first became a lake 1,300 years ago when the Colorado River silted up its normal route to the sea and overflowed. Since that time, I dried up and refilled many times. Only 500 years ago, I held 26 times more water than now, but then I dried up again until a flood re-filled me in 1906. Today, the water that keeps me full comes mostly from farms in the Imperial Valley. The land near me has been used for agriculture for more than 8,000 years! Hundreds of species of birds and wildlife live here, and migrating birds stop over every year during their migration along the "Pacific Flyway." Like Mono Lake, I am very salty because I am a "terminal lake." My water evaporates, leaving all of the salts and minerals behind. I am saltier than the ocean and getting saltier every day.

18 I am the southernmost major city in California. The city of Tijuana, Mexico in the state of Baja California lies just to my south. I am a real favorite with tourists who flock to my world famous zoo and beautiful beaches. Jobs related to the U.S. Navy and its fleet account for much of my economic activity.

19 I am one of America's most loved cities, with my picturesque cable cars and my steep, steep hills. San Francisco Bay is the largest bay in the state, and to enter it, ships must sail through the "Golden Gate," a one-mile-long, three-mile-wide "strait." I grew into a vibrant city in 1849 as a result of the California Gold Rush.

20 You will find me south of Sacramento and east of San Francisco at the northern end of the California Aqueduct. I am formed by the waters of the Sacramento River flowing from the north and the San Joaquin River flowing from the south. My water comes from Lake Shasta in the far north and Lake Oroville, also in the north. After traveling through me, some of my water flows into the California Aqueduct for cities and farms in western California. Some waters the crops in the Central Valley. The rest of my water flows into San Francisco Bay, helping to keep it healthy.

21 I rise up out of the ground at the southern end of the Central Valley and the northern end of the Mojave Desert. Water flowing southward through the California Aqueduct must be pumped over me before flowing downward into the Los Angeles Basin and Lake Perris.



California Cartography

Weather: What you choose to wear today.
Climate: How you shop for your full wardrobe.

Bright, Warm, and Boring

By Sonny Daize

How many heavy winter coats do you own? How many umbrellas? How many bathing suits or pairs of shorts? Do you have more long-sleeved flannel shirts or short-sleeved T-shirts?

Your answers reveal something important about Southern California's so-called "Mediterranean" climate. Like the countries that rim the Mediterranean Sea (Spain, Italy, Greece and Morocco, among others), the weather here is warm, sunny, and somewhat arid. It rains only occasionally, and the winters are mild.

In fact, Southern California really has a rather boring climate … in a good way. Tornadoes, hurricanes, blizzards, and thunderstorms are rare, and our day-to-day weather changes little.

The prevailing winds blow from west to east, so our breezes come from the Pacific Ocean. The ocean keeps temperatures stable because of water's unusual ability to hold heat, which scientists call "heat capacity." (A cup of hot water will stay warm longer than a cup of hot air because water has a higher heat capacity than air.)

Of course, our climate does have its flaws. Sometimes we endure long droughts, strong winds, and torrential rains. Today, we plan for droughts by building storage lakes called "reservoirs" and by conserving our water supply. People have tried many strategies to combat drought. Hold onto your umbrellas. The story of *Hatfield the Rainmaker* may surprise you…

WORD ROOTS

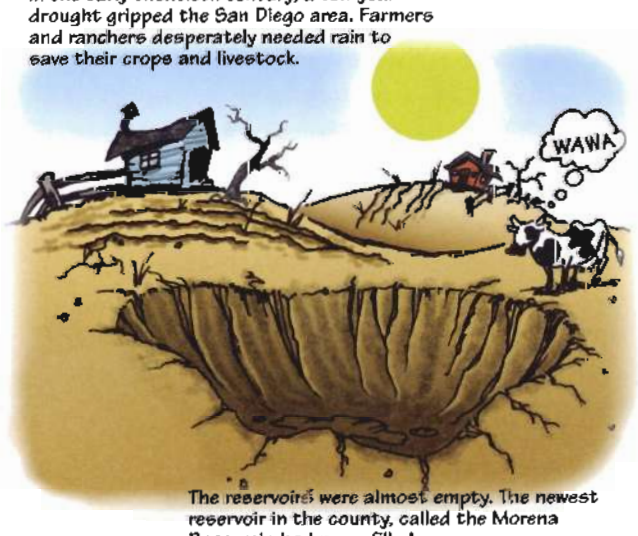
Reservoir
comes from the Latin word meaning "to keep back." A reservoir keeps water behind a dam and stores it for later use.

STRANGE BUT TRUE...

HATFIELD THE RAINMAKER

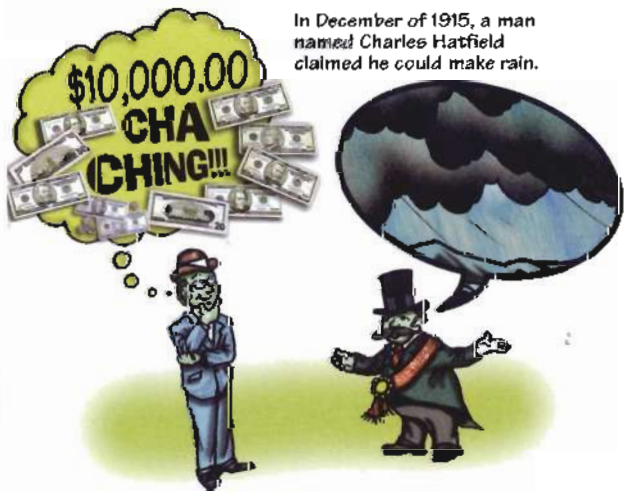
Comic Strip by Flo Ding

In the early twentieth century, a ten-year drought gripped the San Diego area. Farmers and ranchers desperately needed rain to save their crops and livestock.



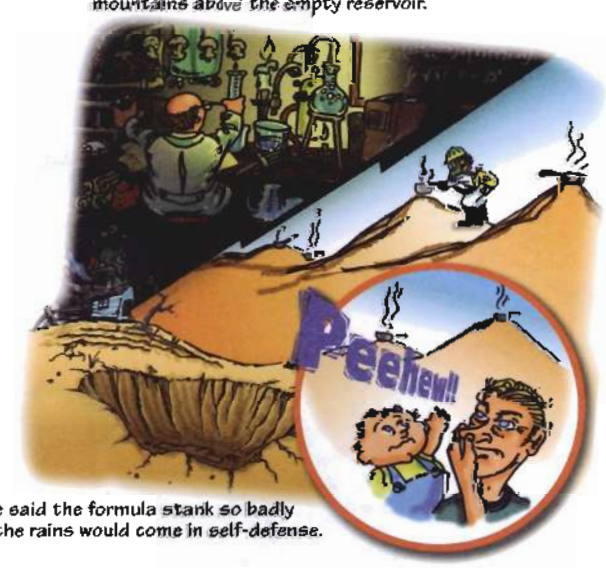
The reservoirs were almost empty. The newest reservoir in the county, called the Morena Reservoir, had never filled.

In December of 1915, a man named Charles Hatfield claimed he could make rain.



