

POPULAR SCIENCE

March/
April
2017



**THE
STATE
OF
WATER
IN
OUR
WORLD**

(NO REFILLS)



PLUS

**FLINT, MICHIGAN:
BY THE BOTTLE**

**THE NAVY'S MOST
ELITE DIVERS**

**YOUR FAUCET IS
FULL OF SECRETS**

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**Ways to Get
Rock-Hard Ice**

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WASTING MORE WATER

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LIFE IS THIRSTY



IT TOOK 338,303,000 gallons of water to make this issue—give or take some sweat and tears. No, we didn't pioneer a way to turn water into journalists and then kick back and watch ol' H₂O dedicate an entire magazine to itself. But we did drink water as we brainstormed, reported, designed, wrote, copy-edited, photographed, fact-checked, and so on. And I'm happy to report that everyone showered, washed their clothes, and went to the bathroom regularly. We probably all directly consumed close to the American average of 100 gallons of water per day.

But that is—and I'm really sorry for this next phrase—just a drop in the bucket. As Sarah Scoles reports (p. 58), the average American actually uses about 2,088 gallons in 24 hours.

Because it's not just the water you pull from the tap: your food, clothes, and even the magazines you read extract a cost in H₂O.

That burger came from a cow that consumed 220 gallons of water to make your half-pound patty; those pants took about 2,000 gallons to go from seed to (cotton) tweed; and this magazine is made of trees, ink, printing presses, delivery trucks, beer.... Just accounting for paper and ink production got us to nine digits.

OK, I'll stop.

The point is, life drinks way more water than we think. And though Earth's population grows 1.2 percent every year, the total amount of water on our pale blue dot is the same as when a T. rex was this magazine's editor. This is all we've got, and we need to be careful how we use it. Whether we're the residents of the recently water-starved La Paz, Bolivia (read about it on p. 36) or living la vida agua in the rainforest, we need to think about our planetary family.

That's why we dedicated this issue to exploring our most precious natural resource. The good news is that for every water crisis, enterprising women and men are inventing new ways to be mindful of our soggy footprints. If we're vigilant about what we consume, the future will be gloriously, wonderfully wet.

Cheers,



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ATLAS

stressed out: gauging global water worries

IN SOME PARTS OF THE WORLD, CLEAN WATER FLOWS straight from a tap. In others, people trek for miles to reach a potable source. How do we measure the availability of this essential resource? Compare the amount of water a region uses to the size of its water supply. This ratio of supply to demand, known as water stress, often shifts over time. As populations grow or move around, so too will demand. And as climate change redraws temperature and

1 Southwestern United States

As climate change pushes water supply down, the wildfire-plagued Southwest grows even more parched. A growing population in the region will drive up demand—and stress.

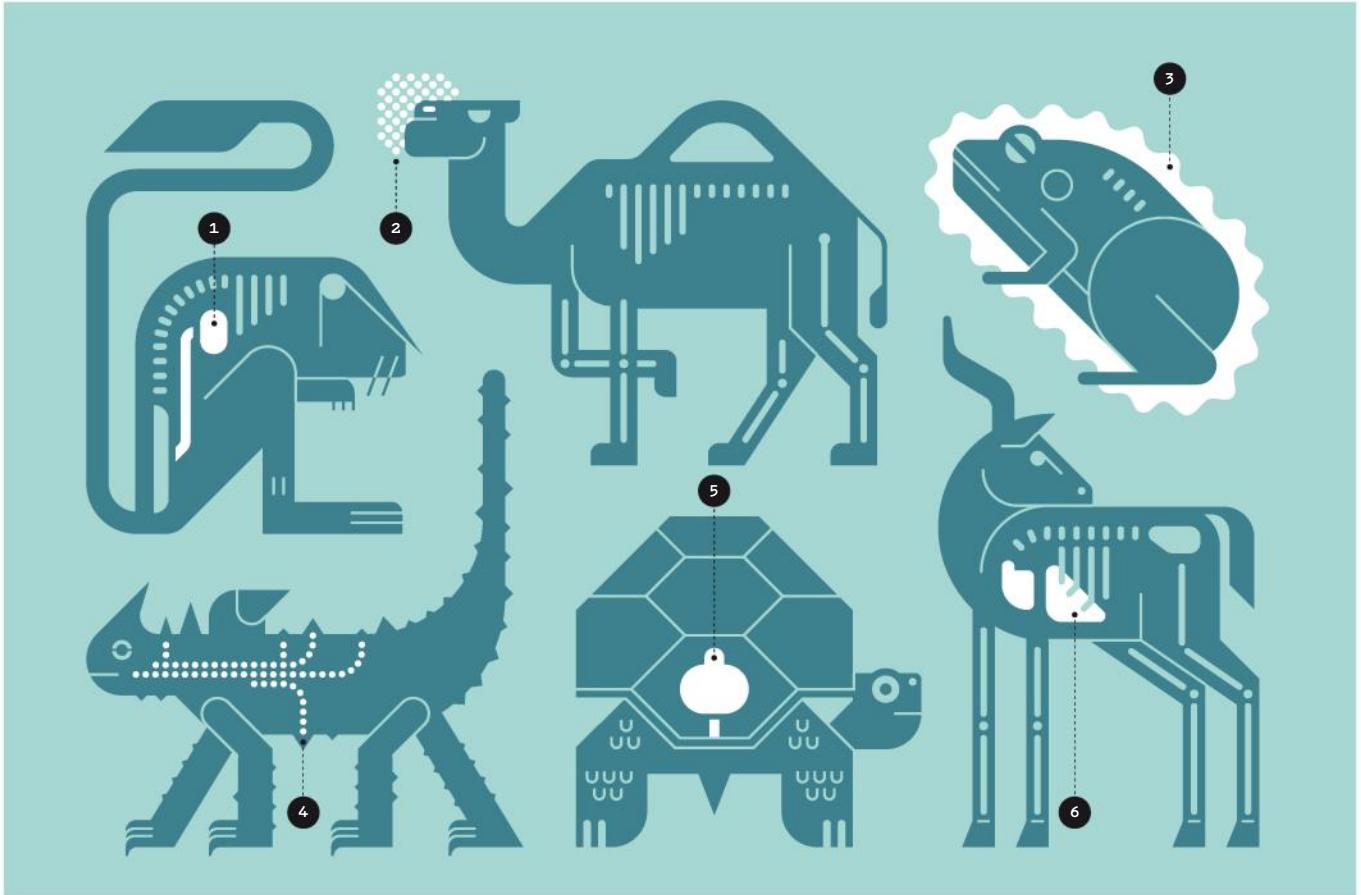
2 Coastal Peru

Shifting precipitation patterns caused by climate change will slightly increase rainfall—and thus water supply—in Peru. But those same weather patterns could increase Chile's water stress.



moisture misers

IN THE DRIEST PLACES ON THE PLANET, HYDRATION IS HARD TO COME BY AND easy to lose. Every moist breath exhaled, every bead of sweat that drips off, and every emptied bladderful of urine means wasted wetness and a greater risk of death by dehydration. Yet some animals manage to survive in these places. They get by on almost no water at all, thanks to clever adaptations that make them super savers and hydration scavengers.



1 Kangaroo Rat
The kangaroo rat never has to drink water—it just gets it from the seeds it eats. To survive in the dry climes of the American West, its kidneys generate super-concentrated urine, and it doesn't pant or sweat. Some species can even lower their metabolic rates so they lose less moisture through breathing.

2 Camel
Camels don't actually store water in their humps, so they have to conserve it. At night, after the chilly Saharan air cools the camel's nasal cavity, mist in its breath condenses inside its nose, where it gets reabsorbed. The camel's extra-twisty nasal passages save up to 60 percent of the moisture it would have lost during exhalation.

3 Water-holding Frog
During hot, dry periods, this Australian frog secretes a waterproof mucus cocoon that prevents moisture from escaping its body. Meanwhile, the frog hibernates underground, waiting for another rainy season. It can survive for two years or more on the liquid stored in its bladder.

4 Thorny Devil
The spikes of Australia's thorny devil do more than ward off predators. The lizard's absorbent skin and spines suck up dew from cool night air, rain, puddles, and any other moisture it can get. Thin grooves in its skin help trap the water, then route it to the lizard's mouth for a tippie.

5 Tortoise
In the Mojave and Sonoran deserts, several tortoise species survive off their urine. During times of plenty, their bladders swell to hold around 16 ounces of liquid gold—impressive for a reptile that's only about 12 inches long. The tortoise can later reabsorb water from its urine to endure a year or longer without a drink.

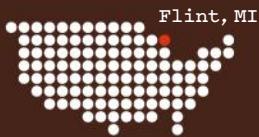
6 Sand Gazelle
Sand gazelles in the sweltering Arabian Desert have evolved the strange ability to shrink their oxygen-demanding organs when dry spells hit. Downsizing their hearts and livers by 20 and 45 percent, respectively, allows them to breathe less. Taking fewer breaths means less water lost to respiratory evaporation.

4

The number of standard-size (16.9-ounce) bottles of water an average adult needs to drink daily to prevent dehydration.

757

The number of bottles it would take to substitute all of a standard American's daily water usage, including showering and tooth brushing.



IN 2014, THE GOVERNMENT of Flint, Michigan, switched the city's water source to the Flint River, and you've probably heard what happened next: Officials failed to add important corrosion inhibitors to prevent water from leaching metal out of the city's aging pipes. Soon, dangerous levels of lead infiltrated the water system. To protect themselves and their children from lead's side effects—weakness, developmental delays, and seizures—concerned residents have turned to bottled water. Lots of it. Here's a glimpse of what it's like to live life in the midst of a water crisis, bottle by bottle.

BREAK IT DOWN

Flint: a day by the bottle

by Rachel Feltman / photograph by The Voorhes



14

The number of bottles the state should give a Flint resident daily; the result of a lawsuit from the American Civil Liberties Union, and others.

100

The number of bottles it reportedly took some Flint families to make Thanksgiving dinner in 2016. One needed 24 bottles just to thaw the turkey.

60

The number of bottles needed to cook—and clean—per day for one Flint family of three, who tracked how much water they used, and for what.

750

The number of water bottles that Flint's Durant-Tuuri-Mott Elementary School uses daily—that's a little more than one bottle per student.

what the frack

OVER 100 BILLION GALLONS—THAT'S HOW MUCH FLUID FRACKING WELLS inject into the U.S. each year. The high-pressure slurry cracks underlying shale, releasing oil and natural gas trapped inside. But fracking's rise raises questions about water pollution. Although scientists have linked individual cases of contamination to fracking, a 2016 EPA report on its safety was inconclusive. Companies don't have to disclose what is actually in the slurry. Like Coca-Cola's formula, these chemical cocktails are trade secrets, so it can be hard for scientists to gauge risk. Here are some components, from run-of-the-mill to rare, squeezed out of cagey corporations.

METHANOL

An alcohol often found in antifreeze that serves to winterize fracking fluid. If you drink it, you could go blind—or die.

2-BUTOXYETHANOL

This solvent keeps the slurry stable at high temperatures. But don't inhale: It can damage your lungs and red blood cells.

SODIUM CHLORIDE

Aka: table salt. It stabilizes fracking fluids. Even small amounts seeping into rivers and lakes can kill freshwater fish.



WALNUT HULLS

Fracking fluid isn't all bad. Gritty shells show promise as a fracking proppant—they prop open fractures made in the shale.

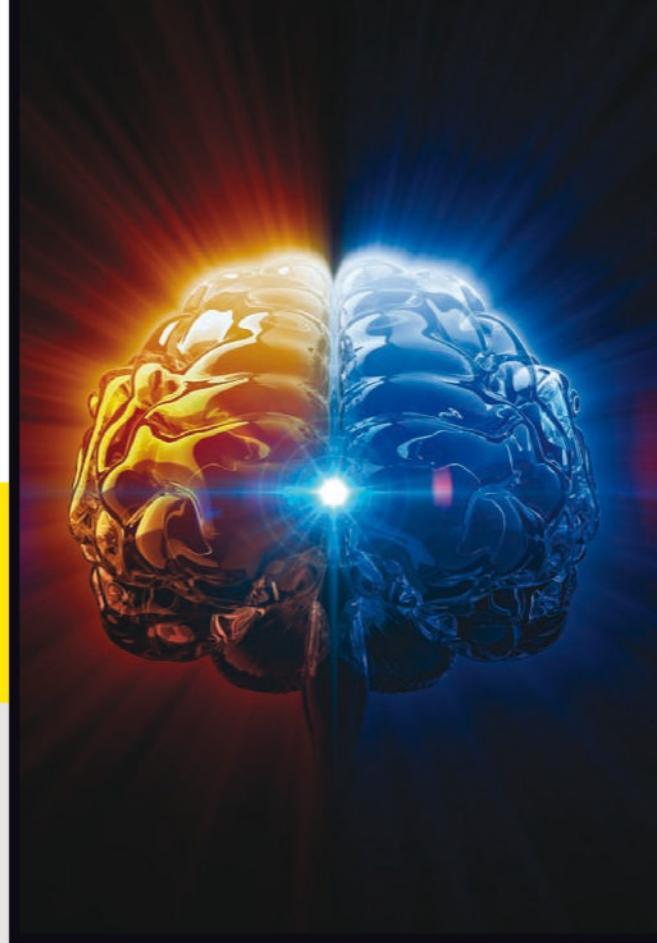
UREA

The urine component undergoes a reaction that makes ammonia, using up water in the process. This means less waste left behind.

DIESEL

It makes the fluid slick, lowering its friction. But its cancer-causing components might contaminate groundwater.

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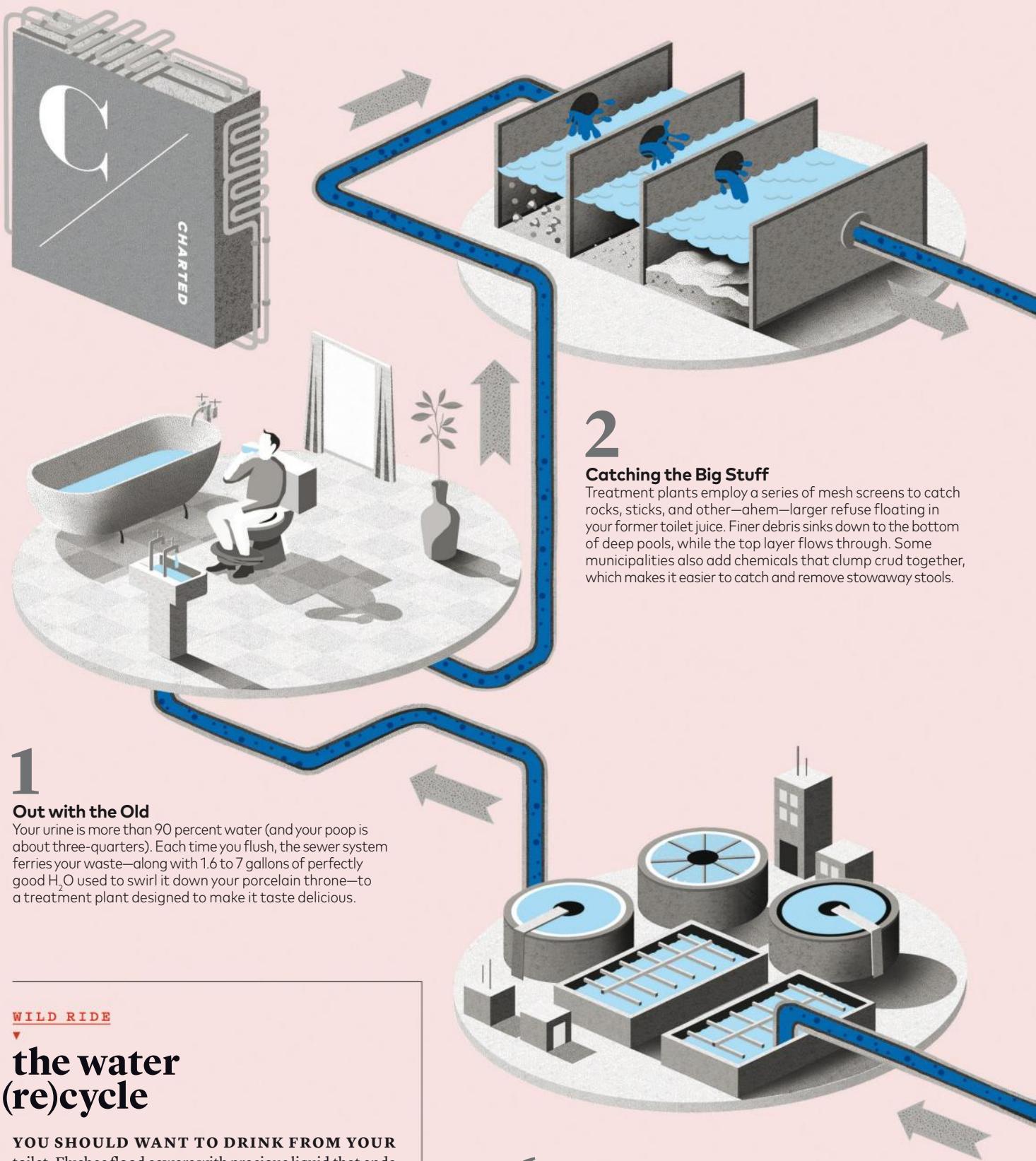
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1

Out with the Old

Your urine is more than 90 percent water (and your poop is about three-quarters). Each time you flush, the sewer system ferries your waste—along with 1.6 to 7 gallons of perfectly good H₂O used to swirl it down your porcelain throne—to a treatment plant designed to make it taste delicious.

2

Catching the Big Stuff

Treatment plants employ a series of mesh screens to catch rocks, sticks, and other—ahem—larger refuse floating in your former toilet juice. Finer debris sinks down to the bottom of deep pools, while the top layer flows through. Some municipalities also add chemicals that clump crud together, which makes it easier to catch and remove stowaway stools.

WILD RIDE

the water (re)cycle

YOU SHOULD WANT TO DRINK FROM YOUR toilet. Flushes flood sewers with precious liquid that ends up washed out to sea or sprinkled on crops. But we could be enjoying recycled urine as a beverage. Some U.S. cities, like the perpetually parched San Diego, are beginning to use advanced purification treatment plants to reclaim the stuff, combating drought by harnessing millions of gallons of would-be waste daily. It tastes so good, you'll forget that it used to be your neighbor's pee.

6

Homeward Bound

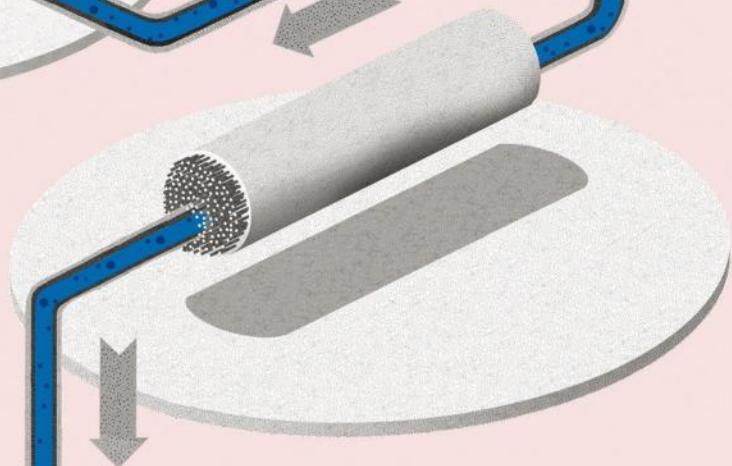
After sitting pretty in the reservoir for who knows how long, all that agua needs another round of filtration before it's safe to drink again. Then a disinfectant like chlorine kills microbes. The result whooshes out through your tap, into a glass, and down your gullet—and so the cycle begins anew.



3

Taking a Closer Look

"Activated sludge" sounds nasty, but this mushy mix of bacteria actually helps break down organic contaminants. A good stir swirls and sashes the sludge through giant vats. When it settles, it leaves behind purified liquid that can then be disinfected for use in irrigation or other industrial applications. But you wouldn't want to drink the stuff (at least not yet).



4

One Last Pass

After another round of filtration for good measure, the good stuff makes its way through strawlike fibers. Pressure forces H₂O through pores so small that only individual molecules can fit, ensuring that only a pure hydrogen-oxygen cocktail crosses over the membrane. This process, called reverse osmosis, makes former toilet contents pristine and drinkable.



5

Back to Nature

People don't like the idea of drinking recycled pee, so the now-pristine liquid goes back into natural reservoirs to mix with droplets from rain and rivers. It can stay there indefinitely, gathering minerals from rocks and soil, and going through natural filtration processes until it's called back into action.

100

Gallons of wastewater, in millions, recycled in Orange County, California, each day.

10L



Broccoli

Broccoli seems like a wonder food, based on the calories you get out for the water you put in. And even though 100 calories of the veggie weighs in at more than half a head, this crunchy snack doesn't need a ton of flow to grow.

180L



Chicken

Chickens not only drink water, but they also munch water-requiring feed. But they don't do so for long: The average broiler takes a mere five weeks to reach its market weight of 5 pounds. After that, the eater becomes the eaten.

170L



Apples

Apple trees are picky growers: They don't thrive in too-wet soil, but they do require irrigation in too-dry soil. Yet, on the liters-per-100-calories scale, they use nearly as much water as chicken. That's because the fruit provides less energy.

