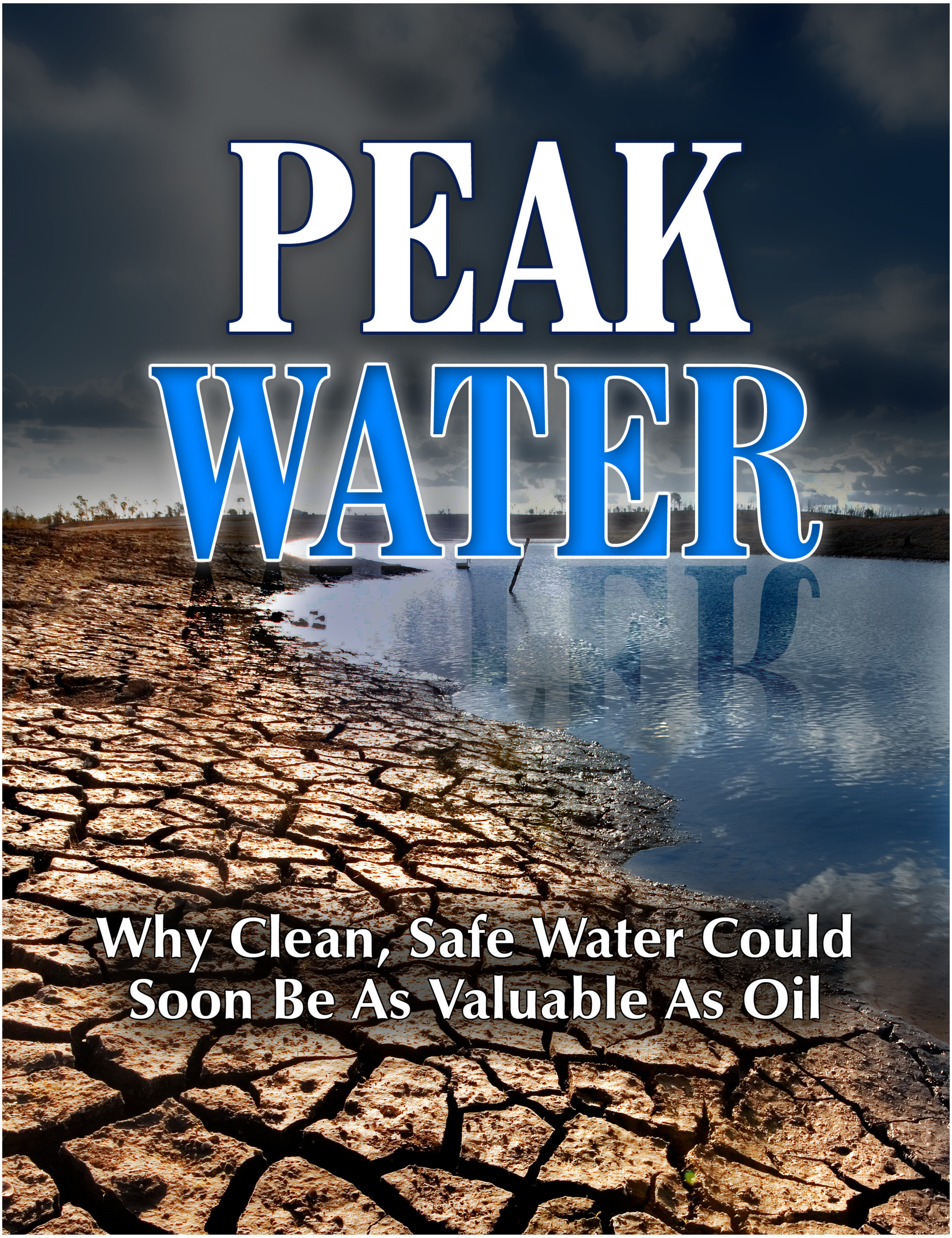
PEAK WATER



Why Clean, Safe Water Could Soon Be As Valuable As Oil

By Bill Heid *and* Brian Brawdy

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About the Authors

Bill Heid is president and founder of Solutions From Science, one of the fastest growing companies in the preparedness and survival industry. Bill started his first business before the age of 21, and has been an incurable entrepreneur and marketer ever since. He is a proponent of families working together for common goals, whether it is growing vegetables in a backyard garden or building a family business. Bill's passion for equipping people to become self-reliant inspired him to start Solutions From Science.