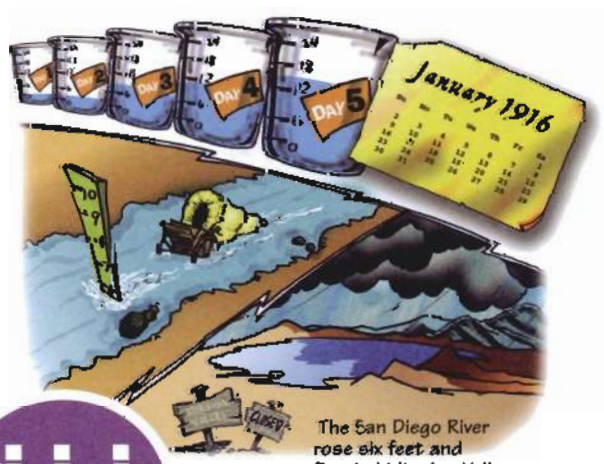
The City of San Diego offered to pay him $10,000 if he could make enough rain to fill the Morena Reservoir. (That was a huge sum of money back then!)

Mr. Hatfield mixed 24 secret chemicals, let them "age," poured them into pans, and placed them in the mountains above the empty reservoir.



People said the formula stank so badly that the rains would come in self-defense.

In the middle of January, a heavy rain started! It continued for five straight days, dropping seventeen inches in the mountains!



The San Diego River rose six feet and flooded Mission Valley from cliff to cliff.

People had had enough. They begged Hatfield to turn off his rainmaking machine. He kept it going though, because the Morena Reservoir was not full yet, and only when it filled would the city pay his $10,000.

Those were the wettest two weeks in San Diego's recorded history. Freshwater springs popped up out of nowhere and continued to flow for years.

The rain fell for another full week. Dams broke. Bridges, railroads and highways vanished. A bell tower fell off a mission church. People died. No one could call Hatfield to tell him to stop because the telephone lines had washed away.

Hatfield left San Diego with his formula but not his money. Perhaps he feared that if he collected, he would be held responsible for all the damage.

Nature's Own Rain Recipe

A Drop of This, a Drip of That

Hatfield's so-called rainmaking may not have been so special, after all. Nature creates rain all the time using just a few simple ingredients that drive the water cycle.

Ingredients

Sunshine

Water (H_2O)

Air (a mixture of gases, including oxygen, hydrogen, carbon dioxide, nitrogen, and water vapor)

A dash of dust or other tiny particles in the atmosphere

Directions

1. Allow the sun to heat the air above a lake or moist ground so the liquid water evaporates, becoming vapor.
2. Let the vapor rise with the warm air until it reaches the "dew point," where the air becomes so cool that vapor condenses and turns back into water droplets.
3. Sprinkle in tiny bits of dust, pollen or smoke. These particles provide surfaces for the cooled water vapor to cling to.
4. From ground level, these floating clusters of condensing water vapor appear white and fluffy. They are "clouds."
5. When enough water molecules come together, they are ready to serve. In fact, when the water droplets become too heavy to stay in the sky, they serve themselves as rain, sleet or snow.
6. Depending on their size and quantity, raindrops can make a great drizzle appetizer, a juicy entrée, or a flowing dessert.

Garnish with puddles, mist, or rainbows. Serves the Earth.

White Variation: Agua Blanco (rarely served in sunny Southern California)

Let the air temperature in the cloud drop below 0°C (32°F), so the condensation forms ice crystals instead of liquid. Serve those crystals as snow or sleet. Snow is by far the more pleasant.

The Rain

The rain is raining all around,
It falls on field and tree,
It rains on the umbrellas here,
And on the ships at sea.

— Robert Louis Stevenson

WORD ROOTS

Meteorologists

Meteorology comes from the ancient Greek words "meteoros" (high in the air) and "ology" (the study of). A meteorologist studies events that happen in the atmosphere (weather).

Make Your Own Weather

To test this recipe, make some simple models of different stages of the water cycle.

Materials needed: water, ice cubes, paper, clean and empty tin can, thermometer, clear cup, plastic wrap, twist tie.

Evaporation:

Sprinkle some water on a piece of paper and let it dry. Presto! The water changed from the liquid state to the gaseous or vapor state. Why is this phase change called "evaporation?" (Look for a telltale root word.)

Describe what you observed.

_____

_____

Dew Point:

Fill a tin can about halfway with colored tap water and put a thermometer in the water. Add a few cubes of ice to the water and watch the side of the can carefully. In a few minutes, you will begin to see water droplets forming on the outside of the can. As soon as they start to form, record the temperature of the water. That temperature is the "dew point." Where do you think the water on the side of the can came from?

If you try this experiment on different days, you may get different results. Why? To find out, look for the relative humidity measurement in your newspaper's weather report. Record the dew point and the relative humidity for a week. Create a chart showing the relationship between these two measurements. Briefly explain your findings.

_____

_____

_____

Condensation:

Put some hot water in a clear plastic cup (but don't make it so hot that it could burn you). Put ice in a plastic bag and twist-tie it closed. Cover the opening of the cup with the ice-filled plastic bag. Watch "rain" fall back into the glass.

Describe your observations. Draw a diagram of the water cycle by illustrating what is happening in the cup. How does this simple activity model the rain recipe?

_____

_____

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Amazing News About Atmospheric Water Vapor

It Prevents Us from Burning Up During the Day and Freezing Solid at Night

By Gassin D. Ayre

When we hear that water is necessary for all life, we usually think of water in its liquid state. Atmospheric water vapor is just as important!

Water vapor holds a great deal of heat energy. (That's why it is said to have a high "heat capacity.") That vapor shows how fast and how much earth's temperature changes. Without atmospheric water vapor, we would be unbearably cold at night and blazing hot during the day.

Water vapor is also the earth's air conditioner. When water evaporates, it carries away heat with the vapor. Then, when the vapor condenses, it releases heat back into the atmosphere. In that way, water vapor transfers heat from where it is hot to where it is cold. That heat transfer keeps the planet's overall temperature relatively stable.

A Little Lunar Lunacy...

The Temperature Really Swings on the Moon!

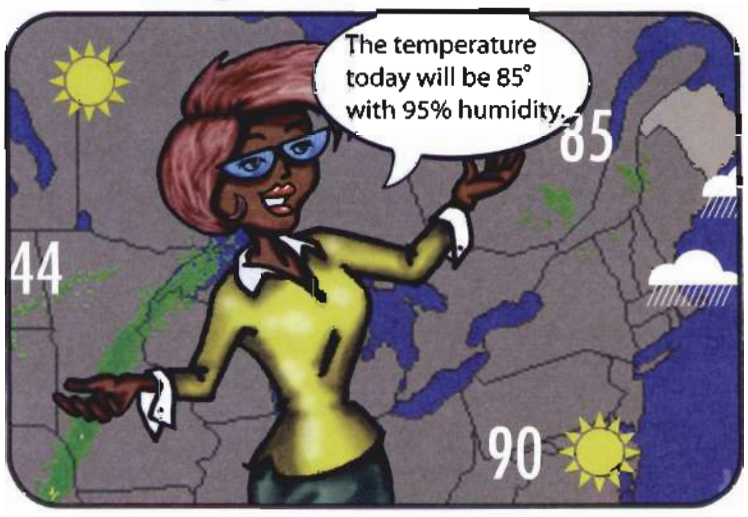
The moon is the same distance from the sun as the earth, but it has no water vapor or other gases in its atmosphere. On an average moon day, the temperature swings from a nighttime low of -181°C to a daytime high of 101°C. What is the temperature range in °F? (Hint: °F = (°C X 1.8) + 32)