55L



Wheat Flour

Wheat usually grows in spring and fall, so farmers needn't water it during the blistering days of summer. Wheat also has a deep and efficient root system, and in ideal circumstances, doesn't even require additional irrigation.

0.089L



Crickets

Crickets are efficient little bugs. Sixty percent protein by weight, they require fewer than four liters of water per pound of protein. Even better, they reach adulthood in just six weeks. The challenge is convincing people to eat them.

1,000L



Steak

Cattle are natural water guzzlers, drinking nearly 130 liters per day. What's worse, a 1,200-pound cow can eat more than 20 pounds of hay while the sun shines, which incurs an H₂O penalty of thousands of additional liters.

MEASURE UP

but how much does food drink?

WHEN YOU EAT, YOU USE UP every drop of water your food required to grow. And depending on your choices—roasted broccoli versus a juicy steak—a meal might consume a few liters of water, or a few hundred. Some plants sip gingerly from the soil, while others gulp; and animals not only drink water, but ingest it indirectly through the feed they eat. In a thirsty world, we should choose our foods wisely. To help, *Popular Science* calculated how much water goes into 100 calories' worth of these staples.



la's far-ranging roots

MORE PEOPLE LIVE IN THE SUNBAKED CITIES OF LOS ANGELES COUNTY than the local water supply can support. Millions more. What's a parched metropolis that's long ago outgrown its groundwater canteens to do? Steal what it needs from other regions. Using elaborate systems of concrete-lined straws and pumps, LA slurps meltwater from the Sierras and flowing H₂O from rivers hundreds of miles away. OK, it's not technically theft—the city secured water rights decades ago. But that doesn't stop people at the sources from grumbling. And as climate change and environmental stresses take their toll, the city and its neighbors will only grow thirstier.

San Joaquin-Sacramento River Delta

Water enters this network of channels via two of California's largest rivers: the San Joaquin and the Sacramento. Some of that fresh water then flows into the 444-mile-long concrete-coated California Aqueduct.

Eastern Sierra

Snowmelt from the Sierra Nevada, delivered via the LA Aqueduct, is the city's easiest and cheapest imported source—for now. Thanks to climate change, more precipitation is falling as rain, and snow is melting earlier, leaving less snowmelt to get LA through summers.

Local Groundwater

Some cities in LA County still extract water from within sediment layers. They take it from basins overseen by court-appointed "water masters," pump the liquid up to the surface, treat it, and send it flowing into the system.

Colorado River

Some 18 million Californians get water from this river on Arizona's border. California gets to siphon off 1.4 trillion gallons every year, but the state's been blowing that budget by some 200 billion gallons. The federal government has kindly asked them to quit it.

Desalination

With so much ocean nearby, why does LA import water at all? Because desalination guzzles a lot more energy and money than relatively passive aqueducts. A fancy desalination plant opened in Carlsbad in 2015, but it supplies Southern California a relatively low volume.

16

minimum number of days water requires to travel the length of the California Aqueduct



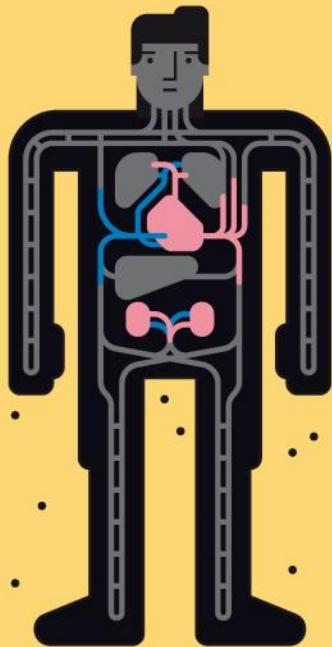
STAGE

1

Thirst

WATER LOST 2% of body weight. For a 170-pound person, that's 3 pounds. You might lose this much sweat by kickboxing for an hour in a hot room without a drink.

EFFECTS When thirst kicks in, your body clings to all remaining moisture. Your kidneys send less water to your bladder, darkening your urine. As you sweat less, your body temperature rises. Your blood becomes thicker and sluggish. To maintain oxygen levels, your heart rate increases.



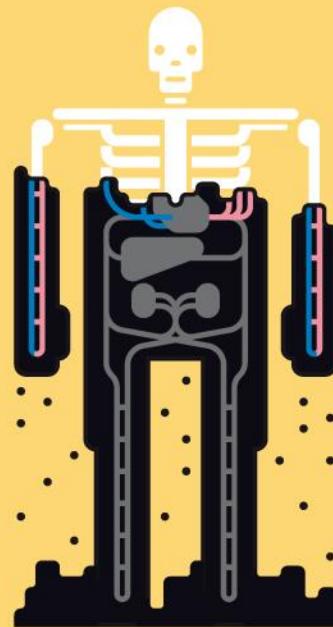
STAGE

2

Fainting

WATER LOST 4% of body weight. For a 170-pound person, that's 7 pounds. This is roughly equivalent to riding a bike for three hours in extreme heat without rehydrating, or going without water for two days.

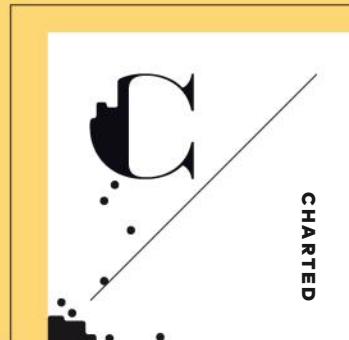
EFFECTS Your blood is so concentrated that the resulting decrease in blood flow makes your skin shrivel. Your blood pressure drops, making you prone to fainting. You've basically stopped sweating, and without this coolant, you start to overheat.



QUENCH YOUR CURIOSITY

▼ **the thirsty body**

WATER MAKES UP ABOUT 55 TO 65 PERCENT OF YOUR BODY. IT'S A CRUCIAL ingredient in the chemistry that helps your brain think, your blood flow, and your muscles move. But what happens after you sweat through a spin class, spend a day at the beach, or simply ignore your thirst? Dehydration is different for everybody—it depends on how much you're exercising, the temperature around you, and how much you typically sweat—but it can get dangerous quick.



STAGE

3

Organ Damage

WATER LOST 7% of body weight. For a 170-pound person, that's 12 pounds. You might lose this much sweat doing hot yoga for eight hours without rehydrating.

EFFECTS Your body is having trouble maintaining blood pressure. To survive, it slows blood flow to nonvital organs, such as your kidneys and gut, causing damage. Without your kidneys filtering your blood, cellular waste quickly builds up. You're literally dying for a glass of water.



STAGE

4

Death

WATER LOST 10% of body weight. For a 170-pound person, that's 17 pounds. This is like going for five days, or running for 11 hours in 90-degree weather, without rehydrating.

EFFECTS You need to drink some water—stat! If it's hot out, your uncontrollable body temperature means your vital organs risk overheating; liver failure will probably kill you. But if conditions are mild, toxic sludge builds up in your blood, and your coroner's report will more likely read: kidney failure.



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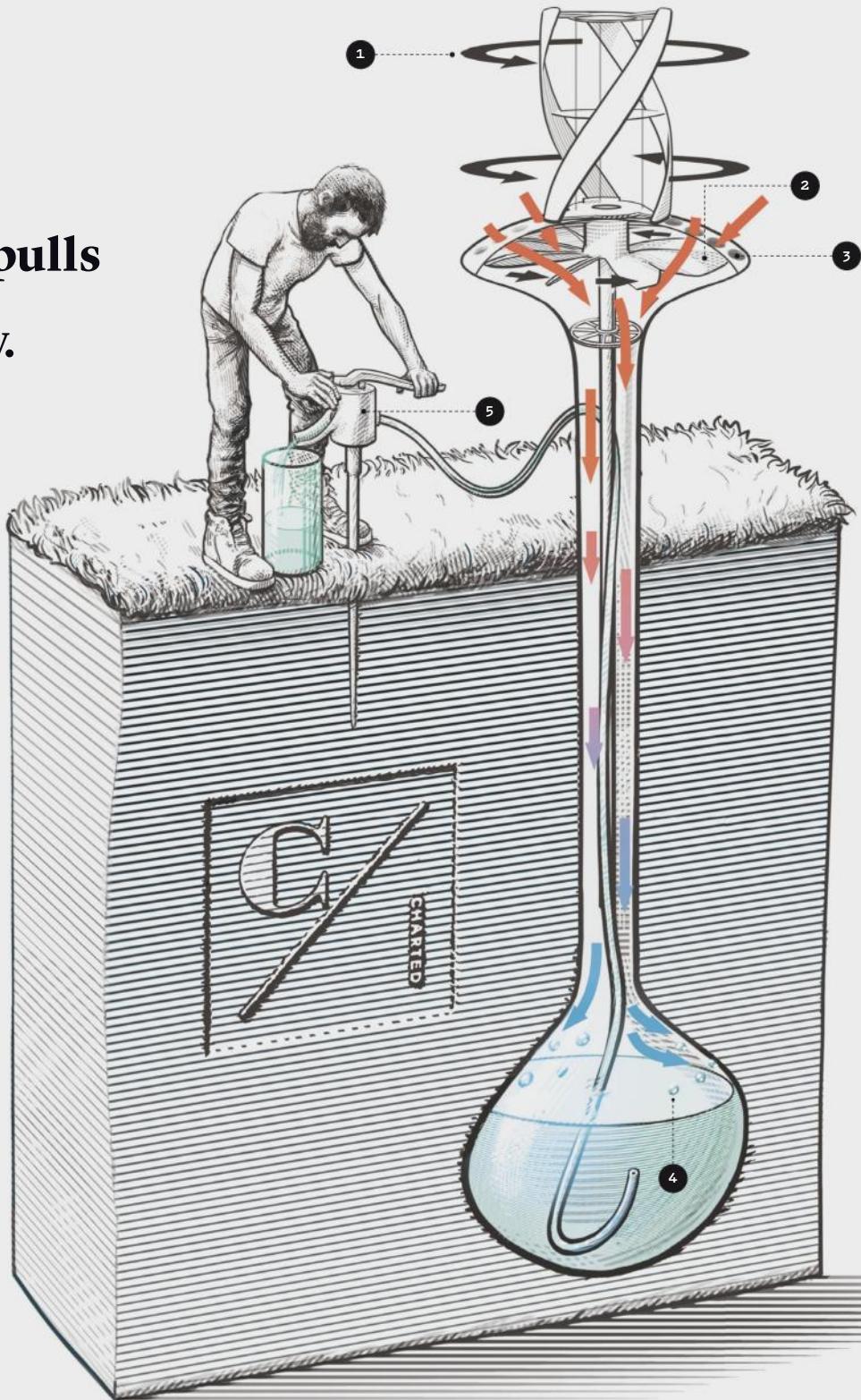
ANATOMY

a machine that pulls water from thin air. literally.

MORE THAN 660 MILLION people lack regular access to clean drinking water. And by 2030, half of humanity will live in areas where the demand for water outstrips the available supply. That's why entrepreneurs Nancy Curtis and Don Zacherl from Vici Labs are experimenting with a device they call WaterSeer, which pulls moisture out of the air using nothing but wind power and basic physics.

The air is full of water vapor. Chill that vapor, however, and the water will condensate into a liquid. This principle makes water bead up on the outside of a frosty glass—and it also drives WaterSeer: The device sends air underground, where cooler temperatures turn the water from gas to liquid. Field tests suggest that WaterSeer can produce up to 11 gallons of fresh drinking water per day in drier environments like San Francisco. It works even better under humid conditions, like in Virginia, where it can provide 14 gallons a day.

Working with the National Peace Corps Association, Vici Labs aims to begin testing the device in up to 10 locations around the world this year. If all goes well, it could provide safe drinking water to communities in developing countries, and even drought-stricken California.



HOW DOES IT WORK?

1

A three-bladed vertical turbine on top of the device spins in the wind, driving a second fan in the PVC body of the machine.

2

The second fan directs relatively warm air from the surface into the condensation chamber, buried 6 feet underground.

3

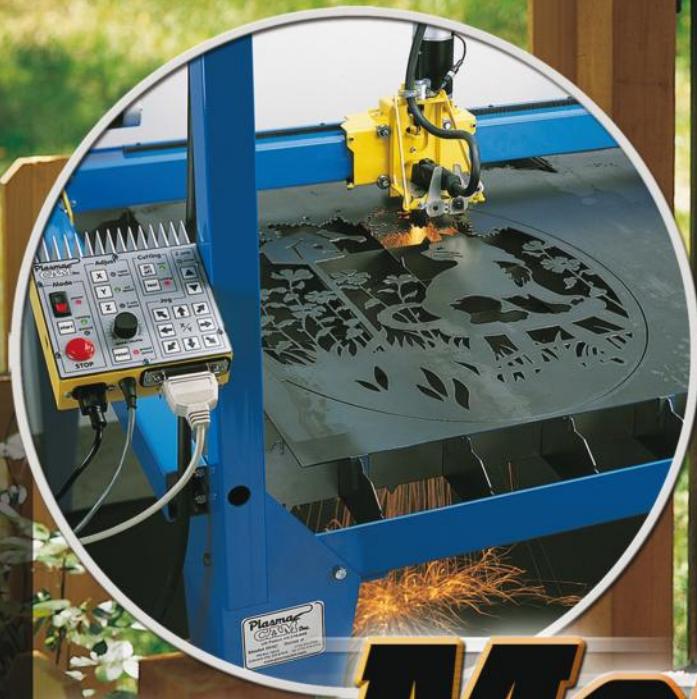
A filter prevents insects and debris from entering the pipe so they don't contaminate the harvested water.

4

As the air cools, liquid beads up on the sides of the condensation chamber, which locals can make from any available materials.

5

A hand-operated pump—no electricity required—raises the liquid, which is even cleaner than tap water, to the surface.



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THE WATER BANNER

OUTSIDE THE WINDOW OF HELEN DAHLKE'S OFFICE, AT THE University of California at Davis, the clouds hang low, their edges seeming to brush against the building. It's raining intensely, an unusual event in a perpetually parched state suffering from a five-year drought. "It looks like the end of the world," says Dahlke happily. As a hydrologist and professor who studies how water flows over and through rock, soil, fields, and farms, she is something of an H₂O whiz. For the past two years, Dahlke has spent days like this doing what water conservationists might find abhorrent: standing in the rain, in knee-high rubber boots, opening sprinklers on a dormant farm or orchard, and letting them spray. She's good at it. She can spray about 45 million gallons in 42 days.

She admits: "I was always fascinated by water as a child. I always liked to play with it."

Dahlke's sprinkler-play could change the way California thinks about its weather and how we all save water. Her floods aim to find out if humans can target and replenish drought-depleted aquifers—the deep permeable rock that holds our farming and drinking water—by harnessing the winter rainy season.

It's a particularly poignant question this year, when winter storms sent as much as 350 billion gallons into California reservoirs. Officials had to literally open floodgates and send the excess downriver, and eventually into the sea. That's like burning money. And we've been burning it for a very long time.

Since the 1930s, California has lost 100 million acre-feet of groundwater, according to Dahlke, who has helped solve water problems in Ethiopia, South Africa, and Sweden. A native of Leipzig, Germany, she was amazed to learn this figure. "One acre-foot of water is a soccer field covered with a foot of water,"

she says, pausing to let that visual sink in. "So imagine 100 million soccer fields of water."

Dahlke and others now want to bank those soccer fields by diverting them to many of the state's 4 million acres of dormant winter farmland and orchards—using the exact same irrigation pipes and sprinkler systems that already feed them in summer—saving the water, in effect, to pump back up on a sunny day.

Following one of her deliberate floods, Dahlke deploys ground-penetrating radar, remote sensors, and field chemistry kits to measure such things as how much water reaches the aquifer, how well plants and trees handle the deluge, and how much fertilizer leaches into the groundwater. She also measures whether yields are affected. Her three-year pilot study, begun in 2014 and the largest of its kind, aims to calm farmers fearful of crop damage and health officials fretting over potential groundwater contamination.

So far, among the many things Dahlke has found: Ninety percent of her floodwaters reach the groundwater table; in the right soil, alfalfa can handle the equivalent of 26 feet of rain; and pecan trees, which, she says, "naturally grow in riparian [riverbank] soils, are well-adapted to having wet feet in winter."

Next under Dahlke's rubber boots: further work in almond orchards, where she and her team will monitor root growth and tree hydration. "I just hope we don't kill any trees," she says. At the very least, she'll be having fun soaking the place. "When it's raining, there's so much happening," she explains. "It's a natural system. And it's just fascinating."

Thanks to her fascination, we might soon be saving rainy days for dry.



SINCE THE 1930S, CALIFORNIA HAS LOST 100 MILLION ACRE-FEET OF GROUNDWATER THAT IT COULD HAVE SAVED. THAT'S 100 MILLION SOCCER FIELDS COVERED IN A FOOT OF WATER."



GOODS



A BETTER WAY

THIS IS CLEAN COAL

THE DEVELOPED WORLD'S CUP overfloweth with potable tap water, but it doesn't all taste quite so fresh. Soil impurities in some regions make for a funky well draught, while algae and bacteria in the dregs of drought-depleted reservoirs—and the chlorine used in treatment—make sinks smell like fish tanks.



Ramona Bajema—founder of purification company Miyabi Charcoal and lifelong resident of ultra-dry Ojai, California—is well-acquainted with floods of faucet funk.

Frustrated by ugly and wasteful home filters (like those in plastic pitchers), Bajema borrowed an ancient, sustainable cleansing tool from Japan: activated

bamboo charcoal. Drop three pieces of the carbonized bamboo (aka *takesumi*) into your favorite carafe, and it will rid liter after liter of tap water of

nastiness for about a month. The coal traps impurities right away, but it will take an hour for your drink to taste like precious nothing. \$16 (THREE-MONTH SUPPLY)

32,000

The square footage in one teaspoon of activated charcoal. Millions of pores grab impurities.

MORE THAN ONE WAY TO...

CARRY WATER

DROP-IN PURIFICATION LETS ANY VESSEL BECOME A self-contained water-cleansing system. No matter who you are—or what mountaintop, elliptical machine, or TPS report you need to conquer—crisp, fresh-tasting H₂O can go right along with you. Just fill any of these fine flagons at the nearest tap, and drink up.

1 Desk Jockeys

Be an adult: Drink from a glass. The MIU Color 18.5-ouncer is made of borosilicate, which, thanks to a makeup that's about 5 percent boric oxide, is durable and stain resistant. **\$23**

2 All-Day Toters

Most double-walled bottles use hefty endcaps to close the chamber between the steel walls. Hydro Flask seals with a glass plug during the vacuuming process, lightening the vessels. **FROM \$22**

3 Trail Trekkers

When climbing, it can be hard to breathe, let alone pull water from a hydration pack's straw. The Geigerrig Rig 700M is pressurized: Bite a valve to get H₂O from its 70-ounce reservoir. **\$140**

4 Gym Rats

Swag canteens are great—if you're into lukewarm water mid-workout. The Camelbak Podium Chill sport bottle's cell-foam insulation keeps water cold twice as long as that freebie. **FROM \$13**

5 Light Packers

The HydraPak Stash collapses from 7.2 inches tall to the size of a hockey puck. The 25-ounce bottle's flexible center stands up to repeated twisting between the hard-shell top and bottom. **\$18**



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IN EXCESS

MIRACLE IN ICE



WHY FREEZE AN OCTAGONAL BLOCK OF ICE ONLY TO shape it into a sphere with an \$800 contraption? If watching the Cirrus Ice Ball Press' aluminum halves channel the ambient air temperature to melt away everything but a perfect globe doesn't blow your brain straight out your earhole, try some whiskey on these rocks. Spheres, of all 3-D shapes, have the lowest surface area, which means less contact with ice-melting booze—and a drink that's cold but not watered down.

PROP STYLING BY WENDY SCHELAH FOR HALLEY RESOURCES

SELECTION

THE ORIGIN OF ICE-IES

THAT CUBE IN YOUR COCKTAIL HAS EVOLVED ALMOST as much as the species that made it. The original drink chillers came from frozen lakes, harvested and delivered to families whose offspring would someday mold it into tiny dinosaurs. Here are the highlights of its trip:



THE FUTURE

Is Clear

Transparent ice takes time. You either carve the clear center of a huge block or use insulation to slowly solidify so the water comes out crystal.

2000S

Going Soft

Slick silicone has a low coefficient of friction and a pliable nature. Both let you create otherwise impossible-to-release shapes with ease.

1980S

Topping It

Modern plastics don't crack as easily as the old stuff, but the genius award goes to lidded trays: You can stack them before the water sets.

1960S

Plastics

Injection-molded polymers changed every industry, ice included. Trays graduated from skin-chilling metal to twistable polypropylene and polyethylene.