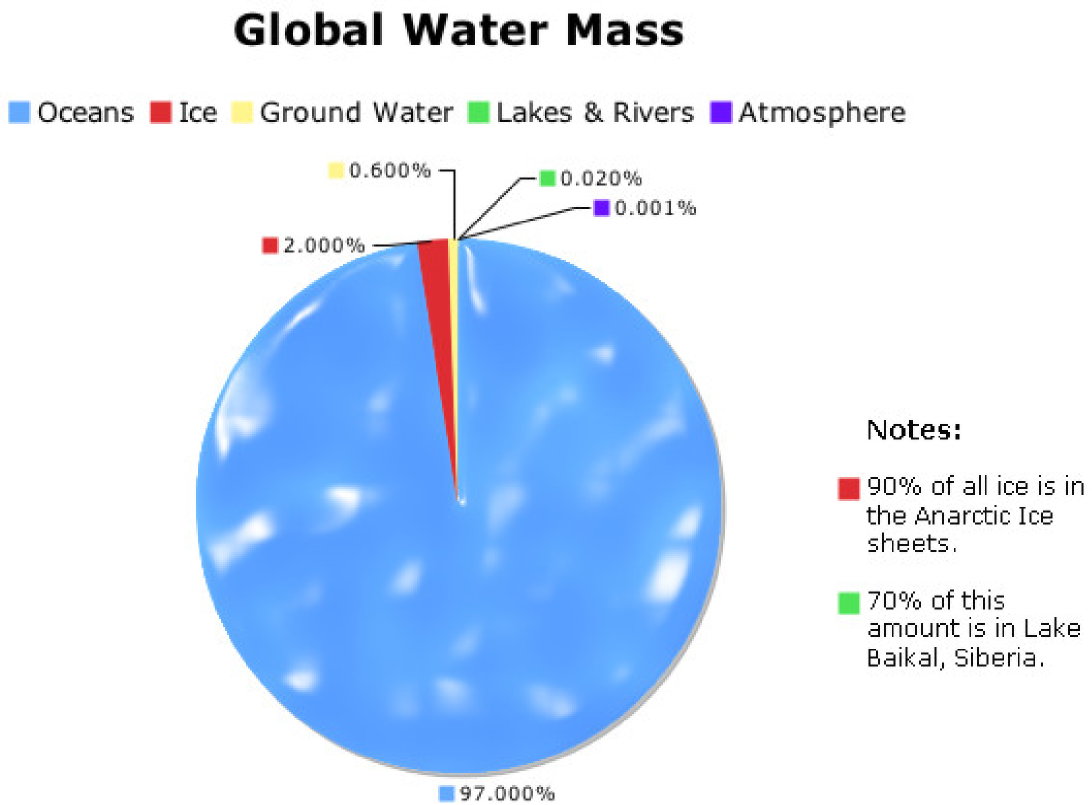
Brian Brawdy is a former New York police investigator and Military Weapons Specialist. He has spent the last 25 years studying psychology, philosophy, political science and the survival mindset. Today he educates international audiences on the importance of self-reliance, survival and Libertarian values. Brian has appeared on CNN, FOX News, ABC, CBS, NBC, and The CW to communicate a compelling message about adapting, surviving and thriving, be it on a mountaintop or on Main Street.

Here's a paradox for you. On planet earth, we never really use up or lose water. (Remember your fifth-grade science class about the water cycle?) It's always recaptured somewhere, in some form. And yet, having enough fresh, clean water is the single greatest crisis facing our civilization. If water doesn't really disappear, why is there a crisis? You may have heard the term "peak oil," but have you heard of "peak water?" It may well turn out to be even more serious than peak oil. In this report, you'll learn why.