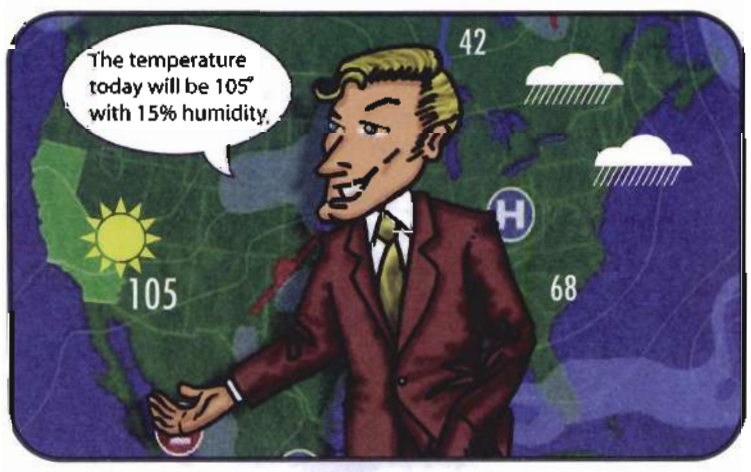
Be a drop

Imagine a place where a water molecule might evaporate. In your mind, become that water molecule, creating a weather system that will take you into the atmosphere and back to the ground as precipitation. Write about the journey from the water molecule's perspective, noting the wind, temperature, humidity, and scenery changes you experience.

Which of these two days will feel hotter?

Why?





Weather Puzzles

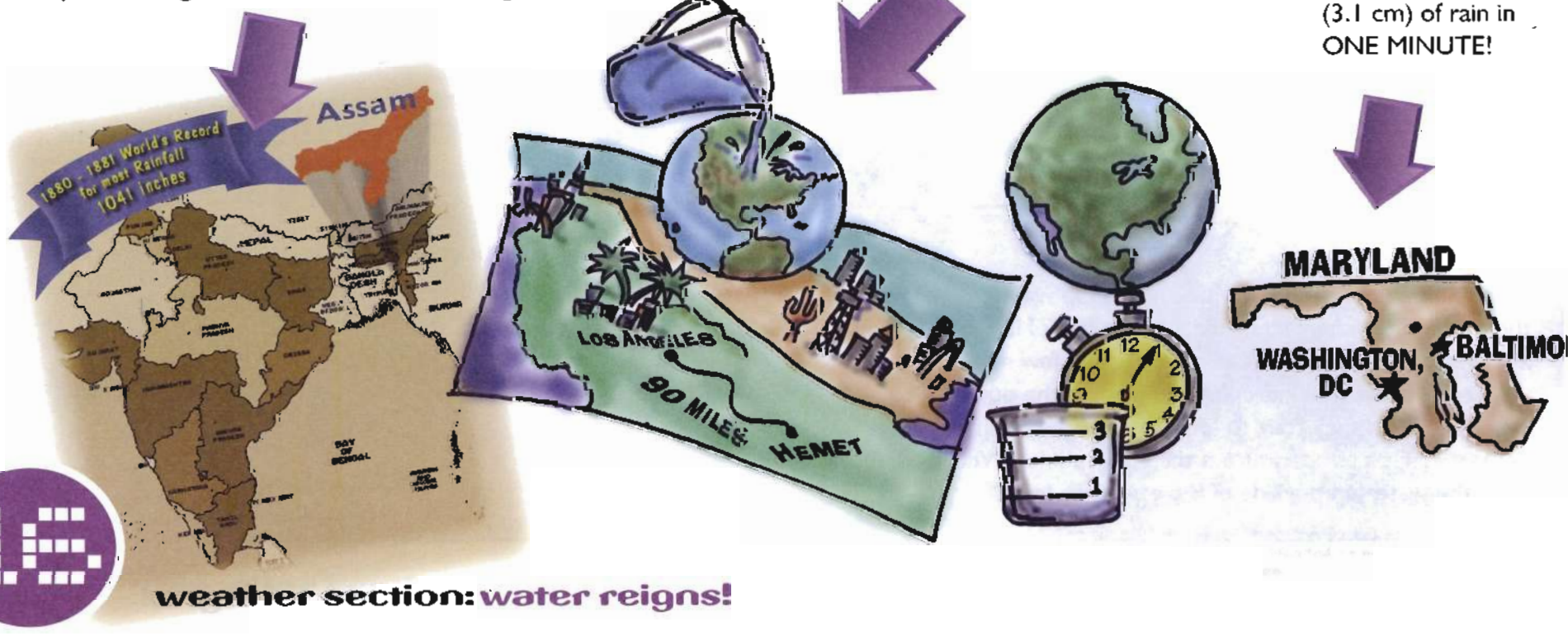
1. Why do some clouds have flat bottoms?
2. Why are cloudy days cooler than sunny clear ones?
3. Why do cloudy nights stay warmer than clear nights?

!WEATHER WOWS!

From August 1880 to July 1881, 1,041 inches (2,644 centimeters) of rain fell in Assam, India. It is the most rainfall ever recorded in one place in a year. Can you identify something that is about 1,041 inches high?

If all of the world's water were poured on the United States, it would cover the land to a depth of 90 miles (145 km), which is roughly the distance from downtown Los Angeles to the Center for Water Education at Diamond Valley Lake in Hemet, California.

On July 4, 1956, Unionville, Maryland received 1.23 inches (3.1 cm) of rain in ONE MINUTE!



Let Me Count the Ways

By Howdu U. Uzit

You use water in all kinds of ways in your home, from cooking to cleaning to watering. You even use it to wash some things down the drain. Take a peek at some of the ways you use water … and at some ways to use less. You may be surprised!

Complete the first column of this table. If you cannot think of ten ways you use water right away, compare responses with your classmates.

	Water use	Every day? (Y/N)	How much? (Rank these between 1 and 10, with 1 being most and 10 being least.)	Importance (Rank these between 1 and 10, with 1 being most and 10 being least.)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

How often do you use water for these activities?
In the second column, put a "**Y**" next to things you do every day, and put an "**N**" next to the items you do less often.

Which of these activities use the most water, and which use the least?
In the third column, rank your ten uses. Put a "**1**" next to the activity that you think uses the most water and a "**10**" beside the activity that uses the least. Rank all of the other items to the best of your ability. (Fortunately, there are no right or wrong answers, so just make your best guess.)

Of all these activities, which ones are the most important to you?
In the fourth column, rank the ten activities from most important to you (#**1**) to least important (#**10**).

If you had to do away with some of these water uses, which three would you miss the most? Why?
Try to think in creative ways. For example, what might your life be like if you could no longer flush the toilet or wash your hands?

The Elixir of Life

By Itzgud Feryew

Elixirs maintain life and cure ills. If ever there were a true "elixir of life," it is water.

An adult needs about two liters of water every day to stay hydrated and healthy. Do you drink that much water every day? If you are physically active and athletic, you may need even more.

You may have heard that your body is about 70% water. Every cell in your body is a tiny system that depends on water to keep its parts lubricated, to bring it food, and to carry away waste. That is why it is so important to keep replenishing your body's water supply.

WORD ROOTS

Hydration

The root word "hydro" is Greek for "water." The suffix "-ate" means "having." To be "hydrated" means "to have water."

The prefix "de" often means "the opposite of." What do you think "dehydration" means?