1930S

DIY Cubes

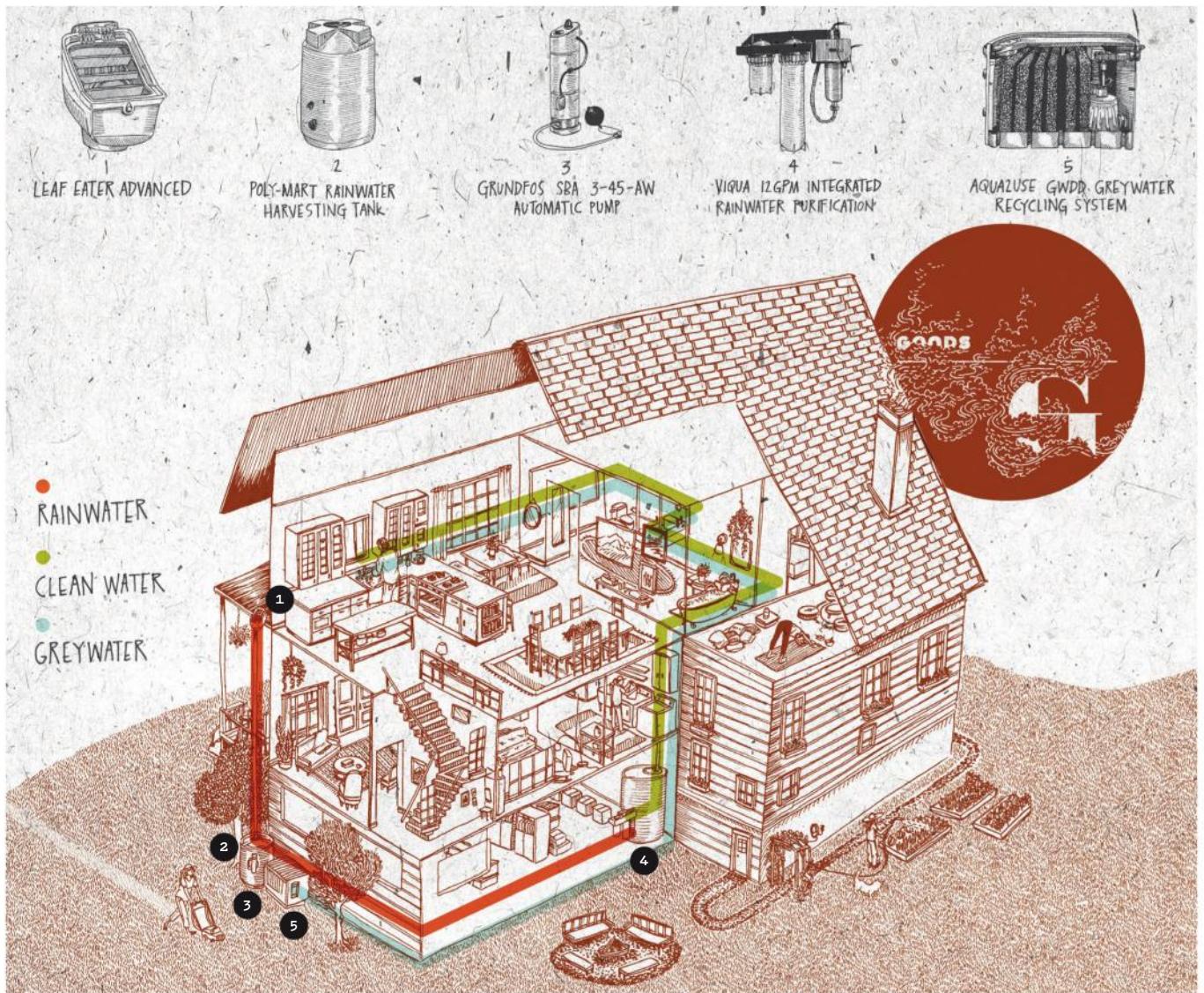
With the advent of refrigeration, you could freeze your own ice in aluminum trays; the metal warmed as it left the freezer, releasing cubes easily.

MID-19TH CENTURY

Early Ancestors

Antique solid water came as giant blocks to chill your insulated icebox. For a frosty sarsaparilla, you'd chip the ol' block with a sharp pick.

PROP STYLING BY WENDY SCHELAH FOR HALLEY RESOURCES



SYSTEMATIC

RAIN, RAIN, STOW AWAY

WHOEVER SAID MONEY DOESN'T FALL FROM THE SKY hadn't mastered the art of harvesting precipitation. A carefully coordinated system can render drizzles and downpours safe to use in all your indoor-plumbing fixtures and water-hogging appliances—and augment your home's reliance on the utility company too.

1 Sift

Rain has a pesky habit of knocking loose all kinds of crud you don't want flowing into your home. As a first line of defense, the Leaf Eater Advanced pre-filter attaches to your gutter's downspout to keep large debris out of the water supply. Its 0.955 mm screen is fine enough to sift out everything from mosquitoes to leaves. **\$38**

2 Store

From the downspout, runoff enters the 200-gallon Poly-Mart Rainwater Harvesting Tank, where a filter basket catches any left-behind floaters. If enough drops fall to fill the drum, a pipe up top sends overflow into your regular storm drains. At capacity, the barrel weighs more than a ton, so it needs to sit on concrete or another solid surface. **\$363**

3 Pump

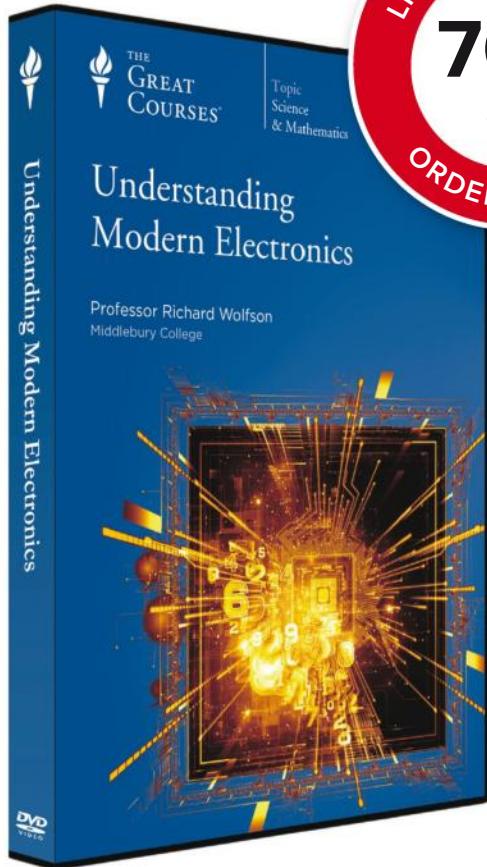
Nestled inside the tank, the Grundfos SBA-3-45-AW Automatic Pump includes a floating extractor buoy that pushes cleaner, more-oxygenated surface water into the home first. An integrated controller unit automatically stops the pump when the tank is empty, switching your water supply back to the regular, public works. **\$700**

4 Filter

Before it flows to fixtures, enough H₂O passes through the Viqua 12GPM Integrated Rainwater Purification System to feed about five simultaneous showers. A carbon filter removes some odors and flavors, while a UV disinfectant stops disease-causing organisms from reproducing. The resulting liquid meets most indoor water-quality codes. **\$1,385**

5 Reuse

Drain lines from showers, sinks, and washing machines (no toilets!) flow into the Aqua2Use GWDD Greywater Recycling System. A series of increasingly fine membrane filters cleanse water of soap, some oils, dead skin, and hair, readying it to run through your lawn- or garden-irrigation setup. Warning: It's safe for plants to drink, but not you. **\$730**



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UNDER PRESSURE

DECADES AGO, OUR SHOWERHEADS blasted away suds with boom-time abandon. Then, in the '90s, efficiency standards cut water flow by half or more—to 2.5 gallons per minute. Faced with ever-tightening laws, engineers are getting crafty about turning drips into deluges.

GOOD

Delta In2ition H2Okinetic Five-Setting 2-in-1 Shower

Rather than push water through pinholes to create the illusion of pressure, Delta engineers steer the liquid into waves to give the feeling that there's more H₂O than there is. Based on the fluidics that help windshield nozzles spray evenly, the In2ition head circuits water through a series of internal dams to make concentrated, body-covering droplets. \$100

BETTER

Waterpik SideWinder

Its max flow rate is only two gallons per minute, but in massage mode the SideWinder can double its apparent pressure. An internal wheel rotates back and forth on a cam, opening and closing banks of nozzles as it moves. With one set closed, water diverts to the open holes. The switchback happens so quickly—up to 40 times a second—that it almost feels like the '50s again. \$70

BEST

High Sierra ReflectionsX

It will take all 20 fingers and toes—if not more—to count the nozzles on most showerheads. On a High Sierra head, you'll see only one. Inside the sole nozzle, a horizontal pin separates water flow into two streams. The cone-shaped opening directs them to collide with one another, which forms a drenching, rainlike spray. It feels like a hose, but uses as little as one and a half gallons per minute. FROM \$125



DO THE MATH

KING OF THRONES

OF ALL THE THIRSTY NECESSITIES IN OUR HOMES, toilets rank among the worst offenders. They flush fresh water down the drain, need regular rinsing and scrubbing, and filth-ify the whole bathroom—creating even more mess to clean. The \$10,200 TOTO Neorest 750H still flushes, but finds plenty of ways to save agua.

1/2

ROLLS OF TOILET PAPER SAVED PER PERSON PER WEEK

Assuming a healthy digestive system, opting to clean up using the Neorest's three bidet hoses will use just four gallons per person per week. It takes 18.5 gallons to make a half-roll of TP.

45

PERCENT DROP IN WATER USAGE WITH EFFICIENT FLUSHES

Dual nozzles turn 0.8 gallons of water into a vortex to wash away number ones. Sit more than 30 seconds, and presence and body-heat sensors infer a number two, signaling a full-gallon flush.

4

WEEKS ONE OFFICE WENT NOT CLEANING THE TOILET

To stop buildup, pre- and post-squat mists of acidic, electrolyzed water rinse the bowl. Then, zirconium in the glaze—activated by an underlid UV light—breaks down any stuck-on gunk.

20

OUNCES (EST.) OF WATER IN A BOTTLE OF CLOROX

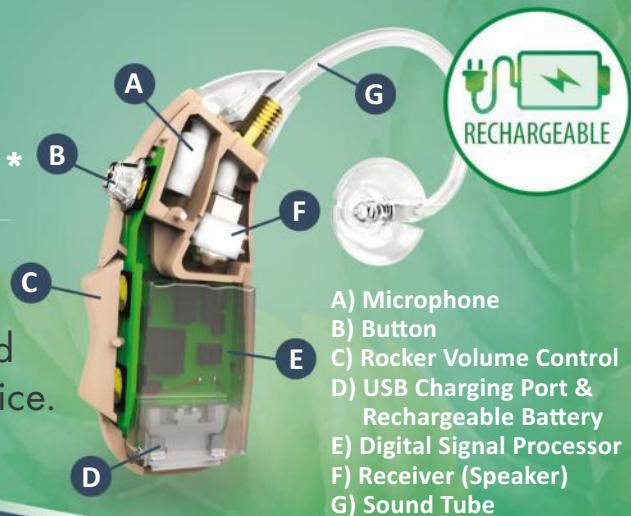
Flushing sprays bacteria and viruses, but the Neorest keeps them on lock—so you'll have to disinfect the room less often. When you leave, sensors tell the lid to close and the toilet to flush.



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Great Hearing Aid! "I'm really glad I tried the HearClear HCRC! It works as good as or better than the more expensive ones I've purchased in the past. It's great that the price is reasonable. Thank you for the great product." - *Tim M.*

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HOW TO
DRINK THE
OCEAN



When the glaciers that fed La Paz, Bolivia, its water vanished, citizens woke to dry taps, civil unrest—and a Water General's reign.



H I G H

A N D

D R Y

T

THE EARLY-MORNING SUNSHINE, sharp and unfiltered in the high Andean altitude, flashes off the Water General's sunglasses. He poses next to a 2,500-gallon tank that his troops placed behind this market of stalls in La Paz, Bolivia. The women who sell here—short, stout, and dressed in the multitiered skirts favored by many of the indigenous—line up with garlands of yellow flowers. The Water General bends so they may sprinkle petals on his head. A crowd of media, assigned to the event, duly take note.

Suddenly a man breaks through the crowd. He screams at the general and the Water Minister, Alexandra Moreira, standing at his side. "It is not enough. You are disrespecting the people!" the man yells. As the general's troops drag the man out by his arms, he adds, "It's the truth." Moreira, in her skinny jeans and a navy-print blouse and suddenly looking far too young for such a weighty position, winces.

At nearly 12,000 feet in altitude, La Paz sits in a zone—the high tropics—suffering the effects of climate change quicker than the rest of us. The glaciers that once fed the city are in retreat; the seasonal rains that should replenish the reservoirs from November through February are increasingly unreliable. In early November, the federal government declared a state of emergency. Overnight, officials cut water to 94 of the city's neighborhoods, leaving about half of its roughly 800,000 residents caught completely off-guard.

On television, the government promised to turn the taps back on in a day or so. But when the water did not return as promised, hundreds of people protested. They commandeered the cisternas, the tanker trucks brought in to distribute the dwindling water





▲
**A Drop in
Their Buckets**
Many residents
get water from
tanker trucks
that troops
drive through
the city daily.

►
**The General in
His Labyrinth**

Brig. General
Mario Enrique
Peinado Salas
commands 113 wa-
ter trucks from
his one-room HQ.



supplies street by street. In one instance, angry citizens questioned local water officials for several hours at a rowdy meeting, refusing to let them leave. That's when the federal government sent in the Water General, aka Brig. General Mario Enrique Peinado Salas, to suppress unrest and enforce a rationing system.

But the drought, decades in the making, isn't so easily solved. As temperatures rose, rivers and lake beds that once nourished fields and crops dried up. Countless farmers and other rural people who relied on the land fled into the cities. There, a woeful lack of infrastructure—a dearth of water-treatment facilities in La Paz, aging reservoirs, leaky pipes—failed to keep pace with the demand.

La Paz has now entered a post-water world, where strict rationing is a way of life for many. For months, some of the city's neighborhoods received water only once every three days for a few hours. (In mid-January, it increased to every other day.) When water does flow, people rush to fill anything handy—bathtubs,

●
**“IT’S NOT ENOUGH!” THE MAN
SHOUTS AT THE GENERAL, AS
SOLDIERS DRAG HIM OFF. “YOU ARE
DISRESPECTING THE PEOPLE.”**



buckets, trash cans—so they can drink and cook and flush until they run out again. The crisis has cut most Bolivians' meager daily use (an average 48 gallons compared with an American's daily 100-gallon habit) by two thirds. To cope, people go without nonessential water activities, like laundry and bathing.

Even when water flows, it too often resembles a failed urine sample; it's streaked with angry orange particles, thanks to pipe gunk and reservoir sediment. Still, piss water is better than no water, which is what you get in the higher-elevation poorer neighborhoods, where the water pressure is just too low.

To survive, most everyone must buy at least some bottled water, a once unthinkable luxury for the poorest people in South America. And they must also rely on the Water General.

Every morning, his troops drive to a dwindling reservoir to fill their fleet of 113 cisternas, each the size of a fuel tanker. They dispatch it gallon by gallon to communal tanks that have popped up on street corners and in plazas. When they arrive, crowds materialize, lugging blue, yellow, and white garbage cans, and keep coming until the trucks are drained.

It doesn't take much of a leap to imagine a scene from an Isabel Allende or Gabriel García Márquez novel where citizens wake to find their land parched, a mustachioed



◀ Glacial Response

For 11 years, officials ignored hydrologist Edson Ramirez's findings and dire warnings.

general holding their water captive. The surreal and real have always co-mingled in Latin America. But while government ineptitude has its place in this story, losing water overnight can no longer be dismissed as a bizarre plotline unique to our southern neighbors.

In fact, a world where generals deliver water—or fight for it—is probably not all that far behind the rest of us. The same forces causing La Paz's drought are taking their toll on the planet, including in the American Southwest, Central Europe, and China. The great glaciers of the Himalayas—the planet's largest body of ice outside the polar caps—are slowly disappearing. With them, an important water source for one-sixth of the world's population is drying up.

The lesson from Bolivia is that it is not difficult to forecast. With a warming planet, there is just not enough snowfall or rain to replenish many of the world's glaciers. As they disappear, one by one, droughts and water shortages will follow. "They are coming, and I don't

● THE SAME FORCES CAUSING LA PAZ'S DROUGHT ARE TAKING THEIR TOLL ON THE PLANET, INCLUDING IN AMERICA.



see clear evidence that people are developing policy proactively," says Martin Sharp. He should know. A professor of Earth and Atmospheric Sciences at the University of Alberta in Canada, Sharp studies glacier dynamics, hydrology, and climate-driven changes. He is frustrated that policymakers in Bolivia, Canada, and

elsewhere have been so unresponsive to the science and to the coming challenges.

They'd better get moving, Sharp says. "These aren't problems that you are going to solve over a cup of coffee at Starbucks."

Nor can you solve it quickly or elegantly once you're in the midst of it. For weeks after rationing began, Moreira remained in semiseclusion; obviously now is not a relaxed moment to be Water Minister. Her foray to the quiet Sunday market with the Water General is a kind of soft relaunch for her public-relations efforts. "We are working on the problem," she promises. She also has good news.

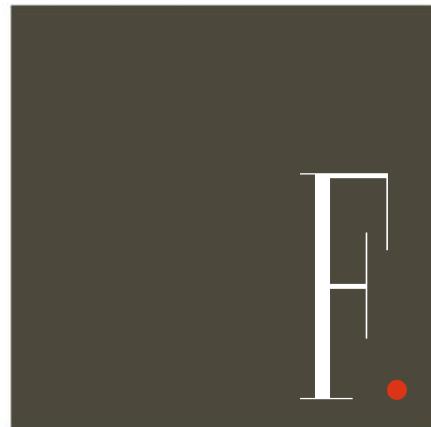
The city, she says, has launched four projects to fix its water woes, including an additional dam and reservoir to capture more rainwater and a pipeline to bring water from a creek. But "the weather," she adds, "is not helping." Her voice trails off as she gazes upward past the brown mountain peaks in the distance and gets to the real point.

Which is that the sky won't cooperate.



▲
**Brown
Diamonds**

With its glacier gone, the world's highest ski resort now sits on a barren rock pile.



FOR YEARS, SCIENTISTS PREDICTED that climate change would cause a devastating water shortage in the Andean plain. Like the ominous rumblings of a movie soundtrack before the T. rex appears on-screen, there were persistent warnings. Nongovernmental organizations like Oxfam (2009) and then the Stockholm Environmental Institute (2013) put out increasingly dire pleas for water management. Lake Poopó, whose waters sustained the indigenous Uru-Murato for millennia, dried up last year. At the same time, the normally robust winter rains shrank by more than 25 percent. And through it all, a local paleo-glaciologist named Edson Ramirez tried persistently to get someone to act.

A soft-spoken professor at the Institute of Hydraulics and Hydrology of the Higher University of San Andrés in La Paz, Ramirez did not want to be the Cassandra for this catastrophe. But the science left him little choice. In 1998, he began measuring Chacaltaya, a glacier an hour's drive from the city, which held a world-famous attraction: the world's highest ski resort. Ramirez expected shrinkage. But the reality surprised even him: Just 15 meters thick, the glacier was disappearing at a rate of at least 1 meter a year. Ramirez calculated it would be gone by 2015. In 2005, he went to city officials to warn them and discuss the consequences for a city that relies on glacial runoff for water. He laid out a dire timeline. The bureaucrats politely listened but were unconvinced. They told him: "Maybe it will happen, but maybe it will not."

It turned out Ramirez was wrong—but only in his optimism. By 2009, six years ahead of his calculations, the glacier had vanished, leaving nothing but a brown stain. The revelation

●

CLIMATE CHANGE QUIETLY REDUCES THE RESILIENCY OF NATURE UNTIL THERE IS NO ROOM FOR HUMAN ERROR.

hit the worldwide media like a storm. But La Paz's travails are greater than glacier melt. In recent decades, temperatures on Altiplano rose by about 2 degrees Celsius. In the past 15 years, annual rain and snowfall declined by 20 percent. Local water officials say that will fall at least another 10 percent by 2030.

Sitting in his university office, with dust particles hanging in the slats of sunshine that filter in, Ramirez seems neither righteous nor angry that his long-ignored prophecies have come true. Instead, dressed neatly in a crisp and buttoned-up short-sleeve shirt like a Wal-Mart manager, his black hair slicked back, he is intent on getting the government to focus on reacting to what will come next.

Speaking without notes, he methodically lays out the devastation to come. Bolivia is responsible for .35 percent of the world's greenhouse-gas emissions, compared with the United States' 14.4 percent. But because of Bolivia's location and elevation, the Andean nation is experiencing the impact of those carbon emissions at a far more accelerated pace than the U.S. The speed of temperature increase has gone from .11 degrees Celsius per decade 40 years ago to .33 degrees in the last decade, he explains. (The global average is .15 to .20 per decade.) Climate change has also provoked an increase in the number and

strength of El Niño in the Pacific Ocean. In El Niño years, the country gets 20 to 30 percent less rain than what was once the average. But even in non-El Niño years, precipitation comes less frequently and in more-intense bursts, making it more difficult to capture, and harder on farmers and their crops.

And all this leads back to the big ice. The Andes glaciers are relics of the last ice age, which peaked 18,000 years ago. Now these rarities are disappearing rapidly. During the rainy season, a small temperature increase means that instead of snowing in the very high altitudes—which would recharge these giants—it rains, accelerating melt. The result, according to Ramirez, is that 37.4 percent of the tropical glaciers around La Paz liquefied and slid away between 1980 and 2009.