Poetry Corner:

Ruminating with Rumi

Jalaludin Rumi was a poet who lived in the 1200s in Persia (which we call Iran today). Almost 800 years ago, he wrote these words,

"The ocean pours through a jar, And you might say it swims inside the fish."

Since our bodies are 70% water, and that water has about the same mineral content as ocean water, how might you interpret these words of Rumi?

Wet Your Whistle

Have you ever wondered why bottled water costs about the same as soft drinks and juices? Can you think of a possible explanation?

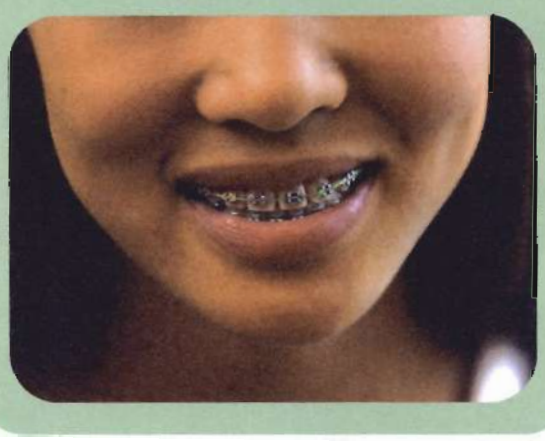
What's Up With That?

Why do you think so many people drink bottled water instead of tap water?

Did You Know

Fluoride is added to some water to protect teeth

Many water utilities in Southern California and around the country add fluoride to the tap water to improve dental health. Young people today have many fewer cavities than their grandparents did at their age. Do bottled waters contain fluoride?



Bottled or Tap?

Decisions, Decisions, Decisions!

By Howmutch Toupay

When you are thirsty, you can choose between tap water and bottled water. Fortunately, they are both safe and healthy, but they do not cost the same.

Try this exercise to figure out how much you are really paying for your drinking water.

Step 1. Collect data

Fill out the first four columns of this table. Gather information on different brands and sizes of bottled water. Look at the costs from different sellers, such as a vending machine, a convenience store, or a supermarket, and be sure to share information with your classmates.

Comparing the unit cost of bottled waters

Sample (brand name)	Size (in ml)	Cost ($)	Location of purchase	Cost per liter
1.		$		$
2.		$		$
3.		$		$
4.		$		$

Step 2. Compare Prices

To compare prices, you will have to find a common unit. The unit you will use is "cost per liter." Figure out the cost per liter of your samples and fill in the last column of the table. You now know the cost per liter of some bottled waters.

Helpful values	**1 liter**	=	**1,000 ml**
	500 ml	=	**about 17 ounces**
	12 ounces	=	**355 ml**

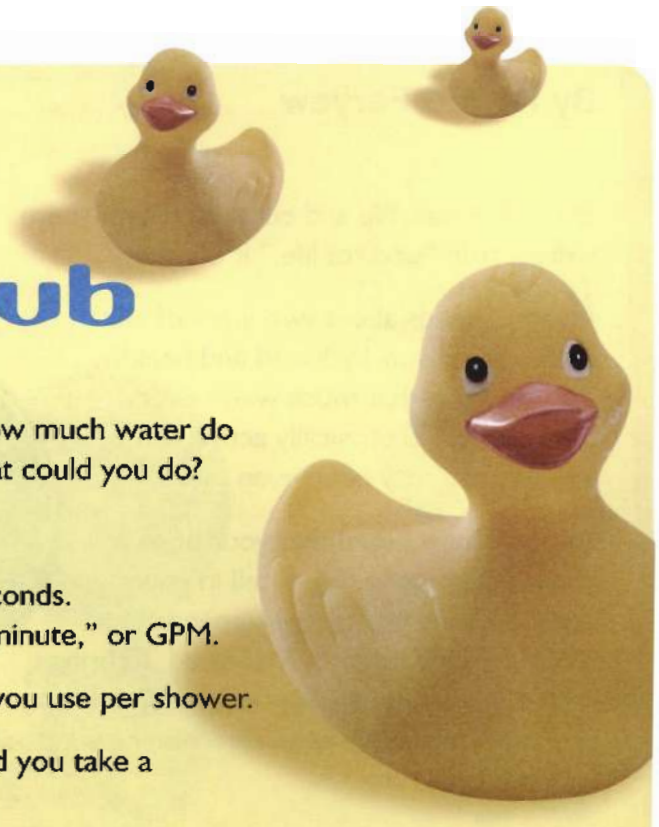
Example: If a 500 ml bottle of water costs $.75, how much does one liter cost?

1,000 ml ÷ 500 ml	=	**2 bottles for one liter**
2 X $.75	=	**$1.50 per liter**

Step 3. Comparing Costs

Tap water prices vary widely across the U.S., but on average one liter costs around one-tenth of a cent ($.001), so ten liters cost about one penny.

About how much would you have to pay for ten liters of bottled water?



Department of Personal Responsibility

Cleaning Up Your Act or Rub-a-Dub-Dub

By Taaka Shorter-Shaur

In all likelihood, showering is the single biggest water use for most middle school students. How much water do you think you use in the shower each day? If you wanted to use less water for showering, what could you do?

The amount of water you use in a shower depends on two factors: **1.** time and **2.** flow rate:

1. Time is how long you stand under the running water. It is measured in minutes and seconds.
2. Flow rate is how fast the water flows through the pipe. It is measured in "gallons per minute," or GPM.

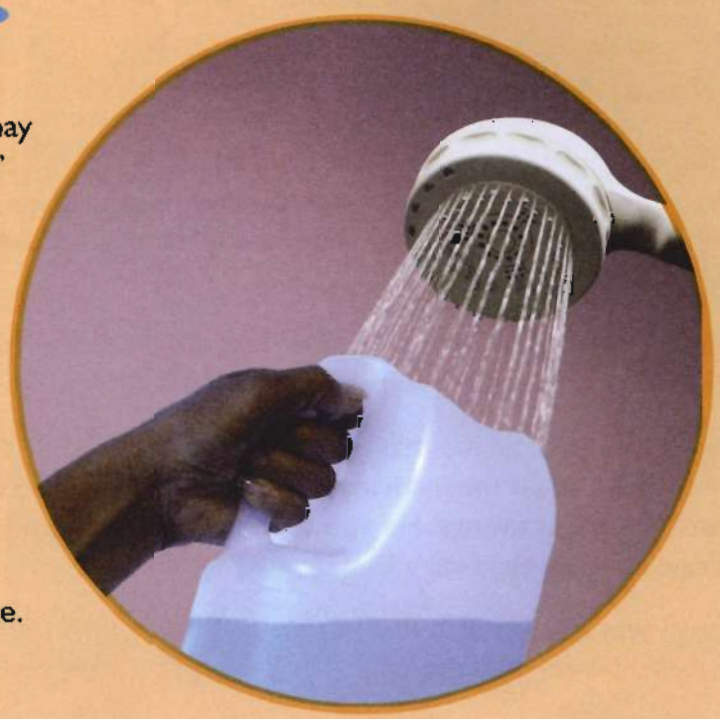
Multiply the length of time you stay in the shower by the flow rate to learn how much water you use per shower.

For example: If your showerhead delivers four gallons of water per minute and you take a 15-minute shower, how much water do you use?

15 minutes X 4 gpm = 60 gallons

An At-home Activity

How Much Water Do YOU Use in the Shower?



1. About how much time do you spend in the shower each day? Even though you may rush sometimes and dawdle at others, try to decide on the length of an "average" shower. If you shower more than once each day, add the times together. Be honest with yourself!

2. Measure the flow of your showerhead. To do this, you will need a watch with a second hand and a one-gallon plastic jug. You will also need to ask an adult to help you enlarge the opening in the top of the container to prevent spilling.

   a. Turn on the shower to its usual force.
   b. Place the gallon jug underneath the showerhead and start timing at the same moment.
   c. Record how long it takes to fill the jug completely.
   d. Repeat this procedure three times to be sure your measurements are accurate.
   e. Average the three trials by adding them together and dividing by 3.

Trial 1	_____	seconds
Trial 2	_____	seconds
Trial 3	_____	seconds
Sum of Trials 1, 2 & 3	_____	seconds
Average Time (sum ÷ 3)	_____	seconds

Suppose two of your trials are similar and one is different. What should you do?

3. Calculate the flow rate of your showerhead.
   Divide the average time needed to fill the jug into 60 to find out how many times the jug would fill in 60 seconds.

   60 ÷ _____ seconds (average time) = _____ gpm

   For example: If the jug fills in an average of 12 seconds, divide 60 by 12 (60 ÷ 12). You have a 5 gpm showerhead.
   If it fills in an average of 20 seconds, you have a 3 gpm showerhead.
   If it fills in an average of 17 seconds, you have a 3.5 gpm showerhead.

4. How much water do you use for showering? To find this amount, multiply the flow rate of your shower by the length of your shower.

   ___ minutes in the shower X ___ gpm = ___ gallons for showering

The Payoff: Using less water!

Write two things you could do to cut down on the amount of water you use in the shower.

1. _____

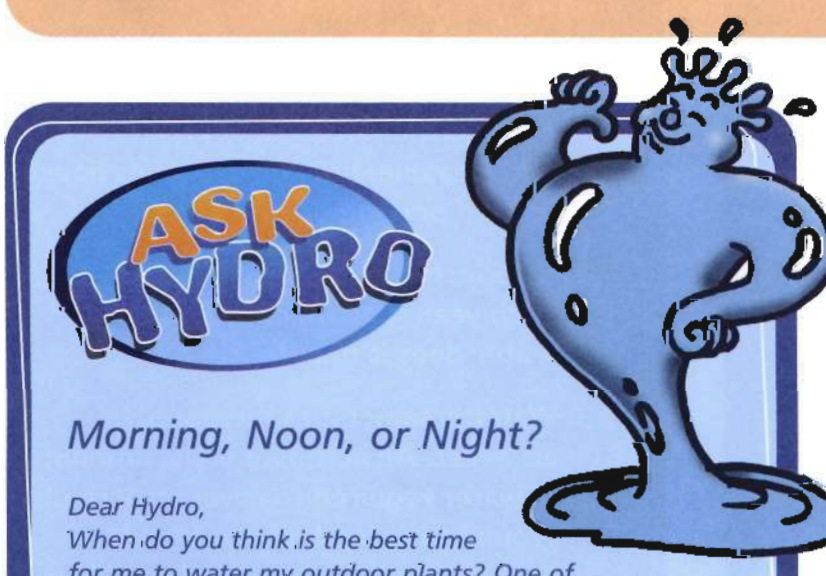
_____

_____

2. _____

_____

_____



Morning, Noon, or Night?

Dear Hydro,
When do you think is the best time for me to water my outdoor plants? One of my friends said noon, and another one said early morning or evening. Which one is right?
Signed,
Caring Gardener

Dear Caring:
At noon, when the sun is high overhead and the temperature is warm, more of the water evaporates and less soaks into the ground to the roots of the plants. Watering late in the day or early in the morning, when the temperature is cooler, allows more of the water to soak in. Watering early in the morning is best, because late night watering might cause fungi to grow.
Yours truly,
Hydro

Getting Practical...

If you shortened the time you were in the shower, how much time could you actually eliminate? _____ **minutes**

If you did that, how much water would you save every day? _____ **gallons**

How much water would you save every year? _____ **gallons**

If everyone in your class saved that much water too, how much water would you and your classmates save each year? _____ **gallons**

If you used a low-flow 2.5 gpm showerhead and took a shorter shower, how much water would you save each day? _____ **gallons**

How much would you save each year? _____ **gallons**

How much would you save in a year if everyone in your class used a 2.5 gpm showerhead? _____ **gallons**

Thirsty lawns

A grass lawn uses as much as four times more water than other landscaping.

Community Notes

$how Me the Money!

By Pabak Sune

The Iwanna Payless family, longtime residents of the Village of Conserve, has replaced a 5 gallon-per-minute showerhead with one that uses only 2.5 gallons-per-minute and costs $10. "It was some of the best money we ever spent," Iwanna said to this reporter. I asked him to explain his logic.

"For the moment, we are $10 poorer," he said. "But the investment in the showerhead started to save money as soon as we installed it."

Then, Mr. Payless told me that their water costs about 1/4¢ per gallon ($.0025), and he challenged me to do the math myself to find out when the showerhead would have "paid for itself" in water savings. He also told me that there are four people in the family, and each one takes an eight-minute shower every day.

By then I was interested in this idea, so I pulled out my pencil. It turns out that each of their 40-gallon showers now use only 20 gallons, so they are saving 80 gallons of water every day.

You can do the rest yourself. Eighty gallons, at 1/4¢ per gallon, is how much money per day? Since the new showerhead costs $10, how long will it take to pay for itself in water savings? Does that seem like a good investment to you?

Still more savings: Energy!

Cold showers are awful! It's the warmth of the water that makes showers feel so good. But heating water requires energy, and energy is expensive. In some California homes, water heating accounts for as much as 50% of a family's energy use. A family that conserves shower water not only saves water, it saves energy and money too. Would adding in these savings shorten or lengthen the Smith's payback time?

Modern toilets

Low-flow toilets use much less water than ones sold twenty or thirty years ago. Older toilets use about five gallons of water per flush, while new low-flow models use only 1.6 gallons (six liters) per flush. The newer toilets are more than three times as efficient. If your toilet is a low-flow model, it will say 1.6 gallons or 6 liters on the bowl or tank.

Hey drip! How do I fix that drop?

You can find out if your toilet has a silent leak by putting a drop or two of coloring in the toilet tank. Blue disinfectant works great, and so does a little pinch of colored gelatin or a drop of food coloring. (Your water agency may even be able to send a special blue dye tablet.) Wait a few minutes without flushing, and then see if the dye shows up in the bowl. If it does, you have a leak.

You might also be able to fix the leak. Water might be leaking between the "flapper valve" and the hole in the bottom of the tank. If cleaning the flapper valve does not work, talk to someone at your local hardware store. The part is inexpensive; the repair is simple; and the savings start building up quickly.

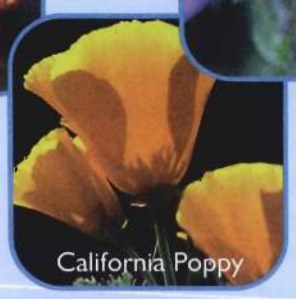
ASK HYDRO

Putting a New Bloom on Gardening

Dear Hydro,
I read that we should plant either native plants or California friendly plants in our garden at home. Should I follow that advice, and if so, why?
Signed,
Ilike Phlouers

Dear Ms. Phlouers:
That advice is excellent, and you should definitely follow it. "Native" plants have grown naturally in Southern California for centuries. "California friendly" plants may have initially come from elsewhere, but they thrive in the hot and dry Southern California climate. Both types of plants have adapted to the natural climate and conditions of our region and do not need much additional water or fertilizer. In fact, did you know that "Hollywood" was named after a native plant!