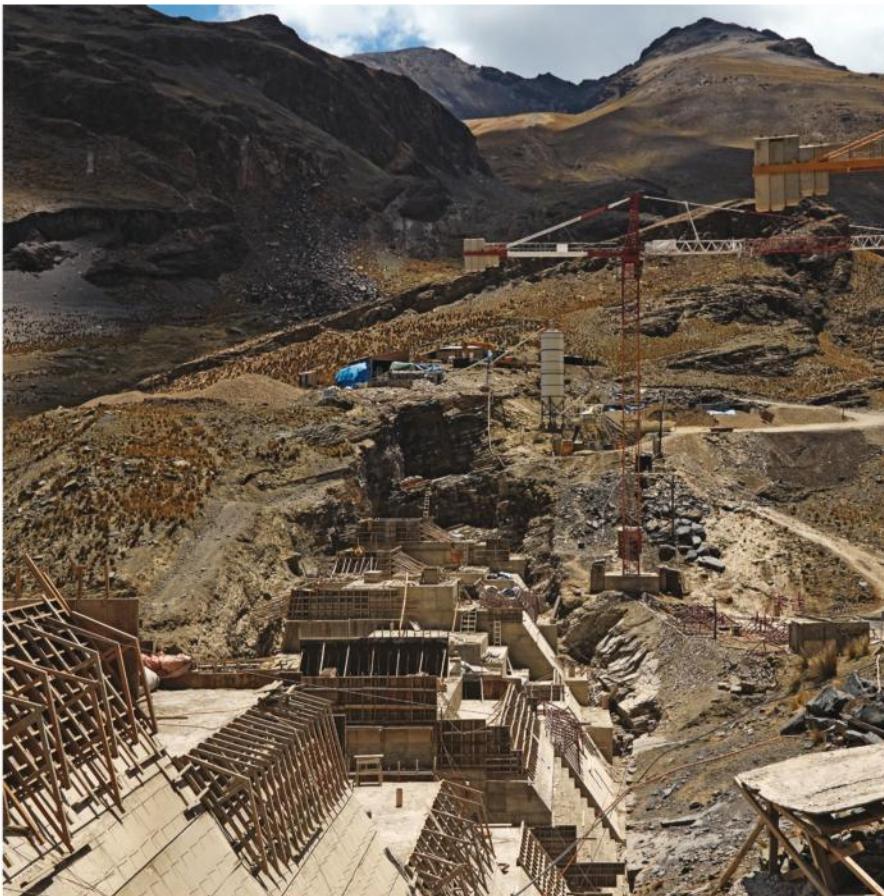
While runoff might provide only 10 to 20 percent of the city's annual water supply, it has historically played a crucial buffering role during droughts. For example, La Paz's nearby higher sister city, El Alto, which sits on the towering 19,000-foot Huayna Potosi mountain, still has running water, despite the drought. "In the heat, runoff from Huayna Potosi has increased, causing equilibrium in the system," Ramirez explains.

A favorite among climbers, the mountain has been reliably covered with snowpack for thousands of years. But even the glacier there, once a thick slab of blue-white ice, is only half of what it was a few decades ago. How long before it too goes? Ramirez does some calculations. "Maybe 40 years," he says. "Maybe."

It is a devastating assessment of the region's water future—well, its entire future. Is there a chance Ramirez would save himself, move out of La Paz? "No." He shakes his head and smiles gently. He has offered to help the government address the crisis. Has the government accepted? He again shakes his head.

The politics of water in Bolivia are touchy. What Ramirez hints at but will not say is that the government will tolerate only so much criticism; if he is too public in his condemnation and focuses on human mismanagement instead of climate collapse, he might lose grants or other financial support. The silence of what is unsaid fills the room.

Ramirez suddenly pipes up and points out a bright spot in the settling gloom. "The way people think about water is changing," he says. "Now people are trying to catch the rainwater. I think this is very important."





◀ **Who'll Start the Rain?**

Workers build a new dam and a bigger reservoir to catch rain—which is not likely to come.

▶ **Have Barrel, Will Wait**

Locals must miss work to wait for the city to turn on the water, and then fill their storage tanks.



AFTER VISITING RAMIREZ, MY local guide, Paola, takes me for a trip up to visit the spot where the Chacaltaya glacier once lay. At 17,115 feet, the glacier's old ski resort perches far above the tree line. In fact, it sits far above the line where anything grows. Without its snow dressing, the barrenness is absolute. The deserted ski lodge and the lift's old winch add to a haunted atmosphere. Paola, now 41, remembers vividly her mother and grandfather taking her here as a child. I try imagining the shrieking of children and snowball fights instead of the desolate pit of shredded rocks. My reveries are broken by a shout of greetings from a day hiker. He has stripped to a T-shirt because of the heat.

Paola is looking off in the near distance, where the 19,000-foot Huayna Potosi looms. She is shocked by its change in appearance. Huge gray granite ridges jut from the snowpack. Perhaps, she conjectures, Ramirez has been too optimistic about that glacier as well.

Bolivia has both a tragic and triumphal history with water. In the 1990s, many of its cities, including La Paz, privatized their water systems, hoping the American and French conglomerates they hired would bring efficiency and expansive service. It worked, but prices climbed; the people rebelled. They booted the corporations. Then, in 2009, Bolivia got a new constitution, one that described water as a fundamental human right. The move also gave the Bolivian government, under President Evo Morales, an international role as defender of this new guarantee.

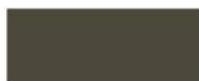
The reality is far more complicated and shameful. One river that bisects La Paz is so thick with raw sewage and industrial runoff that people won't touch it, even in a drought.

The nationalized utility, ESPAS, which replaced the French company in La Paz, is awash in incompetence. A 2013 audit found that millions of dollars of potential revenue were lost due to leaking hardware. The city's infrastructure, which is separate, has fared no better. One audit revealed 45 percent of all its water escapes through faulty pipes. New pipes and better oversight could improve the situation—but maybe that is not even enough. One of the insidious qualities of climate change is that it quietly reduces the resiliency of nature until there is far less—or no—room for human error. La Paz seems perched on that precipice of no return. And the city's leaders still may not have accepted that.

WHITEBOARDS CROWD THE WALLS of the Water General's headquarters, a single vast room of planning and plotting. Here he charts the progress and locales of each of the 113 cisternas at his disposal. He is proud of his efficiency. He brags that the number of daily requests for water have greatly diminished since the height of the crisis. Things seemed to have leveled out. The people are being served. But when asked if his solution—using trucks to take water from the same source that normally feeds the city's pipes—isn't a bit like robbing Pedro to pay Pablo, he shrugs. It slows the pace of consumption, he explains. Asked how much water is left, he says confidently: "We have 10 days. And soon it will rain."

Two days of dry weather later, and under clear skies, the Water General and the Water Minister lead a caravan of four-wheel drives into the mountains to show reporters two new construction projects. One is a pipeline that will raid water from a nearby "creek" at

37.4 PERCENT OF THE ANDES' TROPICAL GLACIERS LIQUEFIED AND SLID AWAY BETWEEN 1980 AND 2009.



the rate of 200 liters per second. That creek, however, is the water supply for local farmers. As their land dries up, they'll move to La Paz, further taxing the city's water system.

We leave the caravan to travel another 45 minutes down a dusty and rock-strewn road to a vast dam/reservoir construction project that Moreira has told us about. It's just upstream from the old dam and looks like workers slapped it up overnight. "It will be operational by mid-January," Moreira pledged. It seems improbable the government will make that deadline—and irrelevant. The evening before, Oscar Meave, the coordinator of the technical unit of dams in the ministry of water resources and irrigation, had already explained the problem. While the new reservoir will be capable of holding much more water than the old one, it will probably take two rainy seasons to fill it.

Being a technical man and not a politician, he says what they will not: This season is a disaster, down 40 percent in its first month.

Back in the city, the people of La Paz do what all humans do in the face of a slow-motion disaster: adjust. On a Friday afternoon, Katherine Sanchez Lopez, a 43-year-old public-relations professional, sits in her two-story home in an upscale neighborhood. Santa Claus figurines perch on cabinets and a stairway landing, ready to greet Christmas with a cheery face. In other circumstances, the house might be described as tidy. These days, buckets and pots of all shapes and sizes, filled with water, perch on counters, hide behind chairs, and crowd the bathrooms. The seven people who live here use them for flushing, cooking, and sponge bathing.

It is 1 p.m. on a workday. Before the crisis began, Lopez would have been in her office downtown. Now she sits at home hoping the city will turn on her taps so she can do laundry. Piles dot the floor. The city said it would turn on her water at 9 a.m. and leave it on for five hours. Lopez checks her faucets again, turning them uselessly. Still nothing. Everything is "totally, totally different," she says. "We have to spend so much time waiting." She wears a pink sweater and a festive red bow in her hair. But her demeanor does not match her upbeat dress. "I wish we had been warned," she adds. "We could have acted more consciously about water." It is too late now, she seems to say, with a shake of her bow. "Now, I think it is the way we will have to live for a long time."

MAR/APR
2300



POP SCI
COMICS
GROUP

THE AQUANAUTS

STILL
\$3.9



A QUEST
FOR THE SOLAR
SYSTEM'S
**MOST
VALUABLE
PRIZE!**

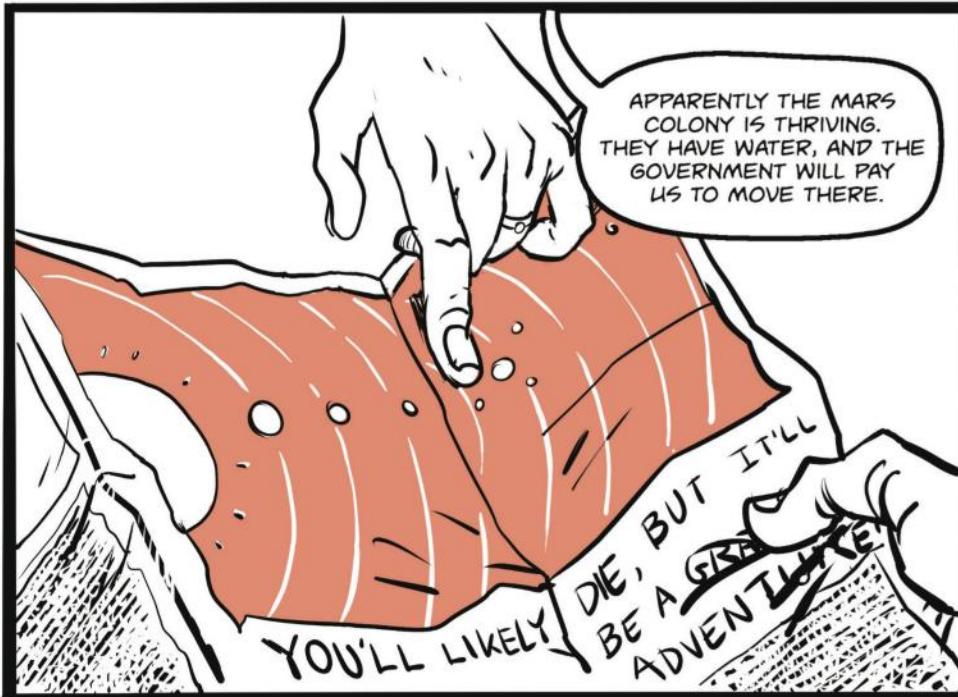
EARTH, 2300 A.D.

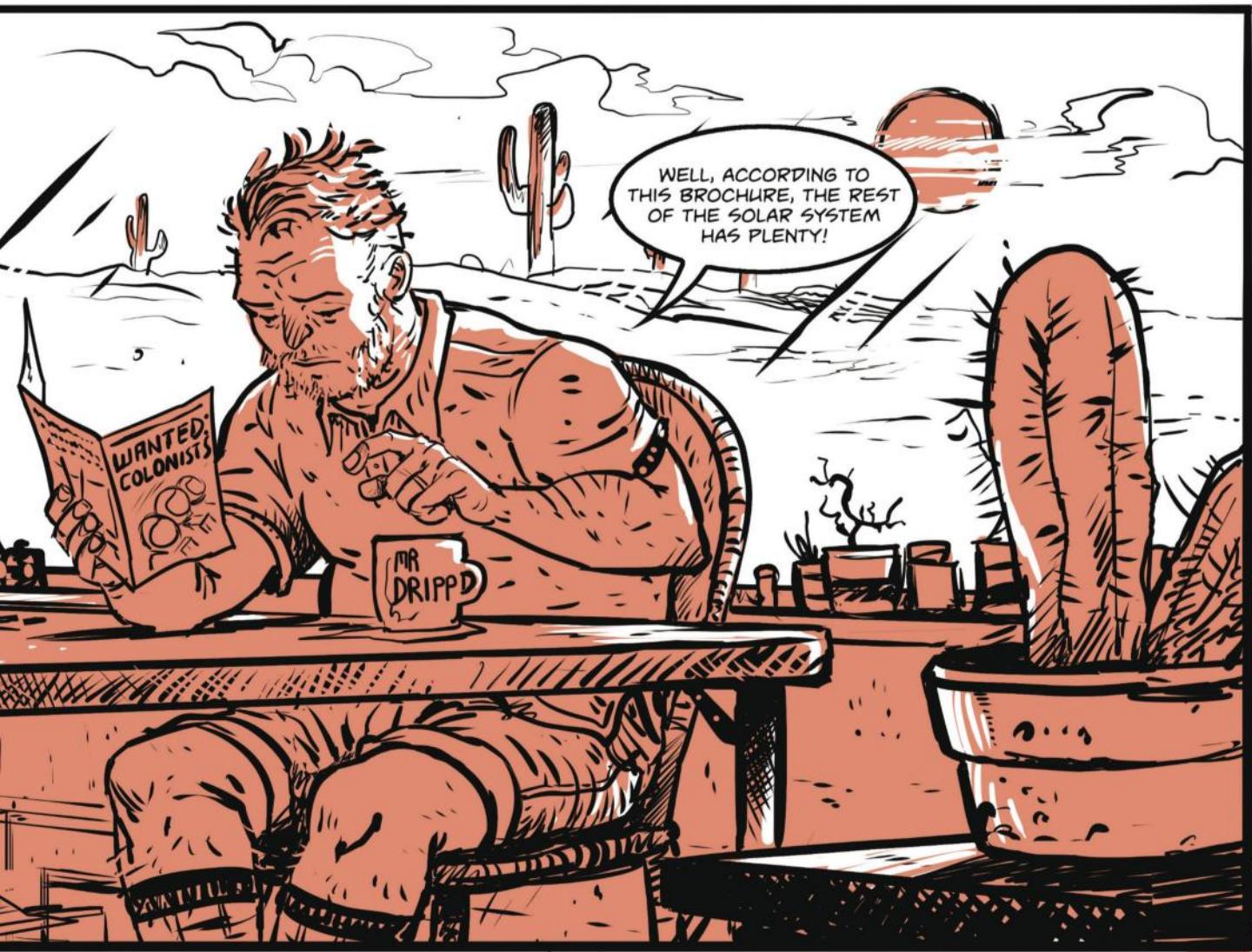
THEY'RE CUTTING OUR RATIONS AGAIN. THERE ARE JUST TOO MANY PEOPLE AND NOT ENOUGH WATER,



WRITTEN BY SARAH FECHT
SCIENCED BY KATE BAGGALEY
ILLUSTRATED, INKED, AND COLORED BY DANIEL WARREN JOHNSON

EDITOR: KEVIN GRAY
ANNOYING ART GUY: MIKE SCHNAIDT
CONSULTING COMIC NERD: THOMAS "ACTUALLY" PAYNE
FACTUAL CHARIVARI: AMBROSE MARTOS
PEANUT GALLERIST: RUSS SMITH
ASSISTANT TO DR. SCHNAIDT: JOE BROWN





LAYOVER ON THE MOON

WHAT ARE WE DOING ON THE MOON?



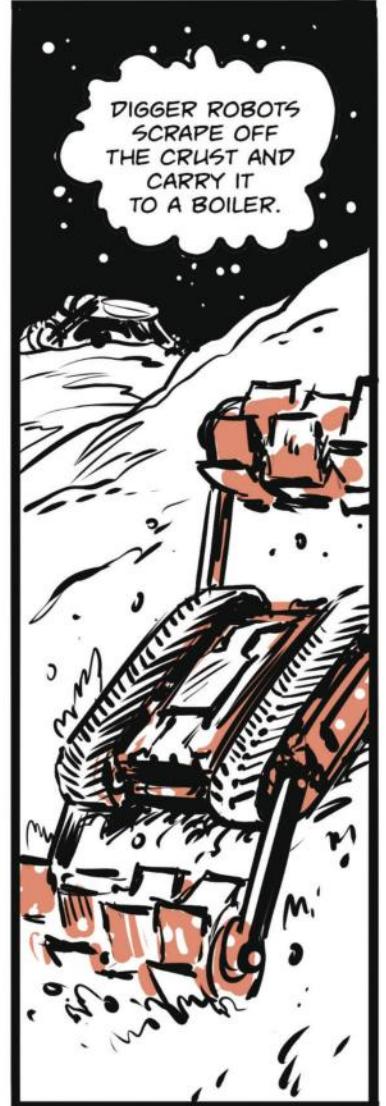
IT'S REALLY QUITE SIMPLE.

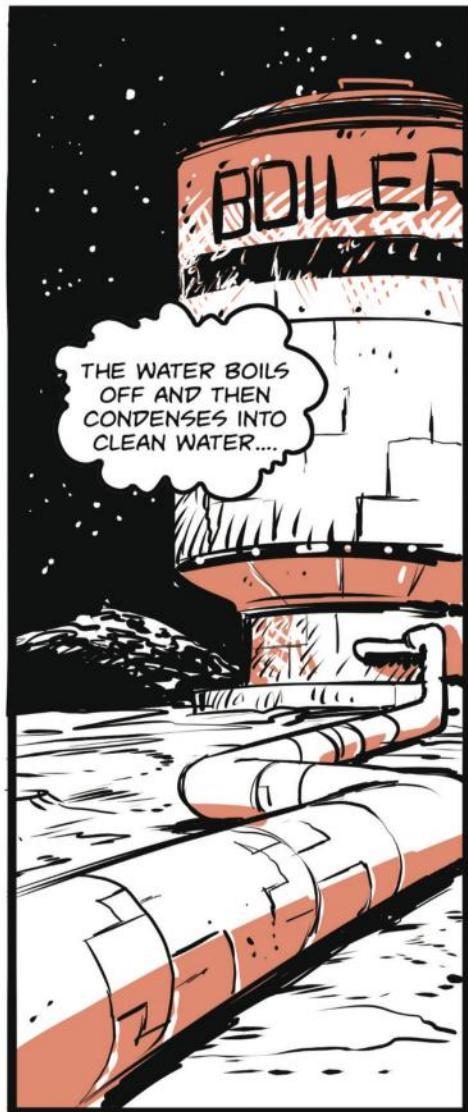


IN THE MOON'S CRATERS, WATER ICE IS MIXED UP WITH LUNAR DIRT.