Yours truly,
Hydro



How much water is needed to keep a football field green all year long?

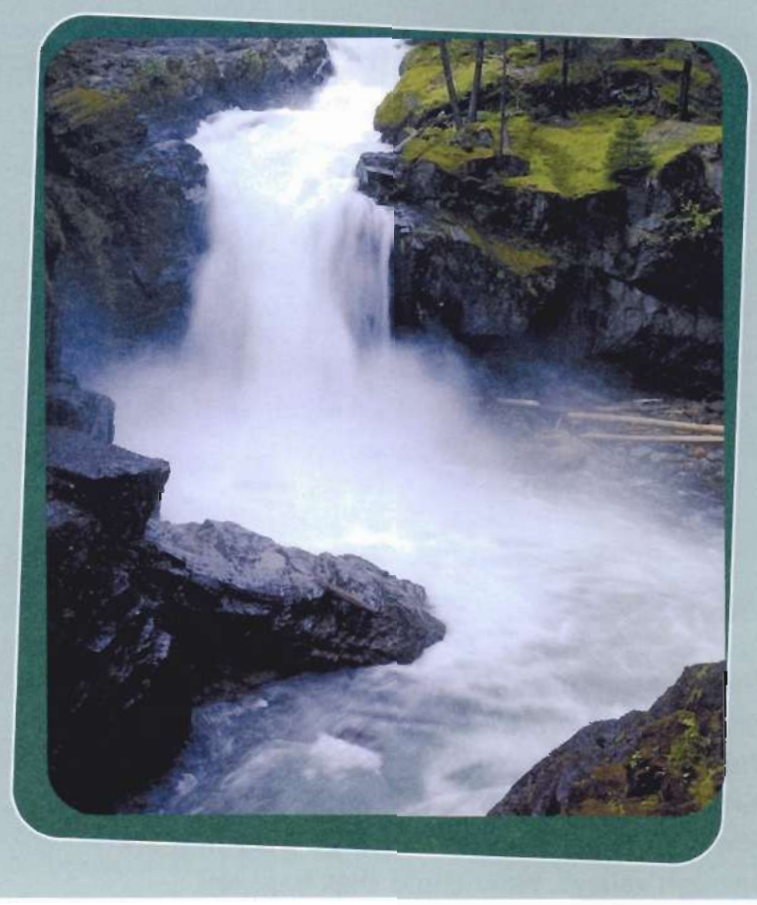
1. If the field's grass needs two inches of water per week to keep it green and playable, how many inches does it need per year?
2. If 15 inches of rain falls on the field each year, how much irrigation water does it need?
3. Water is sometimes measured in acre-feet. An acre-foot is the amount of water required to cover an acre of ground to a depth of one foot. It is enough water for two families of four for one year. A football field is roughly one acre in size.

   An acre-foot contains 325,851 gallons. Most people round it to 326,000 gallons.

   If a football field is roughly one acre, how many acre-feet of irrigation water will it require per year?
4. If that football field were no longer watered, how many families of four could live on the saved water?

Water on the Move

By Kerry Waters



Imagine life without running water: no shower, laundry, sinks, toilets, or hoses. In much of the world today, people are still without running water. They have not developed the resources to move it from where it exists to where it is used.

In California, all of us have running water. We have it because we have built systems that move water from one place to another.

The story of people moving water started long ago, and it is still unfolding today.

About 10,000 years ago, our ancestors started cultivating crops and domesticating animals. Agriculture allowed them to stay in one place because they could grow their own food. As they settled into villages, they often chose locations near rivers or streams because moving streams brought fresh water to them and carried away their wastes.

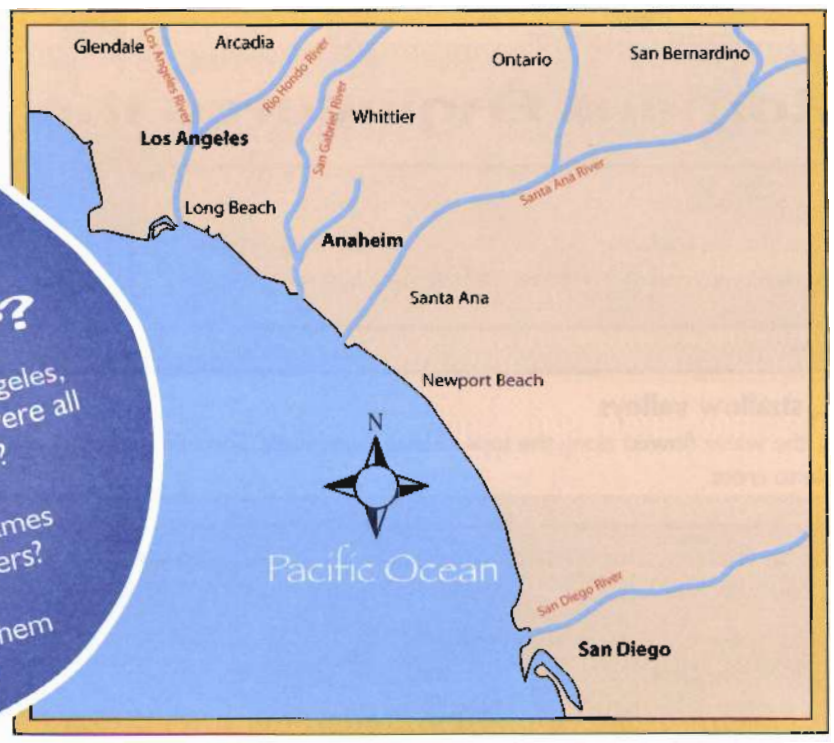
Soon, they started to irrigate, which allowed them to expand their fields. For the first time, people were learning to move water.

Was Your Hometown Founded Near a River?

Did you know that Los Angeles, San Diego, and Anaheim were all founded near rivers?

Do you know the names of any of those rivers?

Could you find them on a map?



The Dawn of Civilization

Where people began to live in larger groups, they faced new problems. With the need for rules to organize commerce, laws and governments developed. With the need to keep track of commerce, writing and mathematics evolved. These advancements are the cornerstones of what we now call civilization, and they all followed the rise of agriculture, which depended on the availability of water.

Test Your River Knowledge

Many of the world's major cities are known for their rivers. Here is a list of some of those cities. How many of their rivers can you name? For the ones you do not know, look them up on a world map or on the Internet.

City	River(s)
New Orleans, Louisiana	
St. Louis, Missouri	
Sacramento, California	
Washington, DC	
Paris, France	
London, England	
Baghdad, Iraq	
Rome, Italy	
Cairo, Egypt	
Shanghai, China	

Successful cities sometimes outgrow their rivers. Perhaps there are too many people for the available water. Sometimes rivers become too polluted, so people get sick. When that happens, people face the challenge of finding more water.