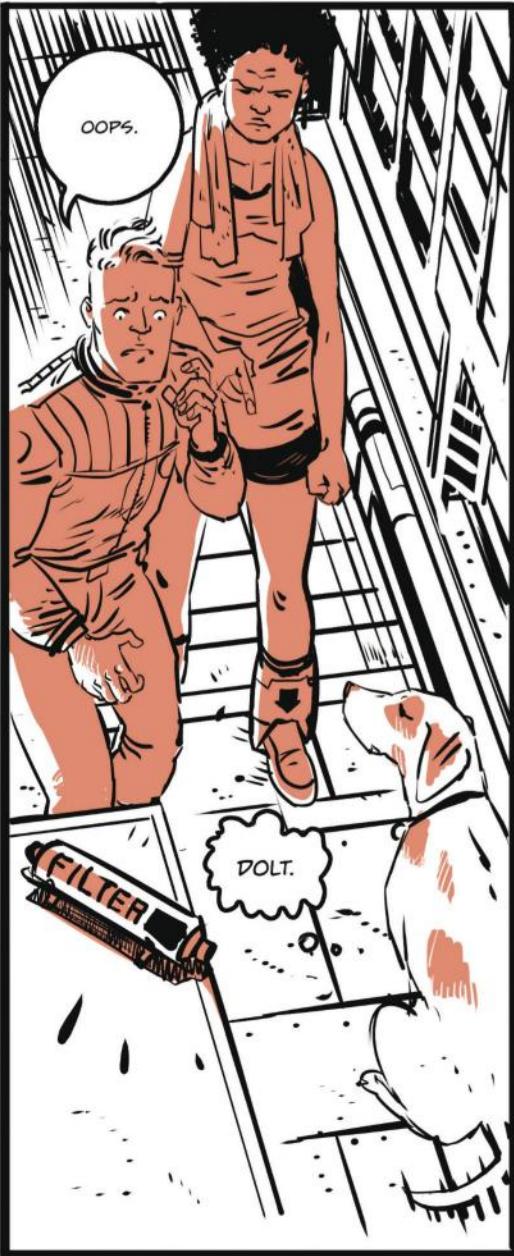
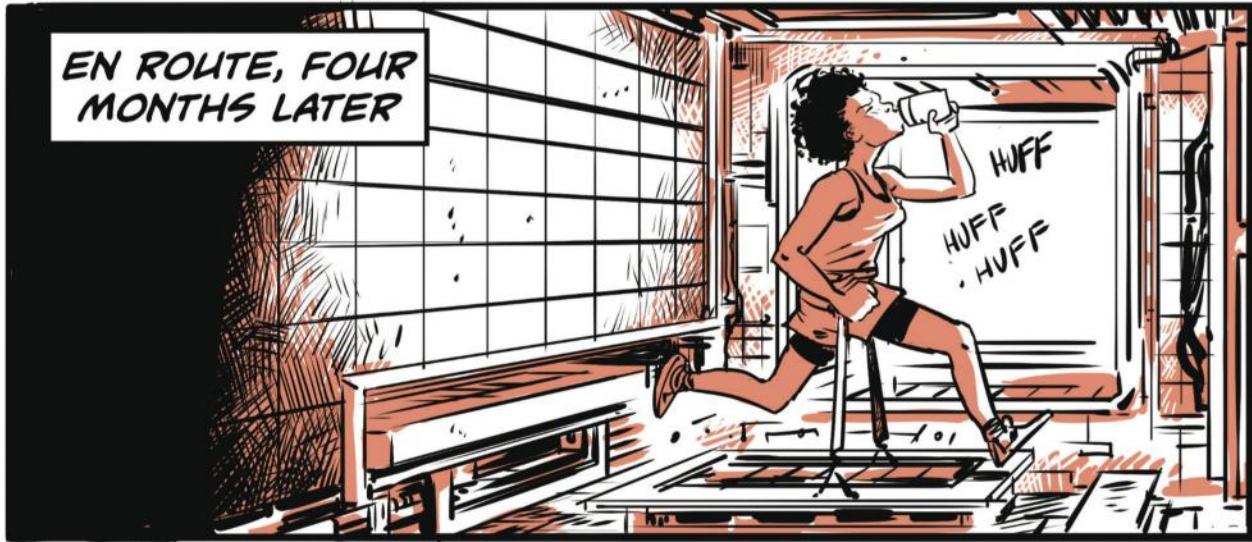


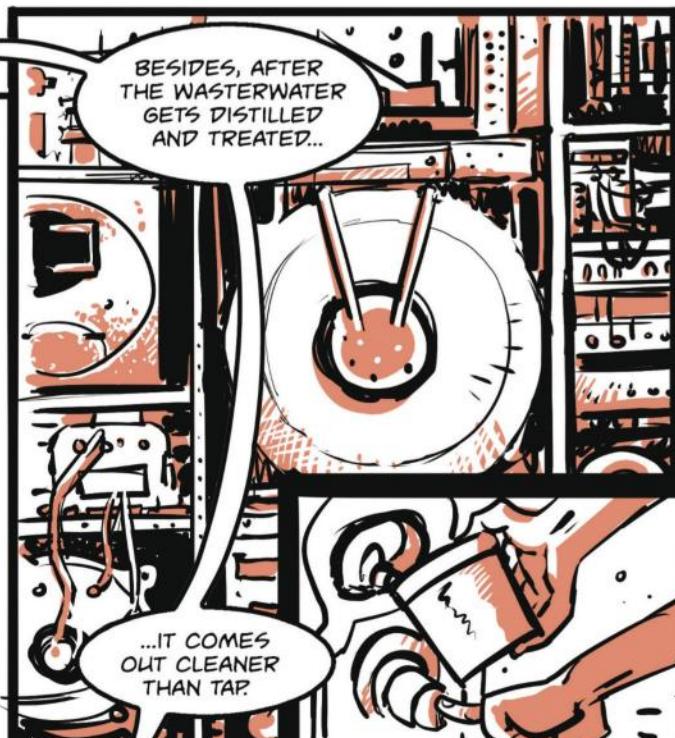
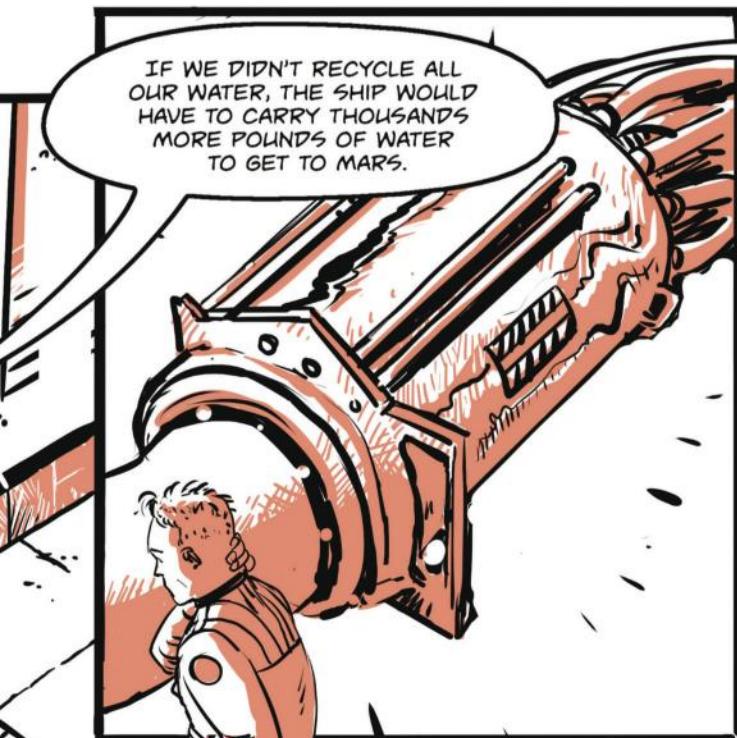
DIGGER ROBOTS SCRAPE OFF THE CRUST AND CARRY IT TO A BOILER.





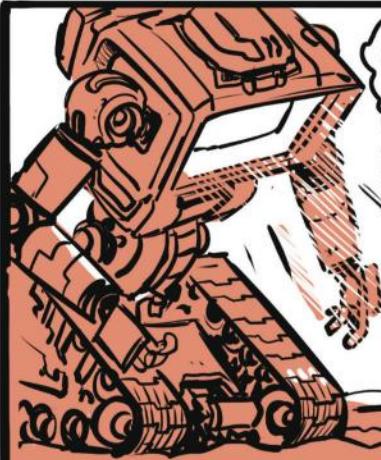
EN ROUTE, FOUR MONTHS LATER



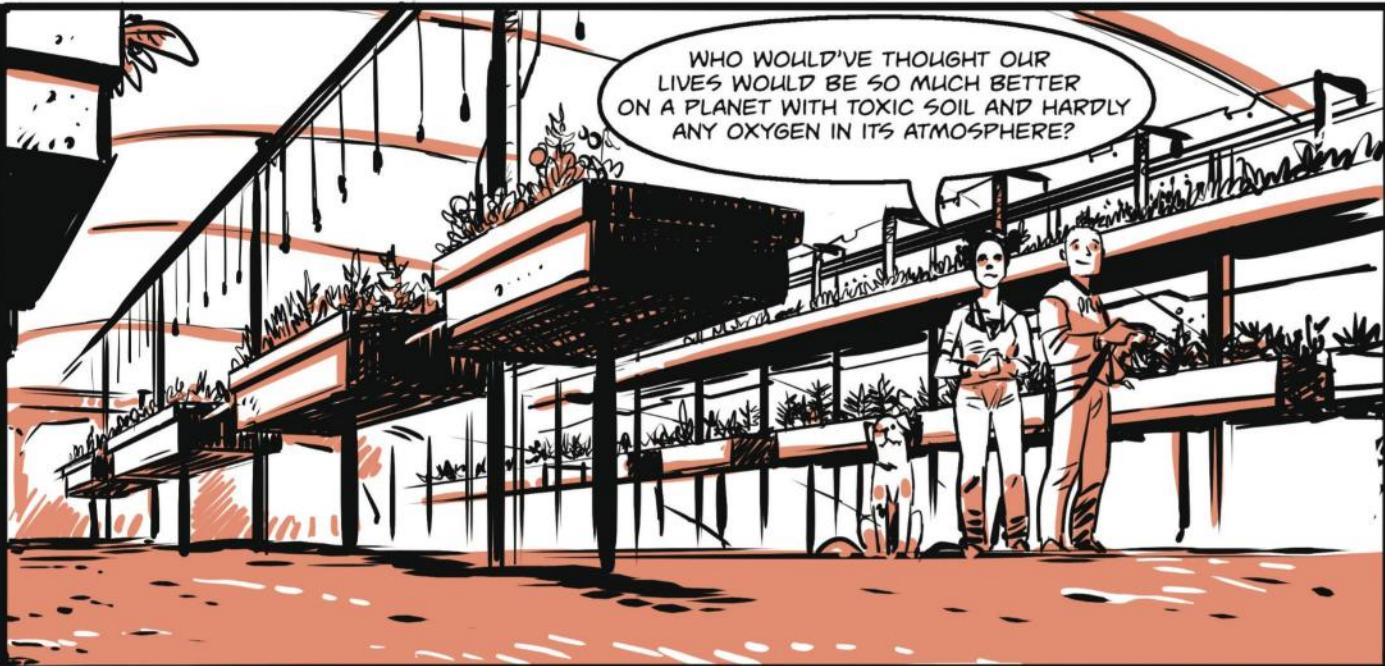


MARS,
2 YEARS LATER

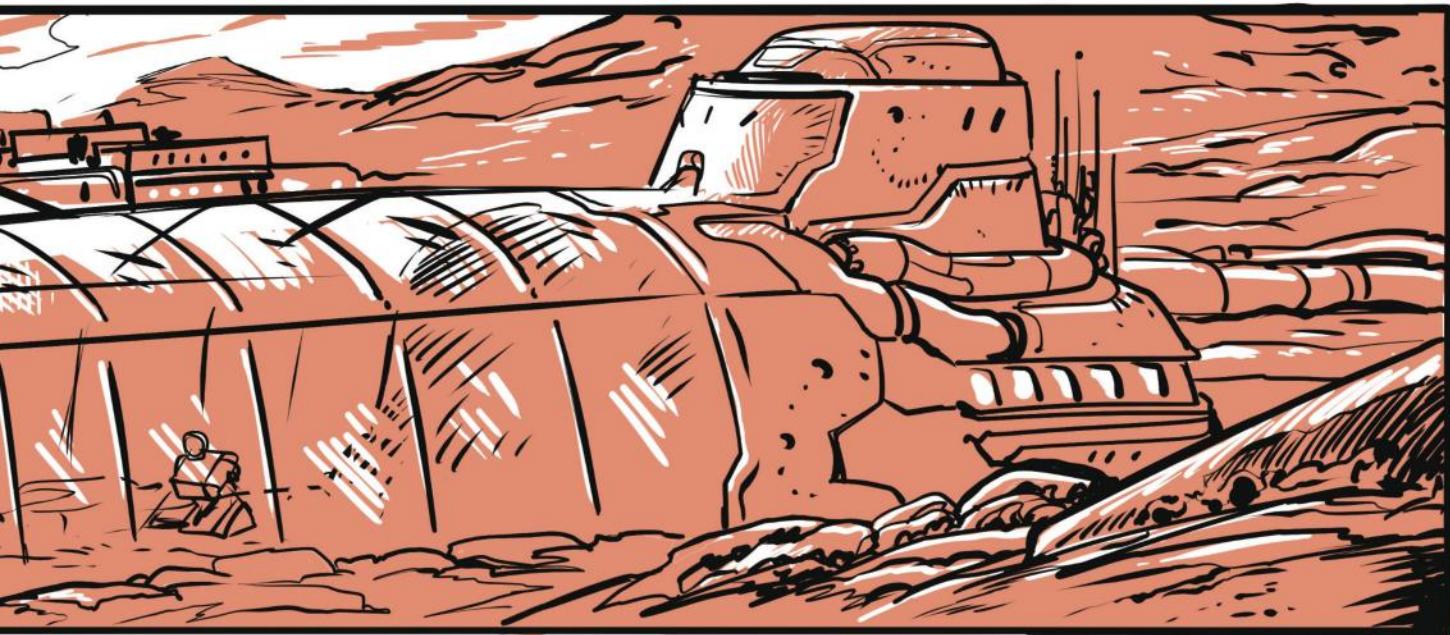
MARS HAS PLENTY OF FRESH WATER LOCKED
IN ITS POLAR ICE CAPS, BUT WE
DON'T LIVE UP THERE. IT'S TOO COLD
AND DARK A LOT OF THE YEAR.



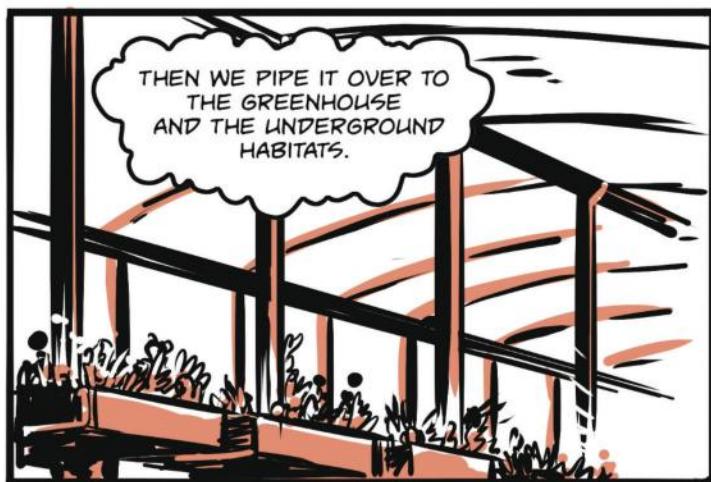
INSTEAD WE GET OUR WATER BY VAPORIZING ICE LAKES
BELOW THE SURFACE, USING SUNLIGHT AND
ROBOTS THAT FIRE MICROWAVES AT THE GROUND.



WHO WOULD'VE THOUGHT OUR
LIVES WOULD BE SO MUCH BETTER
ON A PLANET WITH TOXIC SOIL AND HARDLY
ANY OXYGEN IN ITS ATMOSPHERE?



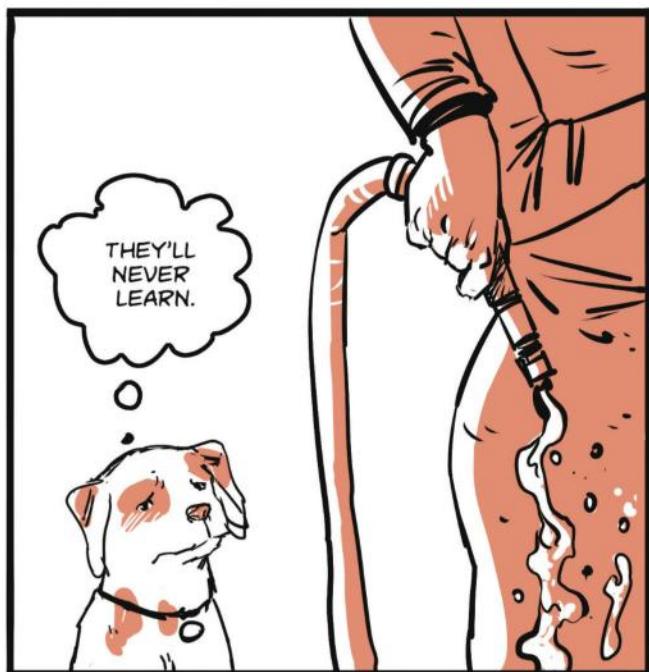
THE VAPOR CONDENSES ON THE INTERIOR OF THE COLD TENT, JUST LIKE STEAM ON A BATHROOM MIRROR, AND DRIPS DOWN AS PURE WATER.



THEN WE PIPE IT OVER TO THE GREENHOUSE AND THE UNDERGROUND HABITATS.



IT'S GREAT TO HAVE A FRESH START. AND ALL THE WATER WE COULD EVER DREAM OF!



WHAT'S IN A GLASS OF WATER?

With nearly limitless beverage options, you might not realize how much variety exists in the seemingly bland realm of tap water. This colorless refreshment can vary widely from city to city, house to house, or even sink to sink. Here are some surprising items that might show up in your H₂O.

BY RACHEL FELTMAN / PHOTOGRAPH BY THE VOORHES



PESTICIDES

Insecticides and herbicides can wash into rivers and lakes and seep into groundwater. The pesticide atrazine has been linked to hormonal imbalances in lab animals but probably isn't carcinogenic.

FLUORIDE

As rocks erode, they naturally release fluoride into soil, air, and most water sources. Because it can prevent tooth decay by rebuilding enamel, many communities add extra to the drinking supply.

CHLORINE

Water-treatment facilities add chlorine as a disinfectant, and it's safe at low levels. But some disinfectants produce byproducts that have been linked to miscarriages.

ARSENIC

Arsenic occurs naturally in rocks and soil, and it's linked to increased risk of cancer. A water-treatment plant should remove the poison, but private well owners must periodically test for it.

HYDROGEN SULFIDE

Naturally occurring and harmless, this chemical is still a pain in the butt: It smells like rotten eggs, stains clothes, and corrodes pipes.

PHARMA

Everything from amoxicillin to Zyrtec makes its way, via your pee, into the rivers and lakes that supply our water. However, pharmaceuticals only contaminate surface water at extremely low levels.

COPPER

You'll notice a medicinal taste—or even greenish hair—with just 1.3 milligrams of copper per liter of water. But the metal, which leaches from old pipes, is safe for humans at those levels. Just don't put it in your fish's tank.

LEAD

Old, corroded metal pipes can deposit this potent neurotoxin into drinking water, as they did in Flint, Michigan. Children who ingest lead can develop permanent learning disabilities.

ALGAE

Agricultural runoff or warm water can stimulate fish-killing "algal blooms." But for us, algae in drinking water is just a nuisance: a musty, fishy taste that persists even after the treatment plant.

SALTS

Salts are a normal part of water, though a strong salty flavor can indicate a wastewater leak. And a high concentration of sodium- or magnesium-sulfate salts might have a laxative effect.





PARCHED.

A
WEEK
EXPLORING
HOW
WE'LL
HAVE
TO
LIVE
IN
POST-
WATER
AMERICA.

BY
**SARAH
SCOLES**

ONE SATURDAY MORNING IN DECEMBER,

I drank half as much coffee as usual and then, dull-eyed, walked to a hardware store to purchase the 18-gallon storage container I would use to take showers for the next seven days. Because for one week, I was going to shrink my water footprint to see how that small shoe felt.

Much of my home state of Colorado is in a drought. Last May, when I moved to Denver, where I share an apartment with my sister, Rebekah, the locals promised me snow by October. None fell till mid-November. Rainfall was about half the amount normal for fall. I'd come from California, where drought is so severe that lawns have turned brown and swimming pools go unfilled. Colorado isn't that bad yet. Neither is most of the U.S. But while we've largely been spared, a big chunk of the world is struggling. In some places, it is our carbon that is melting their glaciers and shriveling their lakes. So I decided to find out what an average citizen—me, you—could do here at home.

How often you and I turn on the tap would hardly seem to make a dent. Of the 355 billion gallons of water that wash through American pipes daily, less than 10 percent is for domestic use. Thermolectric power accounts for nearly half of the total, while irrigation amounts to a third. Much of the rest goes to livestock, aquaculture, and mining.

But did you ever think about how much water your shirt uses? Not just to wash it, but the amount that went into making it? Then there's the water that feeds the food you eat and helps produce the gas that makes your car go.

In other words, our individual choices add up to an enormous demand as a society—664 billion gallons per day. In a 2014 Government Accountability Office study, water managers in 40 out of 50 states said they expect shortages in their states in the next 10 years. By late last year, nearly a third of the contiguous U.S. was in moderate to exceptional drought, the latter defined as widespread crop loss, shriveling reservoirs, and water-shortage emergencies.

I decided to see how low one person could go to ease the problem, and whether that could make a difference.

Feeling overwhelmed by all the complicating factors, I walked back to my apartment, big blue bucket in hand,

and set it on the living room floor while I used an online calculator to tabulate how much water I had consumed—directly and indirectly—in the heedless days before this one.

The result: 1,320 gallons per day, compared with the American average of 2,088 gallons per day.

Well, congratulations to me.

I took the bucket into the bathroom, plunked it in the tub, and got ready to go lower.

Then I headed to the kitchen.

YOU ARE THE WATER YOU EAT

I knew that changing the way I ate would make the biggest difference. It takes 500 gallons of water to produce 1 pound of chicken. The same amount of beef needs 1,840 gallons. A single egg floats on 50, while a half-pound of cheese can take as much as 350.

Going vegan was the obvious solution. To help me plan, I invited my friend Tasha Eichenseher, an editor who helped create *National Geographic's* water-use calculator, over for dinner the first night. She gave me some general guidelines. "No meat or dairy," she said. Food should be "locally sourced to avoid transportation water footprints." An average tractor-trailer can go only 6 miles on one gallon of fuel. For every 6 miles cargo travels, it sucks up 13 gallons of water. And then came more considerations: "Small portions so there is no waste," Eichenseher said. "Minimal cooking. Minimal packaging. No diuretics."

"OK," I said, and then simply googled "drought-friendly recipes." Luckily for me, television chef Nathan Lyon has a tag on his blog called exactly that. I picked out his "eggless shakshuka," normally a dish of eggs poached in a simmering spiced tomato-and-onion sauce. His suggestion to include avocado seemed water unwise (141 gallons per pound), as did his call for goat cheese (very dairy). So we decided to chuck both—meaning we'd basically be eating tomatoes and onions sopped up with bread.

Later that day, recipe in hand, Eichenseher and I visited Sprouts Farmers Market, a Denver mini chain with lots of

**Use This,
Not That**
Bad: Burgers
and plastic.
Good: Unwashed
jeans and one
daily coffee.





grass-fed, paleo, and raw foods on offer. But our attempts to choose the best version of each ingredient faltered. Was it more water-efficient to get tomatoes from California because it was closer, or from Florida because it rains more there? A small amount of spice from the bulk section cuts down consumption but requires a plastic bag. I could get prepackaged versions in glass bottles, but glass is heavier so it requires more fuel to transport. We talked circles around each decision, trying to weigh conserving water against other Earth-friendly factors.

Turns out we were not alone in our perplexity, according to Christie Manning, a professor at Macalester College in St. Paul, Minnesota, who focuses on environmental issues. “People frequently find themselves paralyzed by confusion,” she writes in her handbook *The Psychology of*

Sustainable Behavior. “They want to do the ‘right’...thing but are not sure which of their options is the most sustainable.”

They’re all intertwined. If you want to recycle a mason jar—a water-friendly choice—you have to face up to the fact that rinsing the inside costs water. If you want to wear synthetic fibers because they’re less water-costly than cotton, you accept that you’re using up fossil fuels.

You won’t be perfect, but Manning suggests keeping big-picture impacts in mind and then just doing your best.

For our part, we chose the California tomatoes and spoon-them-yourself spices, and tried to be at peace with our decisions. For the rest of the week, I would eat oatmeal for most breakfasts, ratatouille and baked root vegetables for dinners, and leftovers (largely) for lunches. This wouldn’t be so hard—after all, vegans do it every day.



But it did seem like a diet—not because the dishes had fewer calories but because of the prescribed set of restrictions. The rules made me want to break them and have a Tuesday cheeseburger. And while I wouldn't do that, the desire to shirk the self-imposed austerity pervaded the whole experiment.

IN THE WATER CLOSET

On that first night, the shakshuka was delicious, and I felt noble and thoughtful and full. There was another dilemma, though, that I wanted Eichenseher to advise me on. It was late into the evening, and Eichenseher had not, as I'd anticipated, used my toilet—maybe because we hadn't been drinking alcohol. So I came right out and asked her: "What would you think if you went into my bathroom and had to look at a day's worth of my urine before you could add your own to it?"

Without pause, she said, "I'd think that you'd probably lived in California."

Right. In California, about half the homes I'd been in had toilets tainted by their inhabitants' pee. When Gov. Jerry Brown declared a drought state of emergency in January 2014, he asked residents to curb water usage by 20 percent. One popular tactic was to flush less. Yellow toilet bowls, in other words, have become the norm there.

So are short showers, another habit I adopted for the week by halving my usual wash time. Every day, I turned on a song (often *Six Feet Under* by The Weeknd, in case you were wondering) before hopping in, and I made sure to be out before the 3:57 track was over. I stood in the big blue bucket, all the water, soap, and shampoo falling into it, and graying up as it pooled around my legs. My showerhead produced around six gallons each time I washed up.

Despite the musical timer, turning off the stream of steamy heat was a daily triumph of will. My experiment coincided with a winter cold snap. I usually showered each day after a run in the subfreezing morning. And while my apartment wasn't cold, the shower was the only place where I didn't want to be under a blanket. The rational decision-maker inside me—which told me I was helping Earth—fought the impulsive, sensory-motivated part of me that said being warm was nice.

Manning's handbook suggests finding ways to make personal reforms seem simultaneously good and wise. I told myself three minutes is not much shorter than six, and that I'd enjoy showers more if I didn't stay long enough to get used to them. We know, after all, that the first few bites of cake thrill our taste buds more than the last couple.

Robert Jones of Missouri State University in Springfield, who studies the psychology of sustainability, main-

DID YOU EVER THINK ABOUT HOW MUCH WATER YOUR SHIRT USES? NOT TO WASH IT. THE AMOUNT IT TOOK TO MAKE IT. FOR ONE FLANNEL SHIRT, THAT'S 700 GALLONS.

tains that the discomfort of short showers and other watery sacrifices is modest. If you don't think you can undergo even modest unease or resist the temptation to alleviate it, change your routine. "Create an environment that doesn't expose you to those opportunities," he says. If you crave a long shower, go for a walk until the feeling passes. That's a bit of a hard-line approach, but the argument holds in less-extreme versions. Learning to stop overconsumption is like quitting any other habit, and taking up conservation is just like forming any other new routine.

For me, guilt was a big motivator: Each day, I had to look at all the liquid from my shower. I also put a Tupperware container in my bathroom sink to catch everything that dribbled from my hands and mouth—about a quarter gallon by day's end. On day two, my younger sister proved an even bigger incentive, as she constantly checked in on how good a job I was or was not doing, and felt no compunction about commenting on my efforts.

TRIPS AND HOMECOMINGS

The holidays were approaching, and Rebekah and I had planned a midweek trip to federal land outside Denver to cut down a Christmas tree to make our parents happy during their upcoming visit. The U.S. Forest Service lets people remove a limited number of small trees that would otherwise become kindling during the fire season, so I felt little guilt about removing nature's bounty. I packed a reusable bottle of water, some leftovers, and a saw, and we hit the road, headed toward the snow-covered mountains.

A couple of hours later, as we searched for the ideal tree, my car got stuck in a particularly drift-covered back road. Cardboard placed creatively under the tires got us out, but at the end of the expedition, I was, predictably, tired, cold, thirsty, hungry. We stopped at a gas station, where Rebekah bought trail mix full of water-hogging nuts and a plastic bottle of Gatorade. "Want anything?" she asked.

Yes, I thought.

"No," I said. I opened up my Tupperware food and gulped my tap water. The National Academy of Medicine sets "adequate intake" of hydration, including from both water and food, at about 15 cups a day for men and 11 for women. If you're doing anything endurance-related, you need more—along with electrolytes—to replace fluid lost to sweat and other bodily processes. On most days, "adequate" was enough for me. But at that particular moment, my non-electrolytic water was definitely not satisfying, nor were my leftovers. Yet what Jones had said was true. The feeling passed, at least as soon as my sister stopped crunching away on her trail mix right (CONTINUED ON P. 90)

Spit, Reuse
Everything that dribbled from the author's mouth went into a bucket, for toilet flushing.

595-685 B.C.

Amphictionic League vs. Kirrans

Pilgrims visiting the Oracle at Delphi had to pass Kirra, a coastal city where thieves often robbed the travelers. To end these attacks, Greek tribes formed a league to besiege Kirra. They poisoned its water with hellebore, a toxic herb that sickened citizens until the village fell.



51 B.C.

Romans vs. Gauls

To drive the Gauls from what is now France, Roman troops had to attack their last remaining fort on the Dordogne River. During the siege, archers shot any Gaul trying to escape. Then, the Romans drained a spring that fed the fort its water. The thirsty Gauls ultimately surrendered.



30 A.D.

Romans vs. Jews

When Pontius Pilate, the Roman governor of Jerusalem, stole funds from a Jewish temple to build an aqueduct, thousands protested in the streets. Pilate sent spies armed with hidden daggers into the crowds. The spies massacred countless Jews, and Pilate built his aqueduct.



1187

Muslims vs. Christian Crusaders

To rid Jerusalem of crusaders, Muslims lured them from the city (and a secure water source) by attacking a Christian village. The Muslims then blocked access to nearby springs, leaving parched crusaders to die, surrender, or flee—and allowing Muslims to retake the Holy Land.



Whether we're poisoning, drowning, or dehydrating our enemies into submission,

1964

Cuban Government vs. U.S. Navy

After the U.S. Navy detained several Cuban fishermen off the Florida coast, Cuban President Fidel Castro cut fresh water to the U.S. Naval base at Guantanamo Bay. The Navy started to ration water there and built a desalination plant to be free of its reliance on Cuban aqua.



1962-1967

Brazil vs. Paraguay

Brazil and Paraguay both claimed hydroelectric development rights to the Guaira Falls, which sat on their shared border. Brazil invaded and occupied the site for five years. The countries signed a treaty in '69, and both now get power from an upstream hydrodam—which killed Guaira Falls.



1980-1982

Guatemalan Government vs. Villagers

The Chixoy hydroelectric dam forced thousands of Maya-Achi from their land. Resistance led to massacres by government troops and militias. During a government assault, 177 women and children were killed. In 2014, survivors were awarded a total of \$154.5 million in reparations.



1997

Malaysia vs. Singapore

The island nation of Singapore, once part of Malaysia, criticized its former sovereign (and main water supplier) during a policy dispute. Malaysia vowed to turn off the tap. Singapore began conserving water and building desalination plants to work toward water autonomy.



1642

Ming Dynasty vs. Peasants

By 1642, foreign invaders and rebellious peasants had nearly overrun the rulers of the Ming dynasty. To stop peasants from capturing Kaifeng, a capital along the Yellow River, a Ming general smashed the river's dikes. The ensuing flood wiped out the rebels—and the city.



1838-1844

Canadian Settlers vs. Mill Owner

A mill owner built a power dam in Lindsay, Ontario, flooding area farms and breeding malaria-carrying flies. So settlers armed with axes and pitchforks attacked the dam, nearly destroying it. The government stepped in, built a smaller dam, and reclaimed farms for settlers.



1863

Union vs. Confederacy

After the fall of Vicksburg, Mississippi—a major turning point in the Civil War—the retreating Confederate troops drove cattle, hogs, and sheep into freshwater ponds and shot them, poisoning the water supply so pursuing Union troops couldn't drink from it.



1924-1927

Los Angeles Bureau of Water Works vs. Farmers

In 1913, L.A.'s aqueduct began diverting water from Owens Valley farmers, parching their crops. Led by Wilfred and Mark Watterson, a group of farmers bombed the aqueduct in several places over three years, until authorities arrested the brothers for fraud and embezzlement.



we humans have long fought over—and weaponized—water. BY KELSEY ATHERTON

2000

Hacker vs. Australian Wastewater System

Armed with a laptop and a radio transmitter, a hacker in Queensland, Australia, seized control of a local wastewater system and released sewage into parks, rivers, and property. His goal: revenge for not getting a job with the local council. Authorities gave him a new gig: prisoner.



2002

Maoist Guerrillas vs. Nepal

In its guerrilla war against Nepal's government, Maoists destroyed several small hydrodam projects, and even blew up a 250-kilowatt one, cutting power to Bhojpur (population: 6,000) and nearby areas. The damage took six months to repair. The war waged on for four more years.



2016

Standing Rock Sioux vs. Energy Transfer Partners

In spring 2016, the Standing Rock Sioux set up a protest camp to block construction of an oil pipeline that crosses the Missouri River, threatening their sovereignty and the security of their water supply. In December, the project was put on hold pending environmental review.



KEY



CUT WATER



SABOTAGE



DAM



TREATY



MASSACRE



WAR



POISON



WATER SUPPLY



WHERE THEY TAME

THE UNDRINKABLE OCEAN

BY KELSEY AHERTON / PHOTOGRAPHS BY SPENCER LOWELL / 66





*One of the fastest-growing cities
in the world is also among the driest.
Situated between the Persian Gulf*

*and the Arabian Desert, the Jebel
Ali desalination plant makes
the metropolis of Dubai possible.*



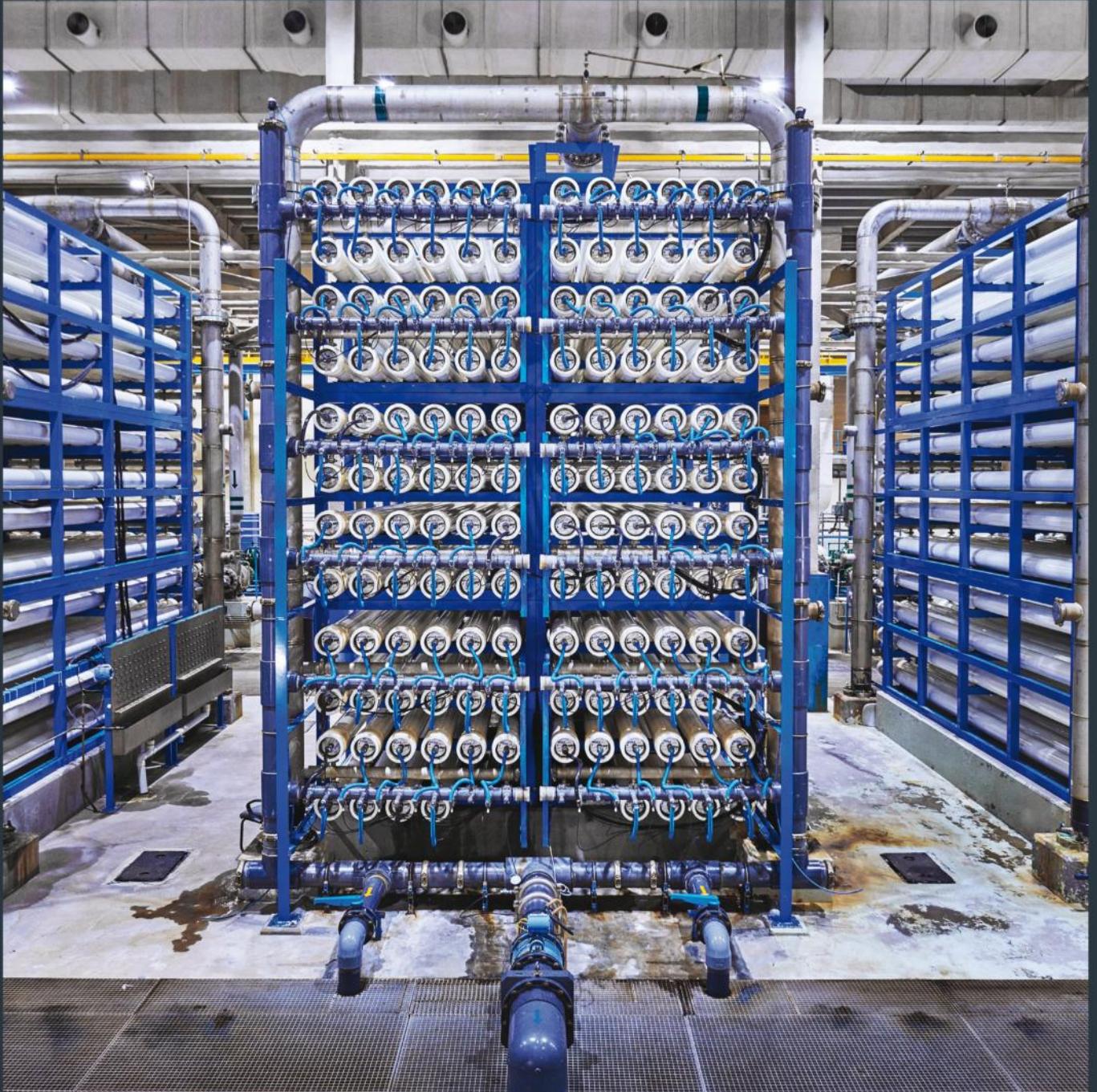
**A Big Gulp
of the Gulf**

Dubai's population boom long ago outgrew its groundwater supply. Today, it provides only 0.5 percent of the city's demand. To meet the other 99.5 percent—a daily peak of 416 million gallons, on average—the Jebel Ali plant imbibes 2.8 billion gallons from the Persian Gulf every day, turning it into pristine drinking water. In the first step, the sea passes through filtration baskets, which isolate large materials including trash, seaweed, and occasionally marine life.



Separation
Under Pressure

At the reverse-osmosis facility, motorized pumps force salt water through tubes filled with tightly wound membranes. The result? Highly concentrated salt water on one side, and something you'd actually want to drink on the other. Reverse osmosis used to be notoriously expensive and energy intensive. But over the past decade, major advances in membrane technology let plants like this one treat more water faster. Jebel Ali produces 30 million gallons per day via reverse osmosis alone.



↓
**Journey Through
the Vape Chamber**

The rest of the seawater—about 98.5 percent—goes through a multi-step heating and cooling process called flash distillation. Turbines send steam via pipelines to a series of evaporation chambers. There, steam heats the salt water, and the resulting vapor cools and condenses into a collector. Leftover salt water travels to the next chamber, which has lower pressure (and a lower boiling point). This repeats many times until pure H₂O—and a dense brine—are all that remain.







From the Ocean to the Tap

The water gets tested for pH, turbidity, and any chlorine dioxide left over from treatment. Then it's transferred to reservoirs en route to the city. The Dubai Energy and Water Authority (DEWA), which operates the plant, services 666,430 customers with water as of December 2016, most of them residential. Currently, the total capacity of the plant is 564 million gallons a day, but demand is growing, so an expansion to accommodate an additional 48 million gallons is underway.



Back
to the Sea

Despite all that work, only about 9 percent of the total original intake becomes potable water (or goes to generate electricity). The rest—now with a higher salinity—gets pumped back into the Persian Gulf. In 2015, that translated to more than 1.3 trillion gallons of discharged brine. DEWA keeps a close watch to ensure all that warm salt water doesn't harm the local ecosystem. At multiple distances from the plant, workers routinely test the sea for things like acidity levels and the health of marine life.



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"LOWEST AFFORDABLE PRICE"

Incredible...

"I was surprised to hear sounds I had forgotten existed – the crispness of the bells we use in Church, the splash of water running, the rich overtones in music. Thank you."

– Rev. John C.

Life-Changing...

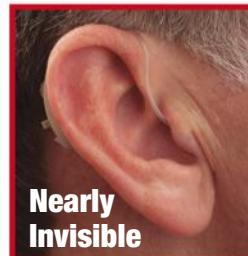
"Thank you for making an affordable hearing aid so that people like me can again be part of conversations..."

– Cathy C.

Value-Packed...

"I'm a physician and I know how much people spend on their health care. MDHearingAids are just as effective (if not more) than traditionally high-priced hearing aids."

– Dr. Chang



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TALES FROM X THE FIELD



KA-BOOM

that time i bombed antarctica

NICK HOLSCHUH, GEOPHYSICIST AT THE
UNIVERSITY OF WASHINGTON



If you were to melt Antarctica, the global sea level would go up by around 60 meters, which would obviously be pretty bad. But to understand how and when the ice sheet might melt, we need to measure its physical properties—the material of the rocks beneath, the temperature of the ice, defects gliding through the system. For something one and a half times the size of the United States, that's a crazy-difficult task.

So how do we do that? Well, if you use a thermometer to measure temperature, you're actually measuring the behavior of alcohol or metal within the thermometer itself. I used a similar principle to measure temperature through the ice. We sent sound waves down into the subsurface to get information on physical properties—like temperature—that affected them on the way.

Explosives happen to be a great source of sound. First, we bored a 20-meter hole down into the ice with a hot-water drill. Then we stuffed in a pound of Pentex H boosters and packed them in with snow. We covered the surface in an array of microphones. Then—boom!

After the explosion, we listened for echoes. Logistically speaking, it's not the simplest method of measuring the properties of ice, but having a variety of data-collection techniques at our disposal helps us understand how human behavior affects this massive system.

On quieter days, I use radio waves to peek through the ice sheets—to look at the configuration of the ice and the properties of the material it's sitting on top of—and I use satellite data to see how the surface is changing over time.

BOTTOMS UP

what it's like to drink your own pee

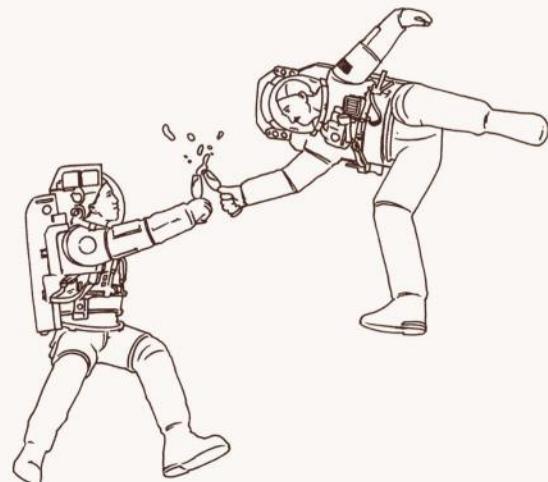
JEFF WILLIAMS, NASA ASTRONAUT AND U.S.
RECORD HOLDER FOR TOTAL DAYS IN SPACE

On Earth, not all water tastes the same. Some water is delicious, but some can leave a funny taste in your mouth—the result of a particular mineral or metal. This doesn't happen on board the International Space Station, even though you're drinking recycled sweat and urine. You don't sense any unusual flavors. The water—and the beverages we make from it—consistently tastes pretty good.

The process of treating wastewater up there isn't all that different from the natural water cycle on Earth—the runoff,

the evaporation, clouds, and rain. The planet's water cycle turns water we might consider nasty into water we consider drinkable; so do the ISS's systems. And we test it almost every single day, so we're confident that our drinking water is clean. NASA has very strict standards for it.

We joke about it a lot, but we really don't think much about what our drinking water used to be. I've been on board with 55 or so different people, and I've never seen anyone hesitate to drink it. We drink the Russian water, and they drink ours.