Over the Hill:

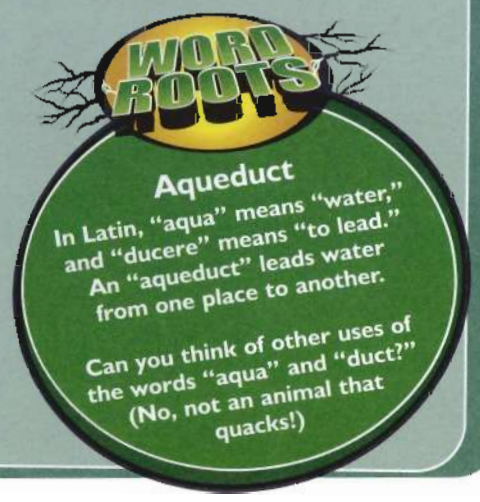
Building the Roman Aqueducts

By R. Kade

More than 2,000 years ago, the city of Rome started to outgrow its water supply. The city had been built on the Tiber River, but as the city grew, it faced new problems: not enough water in the dry season and pollution from too many people and animals living in a small area.

The planners knew there was plenty of fresh water in the nearby hills, but they needed a way to move it into the city. They envisioned a superhighway for water. Over a span of many years, they solved one engineering problem after another until they successfully built the amazing aqueducts of Rome!

Citizens of the Roman Empire proved to be among the greatest aqueduct builders of all time. They moved more water from greater distances than any other culture for more than a thousand years!



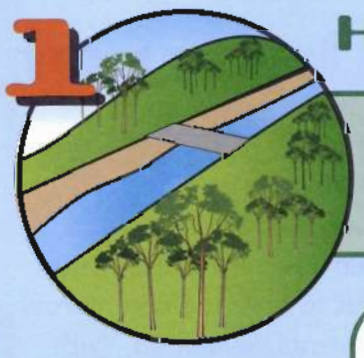
The great minds of Rome believed they could bring water from the mountains to the city, but they were not sure how. Aqueducts presented some vexing problems. The water had to flow downhill, but it would have to go over hills and through valleys. How could that happen?

Activity

Pull Out Your Ruler!

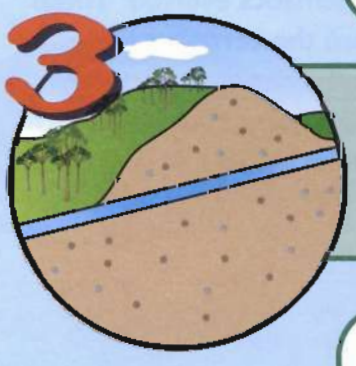
Using the scale of miles on the map in the center of this booklet, measure the length of the Colorado River Aqueduct and the length of the California Aqueduct. Now measure a distance of 57 miles starting from the center of Los Angeles and moving toward either of those two points. (That was the length of Rome's longest aqueduct.) How does the length of Rome's longest aqueduct compare to the length of California's great aqueducts?

How the Romans Engineered their Aqueducts

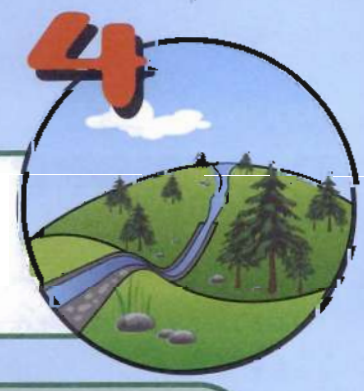


Terrain #1: Sloping hillsides
On gentle, sloping hillsides, Roman engineers dug and built water channels directly into the ground. Where people needed to cross the channel, they built small bridges.

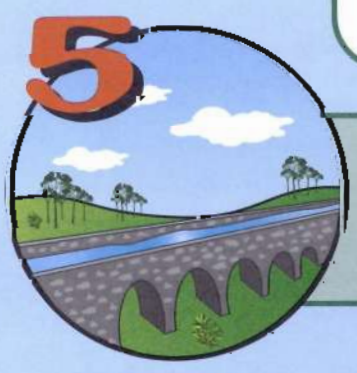
Terrain #2: Short, shallow valleys
In short, shallow valleys, the water flowed along the tops of long stone walls. Sometimes these walls were too high for people to cross.



Terrain #3: Mountains
Without mechanical pumps, water could not move over mountains. The Romans solved the problem by digging tunnels through the mountains. The technology was old-hat for them because people had been mining under the ground for centuries.



Terrain #4: Steep narrow valleys
When water runs down one side of a valley, how can it climb back up the other side? People had long known the principle of the siphon and had used it to move small amounts of water. The Romans built giant inverted siphons to span entire valleys.



Terrain #5: Broad valleys
To cross broad valleys, the Romans built beautiful arched structures, called arcades, like the ones you see in the photograph on the next page. The arcades required less stone than solid walls and allowed for easy movement from one side to the other. Even better, they were beautiful structures that graced the Roman landscape and continue to do so today.

Despite the familiar image of stone arcades that we often link with the Roman aqueducts, only about 30 miles of the total 260-mile aqueduct system were elevated on arcades. Most of the aqueducts were built on hillsides and in tunnels.

Aqueduct Trivia

California Aqueduct

1. Longest aqueduct in California
2. Begins at the Delta (near Sacramento) and ends in southern California
3. Astronauts report that it can be seen from thousands of miles into space
4. Began delivering water to southern California in 1972
5. As water travels to southern California, it is pumped nearly 2,000 feet over the Tehachapi Mountains (lifted higher than anywhere else in the world)

Colorado River Aqueduct

1. 242 miles long (from Lake Havasu to southern California)
2. Takes 2 days for water to travel from Lake Havasu to Lake Mathews
3. Construction of the aqueduct took 8 years (1933-1941)
4. Designated as a National Historic Landmark and one of the seven civil engineering Wonders in the United States
5. Maximum flow of water is over 1,800 cubic feet per second (or over 1,800 water-filled basketballs moving per second)

Making Water Clean:

Ancient Practice, Modern Practice

By Settel Aught, Phil Terr, and Dyssin Phekt

Perhaps because it looks more appetizing, the Romans seemed to know instinctively that cleaner water was healthier.

Amazingly, the way they treated their water was almost the same as the way we treat ours today. The biggest difference is that we know the science, we can measure water pollution, and we add chemicals to disinfect the water. The Romans did what seemed right and added a little dose of good luck along the way.