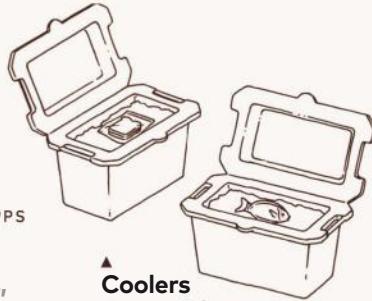
GEARED UP

look at this trove, treasures untold

EMILY KELLY, ECOLOGIST AT THE SCRIPPS INSTITUTION OF OCEANOGRAPHY

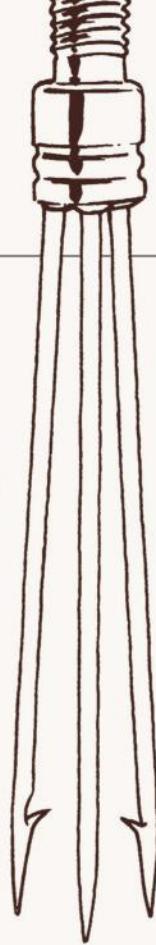


Among Hawaii's reefs, Emily Kelly dives with surgeonfish and parrotfish. By grazing on fleshy algae, these "underwater lawnmowers" make room for hard corals to grow. To study how the fish aid the reef, and how to protect them from overfishing, Kelly uses this collection of gadgets and gizmos.



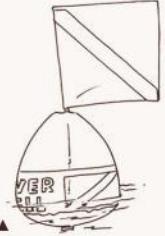
▲ **Coolers**

The researchers preserve specimens on the way to the lab in an ice-filled cooler. A similar cooler holds snacks. The trick is remembering which cooler is which!



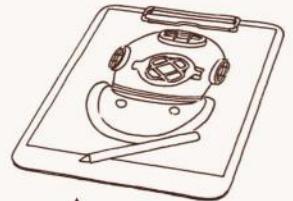
◀ **Spear Gun**

Kelly and her colleagues like to get their fish-gut specimens from local fishers when possible. But if they do go collecting, they rely on a Hawaiian sling-style gun with a three-prong spear tip.



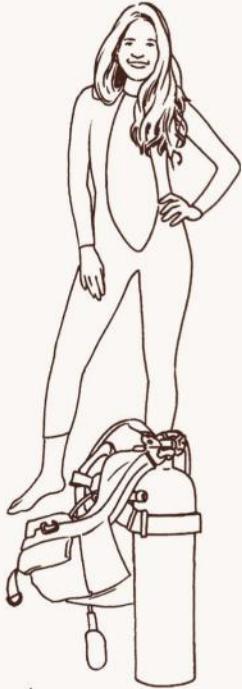
▲ **Buoy**

Forget about sharks—stray boats are a more threatening concern. To avoid accidents, Kelly's team totes a float out to the water to mark their diving location.



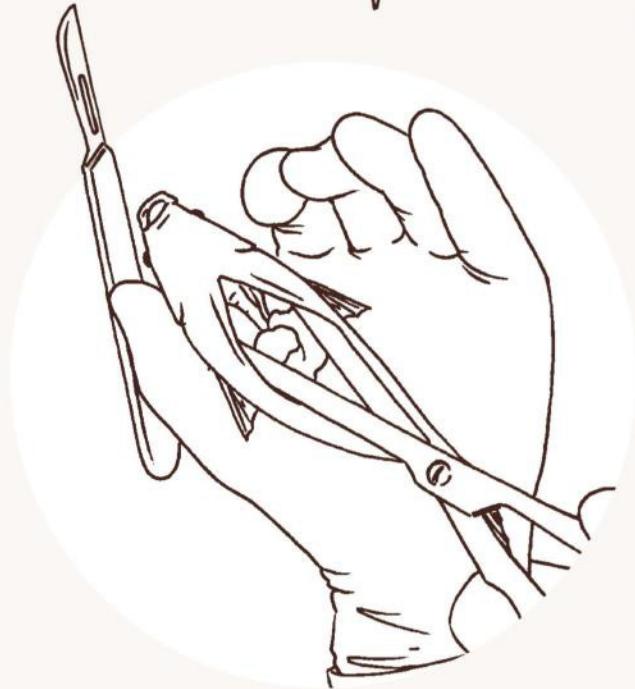
▲ **Waterproof Paper**

Kelly takes notes about what algae fish prefer, how they eat (nibbles versus chomps), and their roles in different ecosystems.



▼ **GPS Unit**

Scientists can't exactly mark a fish's street address. So they use a civilian GPS unit to track where they make observations and find specimens.



▲ **Surgical Equipment**

Although the fish go to the lab for later study, Kelly and her colleagues use razor blades and forceps to dissect some specimens right in the field. First they remove essential organs and collect the ear bone, whose tree-ring-like structure can help determine a fish's age. Then they take out the guts and slice them open before putting them into a vial of formalin, allowing the preservative to permeate the organs.

▼ **Seaweed Samples**

Parrotfish and surgeonfish sometimes graze on seaweed, which Kelly and her colleagues store like flower pressings. She displays some in her office, but they're not just decorative: Kelly can always slice off a piece, rehydrate it, and examine its cell structure under a microscope.



▲ **Wetsuit**

Even in Maui's balmy 75- to 80-degree waters, up to eight hours a day in the water saps Kelly's body heat. A wetsuit keeps her cozy.

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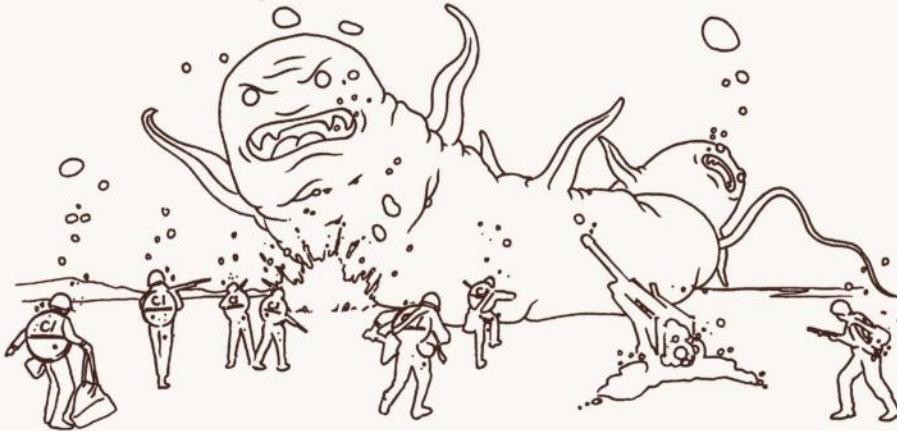
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KILLER JOB

battling a waterborne plague

RICK GELTING, U.S. PUBLIC HEALTH SERVICE OFFICER AT THE CENTERS FOR DISEASE CONTROL AND PREVENTION



When you're in a water emergency, it's really not the time to try something new. In 2010, when the cholera outbreak hit Haiti, the local government invited us to help implement a water-cleaning system. We had to work quickly to get clean water to small communities fighting against the waterborne disease. But we also couldn't introduce any new technologies or products that local workers and residents might not be familiar with.

Chlorine was our go-to: It's available, inexpensive, and incredibly effective. Problem is, there are different types of chlorination, so we had to trace where people got every drop of their water—whether they piped it in, hauled it from wells, or got it elsewhere. This is

where local knowledge comes in handy.

For large community water systems, we used locally available materials to drip a liquid chlorine solution directly into storage tanks, a method that Haiti's national water and sanitation agency (DINEPA) developed. But some people were bringing in small batches of water from other places. In those cases, special chlorine tablets and solutions let individual households treat their own water.

Working with DINEPA was key because they knew the local conditions and communities better than we did. Local knowledge ensures that what you build will sustain itself and make a difference in the long term—because you will eventually leave.

as told to Claire Maldarelli

Hydroplaning and hail are usually scarier than the tornado itself. It's like driving on black ice in the middle of nowhere with no cell reception.

EMILY SUTTON, METEOROLOGIST AND STORM CHASER AT KFOR-TV IN OKLAHOMA CITY



STORMCHASERS

flying into a tempest

ROBERT ROGERS, METEOROLOGIST FOR THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



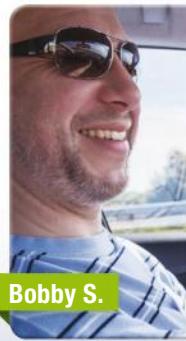
When we fly Hurricane Hunter aircraft into cyclones, a lot of the data we gather is to monitor for "rapid intensification." That's when a storm increases in strength by 35 miles per hour or more within a 24-hour period, and it's a big concern for the forecast community. The nightmare scenario is for this to happen to a Category 1 hurricane just before landfall on the U.S. coast: It goes from a Category 1 to a catastrophic Category 4, and no one has any warning.

Back in 2007, during Hurricane Felix, we flew into a Category 2. But at 10,000 feet, I saw flashes—at first I thought someone took a photo, but then I realized it was lightning. When you see lightning in the core of a storm, it's a sign that it's really intensifying. We wound up hitting such a strong updraft, maybe 60 miles per hour, that we hit zero g for a couple of seconds. My notebook started to float, and drops of water from the cup next to me were hovering in the air. At that point, the mission switched from collecting data to just getting home safely.

as told to Rachel Feltman / illustrations by Mark Nerys

Do You Suffer From:

- Plantar Fasciitis
- Joint Pain
- Heel Pain
- Back/Knee Pain
- Bunions
- Heel Spurs
- Arthritis
- Neuropathy



Bobby S.

I stand on cement floor eight hours a day, but my body just can't take the pounding of walking or even standing. After trying Gravity Defyer shoes, I can keep my job and enjoy it pain free. I am Gravity Defyer's #1 fan.

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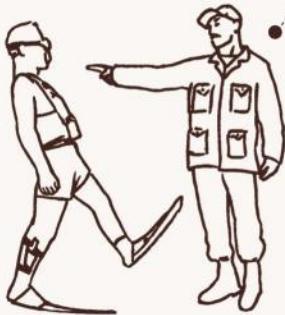


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1

Join the Seabees

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WET WORK

becoming a navy master diver

JAMES EMERSON, NAVAL CHIEF WARRANT OFFICER AND MASTER DIVER

From salvaging wrecks to building aquatic infrastructure, master divers like James Emerson handle some of the U.S. Navy's most complex subaqueous projects—because if something is tricky on dry land, it can be diabolical in the drink. Emerson is in charge of turning Seabees (the name comes from the abbreviation for "Construction Battalion") into underwater experts. Out of 160 Seabee divers, only 2 to 4 percent will ultimately earn the title of "master."

2

Become a Seabee Diver

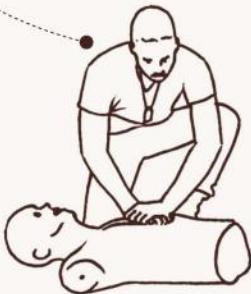
Now to perform those same tasks in scuba gear. Lessons include hydraulic cutting and welding—and avoiding electrocution.



4

Go Back to Dive School

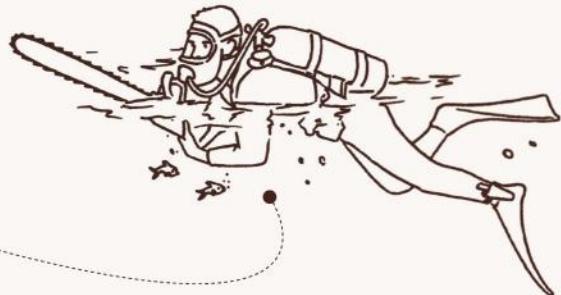
Five or more years later, Seabee divers can try for First Class level, learning project management and how to treat injuries.



3

Learn on the Job

One of Emerson's first tasks was to cut up a ruined Virginia pier in "some of the coldest, darkest water you can imagine."



"Yesterday's coffee is tomorrow's coffee."

ASTRONAUT DOUGLAS H. WHELLOCK TO THE NEW YORK TIMES ON DRINKING RECYCLED LIQUID ON THE ISS

THE MOST COMMON QUESTION POSED TO ME BY MEN:

Male Enhancement Pills ... Do They Really Work?

**Dr. Steffanie Seaver PSY.D**Researcher, Author,
Accomplished Public Speaker

Well, unfortunately, there are not many Natural Male Enhancement products that live up to their hype, but one of my readers recently emailed me about a new **RED** pill that blew his (and his partner's) mind. After a little research on my end, I feel compelled to share this with the rest of my subscribers. Please read on ...

To: Seaver, Steffanie

Today at 7:54 AM

! Red Hot Pill Partner Reaction Challenge

Dear Steffanie,

I recently received a sample for a new male enhancement product, **RED FORTERA**, in the mail. I've tried a few of these natural alternatives (not that I have a real problem) and I'm a relatively healthy male - but what guy **WOULDN'T** want an extra boost every now and then with that special someone? Well, most of the time, results from these products are somewhat underwhelming, but the moment I received this sample, I knew something was definitely different! First, this pill is **RED**, actually a sort of luscious red that you don't ordinarily see. Second, and more importantly, the sample came with an interesting letter from the manufacturer. The letter didn't make any ridiculous claims of how many inches I was going to gain, but *it did* make a rather bold statement that I could not get out of my head, one that intrigued me to the point I had no choice but to try this new red pill. Here's what the letter said, verbatim:

" ... take our "**Partner Reaction**" Challenge, simply use this **FREE** sample 30 minutes prior to engaging in sexual activity and **TAKE NOTE OF YOUR PARTNER'S REACTION!** That's correct, don't believe our rhetoric, let your partner's reaction tell the real story - we **CHALLENGE** your partner **NOT** to show a reaction to the drastic difference in your performance. We're so sure that you're going to agree, we're **GIVING AWAY A FREE 3 MONTH SUPPLY** to the best testimonials we receive. Simply send us a paragraph or two describing your partner's reaction to your newfound prowess. We'll post the best descriptions we receive to our website (so keep them "clean"), and if yours is one of them, we'll send you a full **3 MONTH SUPPLY** absolutely **FREE!** (All personal info will be kept confidential.)

I couldn't believe it - these guys were so confident in their product, they were literally saying **MY PARTNER WOULD NOT BE ABLE TO CONTAIN HER REACTION** to the distinct difference in my performance. **THAT'S BOLD!** I mean, jeez, it's one thing to say take a pill every day for the next 60 days and feel a difference, but to literally say - take this pill today, **ONE TIME**, on your very **FIRST TIME** trying it, and watch how your partner reacts? I was compelled to try just for the pure principle of it.

Steffanie, all I can say is, they weren't kidding. I didn't tell my wife I was trying it. Literally, in the middle of our "experience," she stopped me and said, "Ok what's going on, what did you take..." - I couldn't believe it! They were right! She couldn't help but to react! Steffanie, you have to find out more about **this New Red Hot Pill!** Now, every time my wife and I are intimate, she asks me, "Did you take the pill?" - it's crazy but I had to order a 3 month supply! She won't let me go without it!

In fact, here's the phone number for your readers: **1-800-586-5194**, or they can go to **RedFortera.com** to check it out. If they call today, they may still be able to get the **FREE SUPPLY** with their order like I did.

**CLINICALLY TESTED FORMULA****EXPERTLY BLENDED FOR
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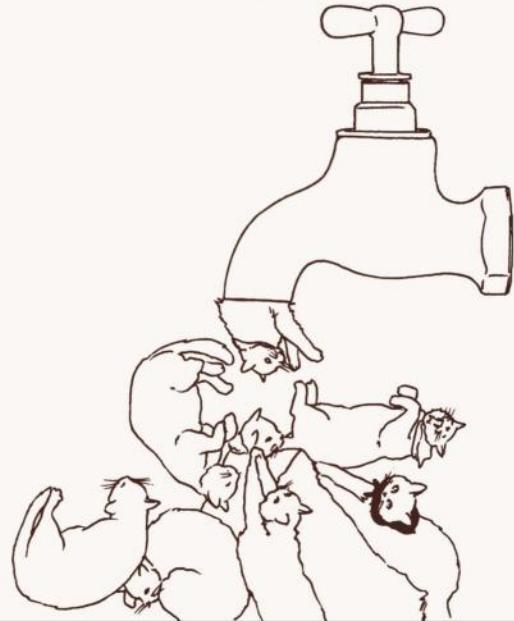
MYSTERY

the case of the cat-scented faucet

ANDREA DIETRICH, WATER CONSULTANT
FOR UTILITY COMPANIES



About 25 years ago, some people would turn on their faucets and smell cat urine. It was one apartment in a building, or one house in a neighborhood. Residents would say, "We don't have a cat." We were stumped for more than a year until a utility employee said, "It's not our water; it's residents' new carpets." He was half right, anyway. At the time, maybe 0.1 percent of utilities in the United States disinfected their water with chlorine dioxide. But chlorine dioxide isn't water soluble, so when people opened their faucets, it would quickly fill the surrounding air. There, it reacted with chemicals in new carpets to create the signature stench. My colleague and I went to his church, which had a new carpet, to test the theory. We sprayed chlorine dioxide into the air, and sure enough: cat urine.



as told to Sara Chodosh

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PACKING LIST

how to survive the desert

KUMUD ACHARYA, HEAD OF ECOLOGICAL ENGINEERING AT THE DESERT RESEARCH INSTITUTE IN LAS VEGAS



Kumud Acharya seeks out the world's hottest conditions. Here's what he brings to stay hydrated—and alive—while doing science in the most scorching environments.



1 Reusable Bottles

Acharya drinks from the tap when it's safe, and bottled or purified when he's not accustomed to the local aquatic flora. For a day's work, he'll bring four to five liters in reusable vessels in a cooler full of ice.



2 Skin Coverage

To prevent painful sunburns, Acharya applies spray-on, waterproof sunscreen copiously and often. He also wears long-sleeved shirts and large-brimmed hats with neck covers for more protection.



3 A Small Tent

It's important to get out of the rays periodically, and the desert isn't famous for its shade-giving trees. Acharya brings his own shelter. While he rests, he reslathers the sunscreen and rehydrates.



4 Water Filters

For unclean H₂O, Acharya uses one of two methods to kill bacteria: a small bag that combines sunlight and a photocatalyst, or potassium permanganate and chlorine dioxide tablets.

by Jason Lederman / illustrations by Mark Nerys

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A Dedication to Health & Human Rights

American Red Cross Founder CLARA BARTON said to her male counterparts: “We nursed you back to health and now we need your help!” But unfortunately some of her counterparts made sure help never came . . . even after thousands of women like my grandmother (Google: Nursing Sisters Port Dover) and Clara Barton went to Rochester, N.Y. and descended on the home of woman suffragist SUSAN B. ANTHONY (Clara Barton’s 6th cousin) to offer their support for a woman’s right to vote! What follows is a brief history of my family’s efforts to make lives better for men and women across the globe . . .

By John Ellis

If you Google: Nursing Sisters Port Dover, you’ll see a book by Harry B. Barrett. In that book are pictures of my grandmother and her heroic nursing sisters during WWI, including one sister who was mentioned in wartime dispatches for her heroism along with a certificate presented to her by King George V. (In spite of her “valor in the face of the enemy,” a woman was ineligible to receive the Victoria Cross!)

There are hundreds of letters and pictures, including one of the ambulances my grandmother donated (before we entered WWII) encouraged by her friend, suffragist CARRIE CHAPMAN CATT, who moved around the corner from my grandmother in New Rochelle, N.Y. As a youngster, I remember all the sewing machines and their many friends at my grandmother’s house sewing thousands of pre-die cut clothes together to keep children warm during the brutally cold English winters. Carrie Chapman Catt also founded the League



Every year thousands visit the grave of suffragette Susan B. Anthony, a fighter for women’s rights.

of Woman Voters and is most famous for her Congressional speech resulting in the 19th Constitutional Amendment that gave woman the right to vote in 1920!

All this took place after Susan B. Anthony died in 1906 in Rochester, N.Y. where my grandfather baked his first loaf of BOND BREAD in 1915, resulting in 50 factories producing over 1.5 million loaves of bread a day . . . a Horatio Alger success story which enabled my grandmother to help further woman’s rights. She was inculcated with a sense of moral responsibility by her family who emigrated here in 1720 and then moved to Canada because they were Loyalists to the King and the Church of England.

BESET WITH MODERN AILMENTS

Now, history repeats itself, except this time their counterparts have problems with clogged arteries, heart attacks, prostate problems and cancer by **stonewalling a Man’s right and a Woman’s right to flush DEUTERIUM** (a major cause of Aging and Cancer) **and Pathogens out of their bloodstreams** . . . so these diseases aren’t handed down to generations of our unborn children and grandchildren!!



Two nursing sisters with wounded soldiers in a ward room at the Queen’s Canadian Military Hospital in Shorncliffe, Kent, England, circa 1916.

NEW VIDEO SHOWS E5 MACHINE AT WORK

Go to www.JohnEllis.com/NIH and you can watch an informative video which explains just how our E5 Water Machine works. And, just below the video, there is a green link to multiple NIH.Gov studies demonstrating the adverse health effects of deuterium in your water.

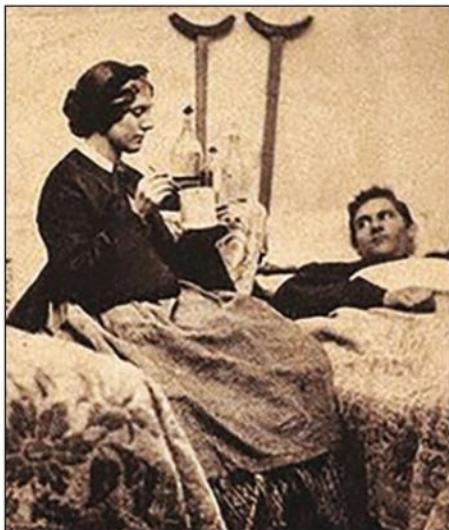
The video shows that by changing water properties, small amounts of this water can treat vast quantities of ordinary water (even an aquifer or lake) so Municipalities can supply this healing water right at the tap!! Go to our website JohnEllis.com/NIH with a link to the National Institutes of Health. (Deuterium is found in every bottle or glass of water you drink!)