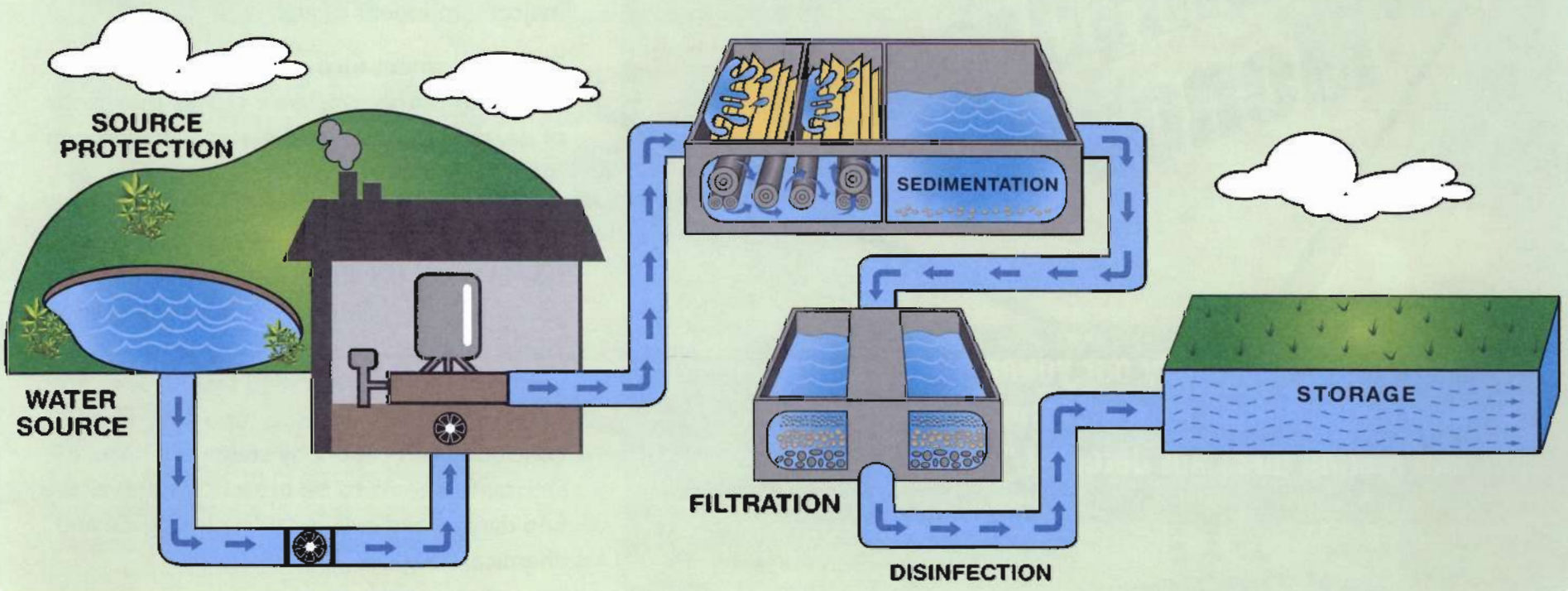
The basic steps of water treatment are:

Source Protection:
Protecting the land that the water flows through so the water is as clean as possible before the treatment process begins.

Sedimentation:
Allowing the solid matter in water to sink to the bottom or float to the top and then removing it.

Filtration:
Allowing the water to pass through a filter of sand or other fine material.

Disinfection:
Killing the germs and microorganisms in the water to prevent illness.



Water Treatment

	Ancient Rome	Modern-Day California
Source Protection	Springs in secluded hills transported to the city through aqueducts.	Water is stored in reservoirs and transported through aqueducts and pipelines.
Sedimentation	The Romans built settling stations along the length of the aqueduct so gravity would cause the solid material to settle out.	We allow water to sit in "settling basins." We then help that process by adding chemicals called "flocculants" that cause the solid matter in the water to clump so it can be removed more easily.
Filtration	None.	Our water passes through filters of fine sand to remove particles and microorganisms, and sometimes it passes through a filter of carbon to remove unpleasant tastes and odors along with other impurities.
Disinfection	Although the Romans did not know about germs and disease, their water traveled in an open channel where it was exposed to bright sunlight. Luckily for them, they unknowingly disinfected their water by using ultraviolet radiation from the sun!	Like in Roman times, ultraviolet radiation from the sun helps to disinfect some of our water in open aqueducts and reservoirs. More importantly, we add chemicals to disinfect our water. Some of our water is disinfected with a combination of chlorine and ammonia, and some is disinfected with a special type of oxygen called "ozone." Our water is tested regularly in high-tech water quality labs to be sure it is free of contaminants that might make us sick.

WORD ROOTS

Arcade
The root of "arcade" is the word "arch." The first definition of "arcade" is "an arched, roofed building or part of a building"; the second is "a series of arches supported by columns, piers, or pillars."

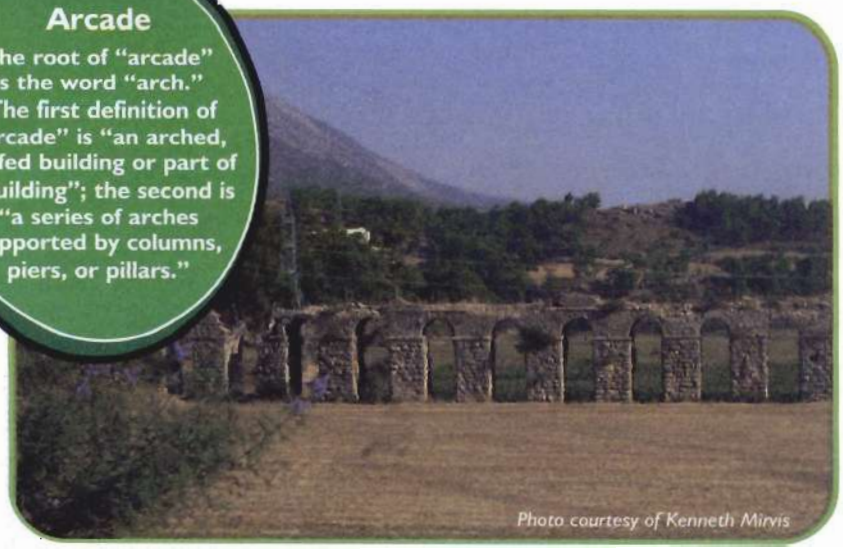


Photo courtesy of Kenneth Mirvis

Looking at the photograph, can you see why the elevated portions of the aqueducts are described as arcades?

The Aqueduct Systems of Rome and Southern California

Based on what you have learned in this section, complete this table by writing a Y for yes and an N for no:

	Rome	Southern California
Convey water by aqueducts		
Tunnel through mountains		
Run water through open channels		
Convey water entirely by gravity		
Support aqueducts on arcades		
Use chemicals to disinfect the water		

PAID ADVERTISEMENT

WARNING
Citizen's Committee Warns of Hazards from Dihydrogen Monoxide

"Our youth, especially our young athletes, are now using it daily as a performance enhancer, and testing does not detect it."

In a recently released report, the California Citizen's Committee on Molecular Activity has stated without reservation that the presence of dihydrogen monoxide has been confirmed in every county in the state of California. Furthermore, it is present in large quantities in every polluted waterway in the state.

The Department of Health Services has not established limits on the substance as being either hazardous or carcinogenic. However, the department has noted that the substance can be highly corrosive under certain conditions, and it is always linked with other highly toxic and dangerous substances, such as hydrochloric acid and sulfuric acid. It is a major component of acid rain.

The department further established that inhalation of the substance causes thousands of deaths each year, and gaseous dihydrogen monoxide can cause severe burns. The committee has recommended an immediate ban on the substance, citing the greatest fear as being the substance's effect on young people. "Our youth, especially our young athletes, are now using it daily as a performance enhancer, and testing does not detect it," the committee reported. They concluded this report by stating, "This scary substance seems to be present wherever we find danger and evil, including biological and chemical weapons."

The committee is urging all concerned Californians to write their congressional representatives for an immediate ban on dihydrogen monoxide until safe limits for its use can be scientifically established.

— By B. Ware and B. A. Lert

WATER LOG

1. What is your emotional response to the presence of dihydrogen monoxide in our environment?
2. Do you think "dangerous" substances like dihydrogen monoxide should be regulated or banned?
3. When you see a "paid advertisement" in a newspaper, what questions does it raise?

WORD ROOTS

Dihydrogen Monoxide

You can figure out the roots for yourself.

WET WEBS

www.mwdh2o.com/mwdh2o/pages/education/education01.html
www.groundwater.org/kc/kc.html
www.epa.gov/owow/oceans/kids.html
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