However, DDW (Deuterium Depleted Water) is only part of the battle for better health as noted by Nobel Prize Winner Albert Szentgyorgy: **“Hydrogen is the Fuel of Life”** because, unlike ordinary DDW, by also changing Water Properties and increasing the Hydrogen Bond Angle between atoms (so it has more room to hold viruses and environmental contaminants in suspension) they can be **eliminated from the bloodstream** with almost **immediate results** (note typical cancer charts!)

Small amounts of this water can treat millions of gallons of ordinary water (as the Municipal Video shows) including markers for disease, so they can be flushed from a human waste lagoon or the blood stream along with heavy metals (Flint, MI: thousands of children have irreversible brain damage)!!

VIOLATING FARADAY’S LAW?

Here’s what a man in Zurich said: “I have had your E5 Water Machine for only 24 hours. I had gross swelling in my legs and hadn’t worn ordinary shoes in years. Your water immediately destroyed the markers for



Famed American nurse and Red Cross founder Clara Barton is shown tending to a wounded soldier.

Gilbert Daunant
(Prince Rainier's
cousin): "I just walked
 40 blocks and I am
 95! Send another E5
 to Monaco!"

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elephantiasis in my blood stream!! I lost all the water weight in my legs and I bought a pair of shoes size 10 1/2. Also unlike ordinary DDW, using electrolysis (a battery and two thin pieces of stainless steel, anode and cathode, not a stack that negates power) your water produces so much Hydrogen it violates Faraday's Law... producing the energy needed to stop disease!!"

AMAZING POWER PROPERTIES

A company that produces hydrogen generators for trucks found the required power slowly went down over 24 hours (a cascading effect that is immediate once it has been treated) from 31 amps to **less than 1 amp** making the same amount of hydrogen by adding only **20 drops** of this water to ordinary water in their hydrogen generator (another website video)! Using this technology, you can power your car, heat your home and produce electricity for pennies. Watch the Video that shows examples **PROVING** you are drinking the wrong water . . . just as food supplies energy, this water provides the **"BODY ELECTRIC"** energy that powers your heart (defibrillator to stop a heart attack, pacemaker)!

COOK WITH THIS WATER!

Since it's made by boiling and cooling, **this energy is imparted to your food, unlike ordinary water that absorbs energy** (from your food and body) **to reach equilibrium!** Also, since **DEUTERIUM** studies (150 ppm) show it kills fruit flies and disease carrying mosquitoes, you don't want to remove all the Deuterium!! Instead, **INCREASE** the Hydrogen Bond Angle (so it holds more contaminants in suspension along with Deuterium) and **flush Deuterium along with viral diseases from the bloodstream** with almost **IMMEDIATE** results!! Note the typical cancer charts: The "purest water" is **USELESS** because it doesn't do the above. They still have cancer!

MAKING DDW YOURSELF

Using our E5 Water Machine, you can make **two types of DDW for PENNIES per GALLON** . . . not \$300 for a small bottle! This is done by heating and cooling water hundreds of times per gallon (not just once!) to change the properties of that water. We have 13 International Patents and 332 FDA Tests. You can judge the blatant dishonesty in the water industry using simple electrolysis. A child in science class could do that!

HELP YOURSELF & OUR FOUNDATION: BUY A MACHINE & TAKE A TAX DEDUCTION!

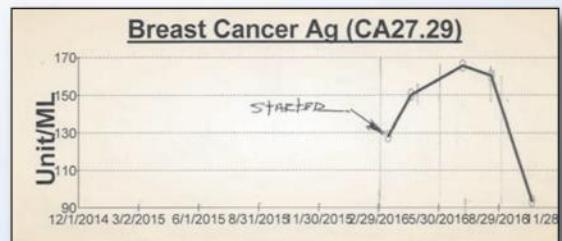
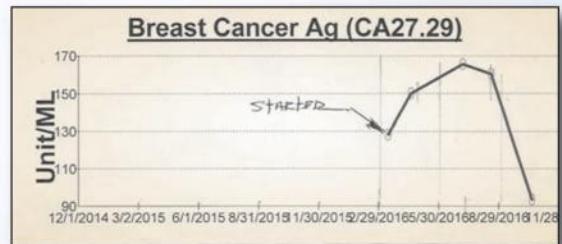
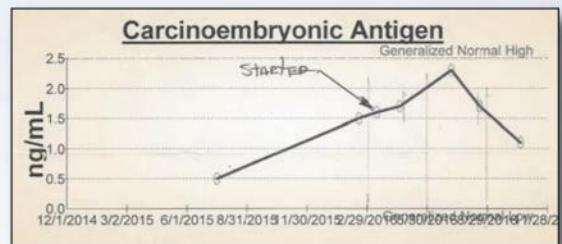
With our 501(c)(3) non-profit Foundation, you can buy a machine and take a Tax Deduction! There are thousands of families around the U.S. and the world who need our water machines—kids in Flint, families in poverty. When you buy a machine, a portion of the proceeds go to this important human aid project. **Contact us at PO Box 553, Westbrookville, NY 12785 or 845-754-8696.**

Check Out These Shocking Cancer Results!

The following is a letter we received here at Crystal Clear Water and at right are the charts this customer forwarded to us:

"Please send us a 6-pack of your water. The enclosed charts show my wife's cancer antigen numbers. Of course the doctors think they are responsible for the dramatic downturns [in the cancer markers], but I think differently. Doctors are not aware of my wife using you water."
 —John W.

Typical results since the Jan. 27, 1992 **Washington Post** investigation: "10,000 people a day said this water will cure anything!" including **The Washington Times**.



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HIDE AND

SEEK



CHANGE OF SCENERY

through the looking glass

WHY DO THE BLACK AND WHITE BARS on this piece of patterned paper seemingly switch direction? The answer lies in the shape of the glass—and what's inside.

First, a few basics about how you perceive the world. Typically, light bounces off an object and hits your eye in a straight line. But when light waves have to travel through a medium thicker than air, they move more slowly. In this case, the water inside the glass has pumped the waves' brakes.

That change in speed causes a redirection, or bend, of the wave, a process known in physics as refraction. You might remember this concept from high school science classes.

Well that's only half the story. Think of the glass as a converging lens, which is one that is curved on all sides. As light passes through it, the curved shape forces the light to bend from every direction. The dense medium of water significantly enhances this bending. The refracting light waves converge at what's called the focal point, then cross each other.

This point lies somewhere between your eyes and the glass. The image you see is the one created by the crossed light waves. Because they now travel in opposite directions, the lines appear reversed. Ignore physics, and the image seems illusive; remember it, and it's just reality.

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“I tried my sister’s cell phone... I couldn’t hear it.” The Jitterbug Flip is designed with a powerful speaker and is hearing aid compatible. Plus, there’s an adjustable volume control.

“I don’t need stock quotes, Internet sites or games on my phone. I just want to talk with my family and friends.” Life is complicated enough... The Jitterbug Flip is simple.

“What if I don’t remember a number?” Friendly, helpful Operators are available 24 hours a day and will even greet you by name when you call.

“My cell phone company wants to lock me in a two-year contract!” Not with the Jitterbug Flip. There are no contracts to sign and no penalty if you discontinue your service.



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|-------------------------------------|-----------------|-----------------|
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| Long Distance Calls | No add'l charge | No add'l charge |
| Voice Dial | FREE | FREE |
| Nationwide Coverage | YES | YES |
| Friendly Return Policy ¹ | 30 days | 30 days |

More minute plans available. Ask your Jitterbug expert for details.

“I’d like a cell phone to use in an emergency, but I don’t want a high monthly bill.” The Jitterbug Flip has a plan to fit your needs... and your budget.

“Many phones have features that are rarely needed and hard to use!” The Jitterbug Flip contains easy-to-use features that are meaningful to you. A newly designed built-in camera makes it easy and fun for you to capture and share your favorite memories. And a new flashlight with a built-in magnifier helps you see in dimly lit areas, the Jitterbug Flip has all the features you need.

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OUT OF SHAPE

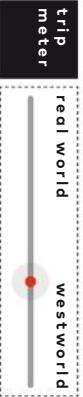
the straw that appears broken

PLACE A STRAW IN A GLASS OF WATER, AND behold: It looks broken. What's tricking your brain?

Similar to the illusion on the previous page, the light that reflects off the straw allows your visual system to process and identify its shape as it travels through mediums of varying densities. But as light passes from air into water, which is denser, it changes direction, or refracts.

Your brain can't correct for these visual effects, so it decides on the location of the object (the straw) based solely on where the reflecting light is coming from. Above the water, the light reflects from the straw through the air and glass to your eyes. But below, when the light also travels through water, the refraction causes the image of the straw to be in a slightly different location. The water also acts as a type of magnifying lens, making the size of the straw seem larger than it actually is. To the brain, the straw appears broken (and bloated).

That's why spearfishing is so hard to master. From far away, the fish you are eyeing always looks nearer to the surface of the water than it actually is. The key is to get as close to the fish as possible, without it seeing you. Otherwise, you go home empty-handed.



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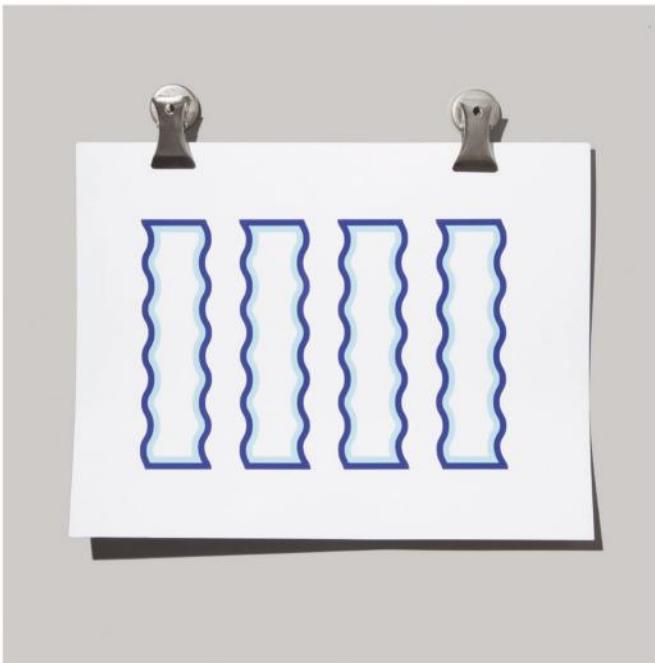
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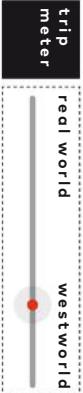
WHEN YOU GLANCE AT THE FOUR RIPPLED rectangles in front of you, do the spaces inside look light blue? They're not. They're white. Try blocking out the wavy sides of each shape with the edges of two pieces of paper, or holding the page really close to your face.

This phenomenon is called the watercolor illusion because it appears the entire interior of the shape is a lighter-colored version of the inner colored line—similar to the effect you get with different dilutions of paint in water.

Why? The brain's visual cortex has far more neurons devoted to finding borders than colors. That's because borders are much more useful in identifying shapes.

Once those neurons identify the dark blue border pictured here, they search for symmetry. Without that inner blue line, the color inside the dark blue border is the same as the color outside. But add a light blue line inside, and your brain grapples with the change. It guesses at the interior color based on the color closest to it—in this case, by incorrectly assuming the entire inside is blue too.

Don't fret that your brain is just guessing at the color. As long as it correctly determines the shape of what's there, you should care less that it flunks the color test.



OVER THE BORDERLINE

coloring inside the lines



✓Yes



✓Yes



xNo



✓Yes



✓Yes



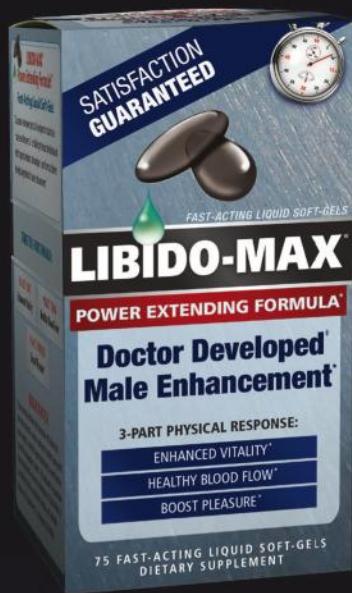
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PARCHED

(CONTINUED FROM P. 63) next to my face.

When we got home, I peeled off the outerwear I would continue to use to go running for the rest of the week. How gross they were, sweaty and slightly smelly. For supper I had a baked-potato and cabbage concoction, while Rebekah made meatballs for herself.

“Let me just smell them,” I said to her, before heading to an abbreviated shower.

It was then, my blue container nearly full, that I faced the practical issue of what to do with all the gray water. With no yard, I had no good purpose for it. I decided to use it for flushing: letting that bucketful of skin-cell-and-soap water spill into the toilet bowl, forcing the appliance to flush without using any tank water. Problem solved, right?

No. My toilet requires about 1.3 gallons for each flush, and I don’t have 4.6 bowel movements per day, which is now a thing you know about me. I had more gray water than I could use. With this realization, I felt as I had in the grocery store. I wanted to do good, and well, but I didn’t know how. So I started pouring out the leftover gallons to flush the yellow I should have mellowed. But I didn’t feel great about it. And the occasional splash-back was gross.

In addition to being full of dirtied water, my apartment was also full of dirty everything else. By the end of the week, glasses and mugs that I’d repeatedly reused—as well as plates, pots, and pans that I hadn’t pre-rinsed—packed the dishwasher. Its interior held an almost-fossilized record of what I’d eaten.

And I needed to do laundry. All week I’d worn the same jeans (2,600 gallons of water to make). I put them in the freezer daily, which, like hanging them in the UV-filled sunshine, is said to kill some of the odor-causing bacteria (but there doesn’t seem to be any science to back this up). And I’d worn only two shirts: one, a thrift-store flannel that had used up 700 gallons in the factory—but that was on the original owner’s conscience; the other, an athletic top whose synthetic fibers had a smallish water footprint but a sizable carbon one. My running clothes, also synthetic, could probably have sprinted on their own. I realized how easy it had become to wear the same outfits repeatedly—almost nice, in the no-choices way of school uniforms. I work from home and hadn’t seen anyone more than once except my sister, and I could not care less what she thinks of my fashion choices.

But even with the experiment nearing com-

pletion, these garments did not amount to a full load of laundry. According to good conservation principles, I’d have to mess up more clothes or add sheets to turn on my high-efficiency washer. It was a source of pride to me that Denver prizes sustainability-friendly appliances, giving rebates for those certified by the Environmental Protection Agency’s WaterSense program, which is like the Energy-Star of water. Machines with this label use 20 percent less than do standard appliances.

But still, my house left me feeling off-kilter. I like order, neatness, and cleanliness—and now I was surrounded by evidence of all the messes I’d made throughout the week.

**RECALCULATING,
RECALCULATING**

Friday morning, the final day of my experiment, I peed on top of my pee, pulled my jeans out of the freezer, drank one paltry cup of coffee, grimaced at my oatmeal, and sat down to calculate how much more responsible an earthling I had become.

Adding up drinking water, showers, hand-washing, tooth-brushing, and cooking, I’d used about 6.25 gallons every day. My dishwasher had drawn about three for its single cycle, bringing my direct use to 46.75 gallons, or just under seven gallons per day. Denver water conservation manager Jeff Tejral told me that efficient customers use around 20 to 30 gallons per day. I patted myself on the back.

I had also done well in terms of indirect use. I’d walked everywhere except for two driving trips—to the mountains for the tree and to the suburbs to pick up mail for a vacationing friend—totaling 216 miles of travel and guzzling about 76 gallons of water.

The food for my vegan meals had been produced at a cost of about 500 gallons of water a day; my diet before this week had taken around 850 gallons per day (a omnivorous one would have consumed 1,056). The two beers and half bottle of champagne I’d drunk—I finished writing a book, OK? I deserved it!—required 410 gallons of water. After adding in 37 gallons of water for each of the two cups of coffee I had per day, my drinking totaled 928 gallons of water for the week.

In sum, my footprint on the water world was 4,550 gallons for the week, or 650 per day, not including the wet cost of electricity. When I checked my math using the same

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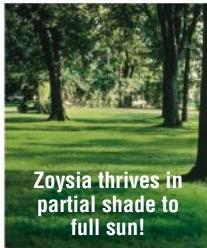


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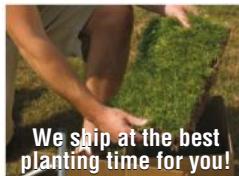
No more pulling out weeds by hand or weeds sprouting up all over your lawn. Zoysia Plugs spread into a dense, plush, deep-rooted, established lawn that drives out unwanted growth and stops crabgrass and summer weeds from germinating.

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online water calculator I'd used at the beginning—which considers electricity—I got 730 gallons per day. I had decreased my water use by about 45 percent, to just 35 percent of the national average consumption.

That sounds like it justifies bragging, but our national average is actually terrible. My experimental footprint was the same size as a Chinese citizen's normal one. Over in Norway, the per-capita use is just half a U.S. citizen's, and right around the global average. Which is to say there's room for improvement here at home. If everyone in the U.S. used 20 percent less—still more than twice what I did—they would each save 152,424 gallons of water a year. That's 49 trillion gallons across the whole country. When you think about it that way, each of us can make a huge difference—especially if our sustainable actions encourage others to behave similarly.

And that is how large-scale water-use changes happen, says Missouri State's Jones. If enough people start employing a particular

conservation tactic—leaving liquids in the toilet, ripping out Bermuda grass and putting in native plants—that thing becomes the expected behavior. "It's a culture change," he says.

The community flips its reward-punishment system. Instead of shaming you for your brown-grass yard, friends might instead criticize your lush landscaping. Conversely, they might start telling you how great your cactus-look. We're hard-wired to want to conform. Essentially, we all want to think that we take action based on personal choice or because we want to help the planet—not because we're following the crowd. But in reality, if our social circle is water-friendly, chances are much higher that we personally will be too.

And if not, not.

So while my individual sacrifices might not register at my water utility, they can influence my family, friends, and neighbors. Those one-by-one modifications create collective change: They make conservation normal.

I knew that after dawn the next day, I'd

probably eat eggs for breakfast and have a cheeseburger once in a while. I would definitely wear more than two outfits. In the shower, I would sometimes let myself have two songs.

But I would also turn off the taps more quickly. I would evaluate my groceries for their origin and water usage. I would let all yellows mellow. Sometimes I'd gravity-flush the toilet with gray water. And before I would eat meat or drive or buy a new cotton shirt, I'd think about how much water saturated those decisions. I'd probably do less of all three.

And that's what really changed that week—not the choices I would make going forward but the thought process behind them. For every action I'd take, I'd think about how water factors in. And I'd hope that the people around me took notice.

Because water, water is not everywhere. But it's pretty much involved in everything. After a week of remembering that 15 times an hour, I'll remember it forever.

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CENTRAL PNEUMATIC SUPER COUPON

3 GALLON, 100 PSI OILLESS AIR COMPRESSORS

A. HOT DOG ITEM 69269/97080 shown
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Customer Rating **★★★★★**

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10" SLIDING COMPOUND MITER SAW
ITEM 61971/61972 98199 shown

Customer Rating **★★★★★**

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A. HOT DOG ITEM 69269/97080 shown
B. PANCAKE ITEM 95275 shown 60637/61615

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SAVE 59%

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I WISH SOMEONE WOULD INVENT...

Electricity-Generating Rain Gutters

@CHUBBS5740 VIA TWITTER

Possible? Absolutely. Effective? Not so much. To generate enough hydropower to charge anything, you'd need a lot of downward pressure, says Bob Bass, a power engineer at Portland State University. "In a rain gutter, you don't have that push." You could create it by storing water on the roof, but the main problem is simple: "It doesn't rain that much." The best you could do with the power is run some LED lights. But don't expect to find one in stores anytime soon.



Lawn-Watering Robot That Finds Dry Spots

MIKE JACOBELLIS VIA EMAIL

Soon, you may be able to plant a few sensors, no robot necessary. Engineer Jim Canyon's prototype measures the soil's ability to store electric energy. Higher numbers mean wetter soil, since water stores energy well. Once you know the moisture levels of your yard's soil, says Canyon, you can design a sprinkler system to water only the thirsty parts. Easy. He thinks his sensors could hit shelves in a few years.



An App That Detects All Waterborne Diseases

DEREK REDGATE VIA FACEBOOK

An app alone can't test water, but a sensor connected to it can. And the key bacterium to check for is E. coli. That's because if any pathogens are present, it's highly likely that E. coli is too, says Sushanta Mitra, a mechanical engineer at York University in Canada. Detecting E. coli usually requires days of culturing in a lab. Mitra's prototype, the Mobile Water Kit, detects E. coli in hours with chemicals that change the water color when the bacterium is there. It's currently being field-tested.



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