Few people are fully aware of the threats that water problems pose to the population at large. Most of us take water for granted. We assume there will be enough. (There isn't.) We assume it will be clean. (It isn't.) All across the United States and around the world, more and more people are coming to the stark realization that fresh, clean water is a finite resource.

An Insatiable Thirst

Of the entire water mass on our planet, only .62% of it is fresh water ... and most of it is in a very deep lake in Siberia.



Data from: *http://education.gsfc.nasa.gov/ess/Units/Unit3/U3L01A.html*

When you look at it that way, it's clear that America's thirst for water is a problem. We use water at a staggering rate. According to the National Academy of Sciences, the average U.S. household used 200 gallons per day in 1999.[1] Now, 12 years later, we're using about 350 gallons per household per day.[2] For the 112 million U.S. households, that adds up to 39,200,000,000 gallon per day – a 57 percent increase in just a decade. In the next decade, we'll need even more.

The U.S. Environmental Protection Agency made a worrisome announcement in 2009. "In the last five years, nearly every region of the country has experienced water shortages," they reported. "At least 36 states are anticipating local, regional, or statewide water shortages by 2013, even under non-drought conditions."[3] (Emphasis added.)

In the western United States, we're gulping so much water that the Colorado River no longer flows to the sea. More water rights are parceled out to U.S. cities and farms than the river can actually supply.[4] Only about 10 percent of all the water that flows into the Colorado makes it as far as Mexico. After traversing 1,440 miles, carving out the Grand Canyon, and providing water for farms and cities in seven states, just thirty miles south of the border the mighty Colorado River has dwindled to a canal only three feet wide. Choked with sewage, fertilizer, pesticides and salts leached from farmland, it ends in a knotwork of muddy rivulets at the base of the Sierra de Juarez Mountains.[5] The Rio Grande, too, is so tapped out that it lapses to a mere trickle and then vanishes into its old, sandy bed just 300 feet away from the Gulf of Mexico.

According to the Environmental Protection Agency, "At least 36 states are anticipating local, regional, or statewide water shortages by 2013, even under non-drought conditions."

Are we running out of fresh water? Yes.

Draining the Underground Oceans

Groundwater is water that seeps underground into aquifers. Aquifers are giant underground sponges made of porous soils including sand, clay, and rock. They absorb and hold the water that soaks in from rain, snow melt, creeks, rivers, and lakes. The amount of groundwater available is reflected in the water table – the depth at which water is found in the soil. The water table varies seasonally depending on local conditions. 40% of the freshwater used by U.S. cities comes from wells that tap into aquifers.

Approximately 15% of Americans get their water from private wells that are drilled deep enough to compensate for seasonal variation in the water table. For example, the local water table might rise to a height of 25 feet below the ground surface during the winter but, during the summer, drop to 40 feet below the surface. To compensate, the well is drilled to a depth of 85 feet. That way, water is available year round.

But drought and over-pumping can quickly drain even the biggest aquifer. When that happens, wells go dry. If the drought continues and usage is unchanged, drilling deeper is only a stop-gap measure. It takes years, if not decades, for nature to refill an aquifer.

> ***"Drought and over-pumping can quickly drain even the biggest aquifer. It takes years, if not decades, for nature to refill an aquifer."***

According to the United States Geological Survey, there are 61 principal aquifers in the continental U.S.[6] Many, such as the Cambrian-Ordovician aquifer in the Chicago and Milwaukee areas, were relied upon heavily in the mid-to-late 1800s for fresh water. During the 1900s they were pushed to their limit without being allowed to recharge sufficiently. Consequently, many U.S. cities began running out of water between the 1960s and 1990s. The solution was to limit the pumping of aquifers and to draw water from rivers, lakes, and reservoirs instead.

Beginning in 1900 the city of Brooklyn, New York, pumped water from its aquifer for 60 years at such a high volume that the water table level fell below sea level. Because the aquifer soil was sandy and permeable, seawater began migrating into the aquifer. In order to ensure the future supply of fresh water, laws were passed in 1965 to stop pumping the aquifer for public supply. Today New York City's water supply travels hundreds of miles from lakes and reservoirs through huge underground pipes into the city.

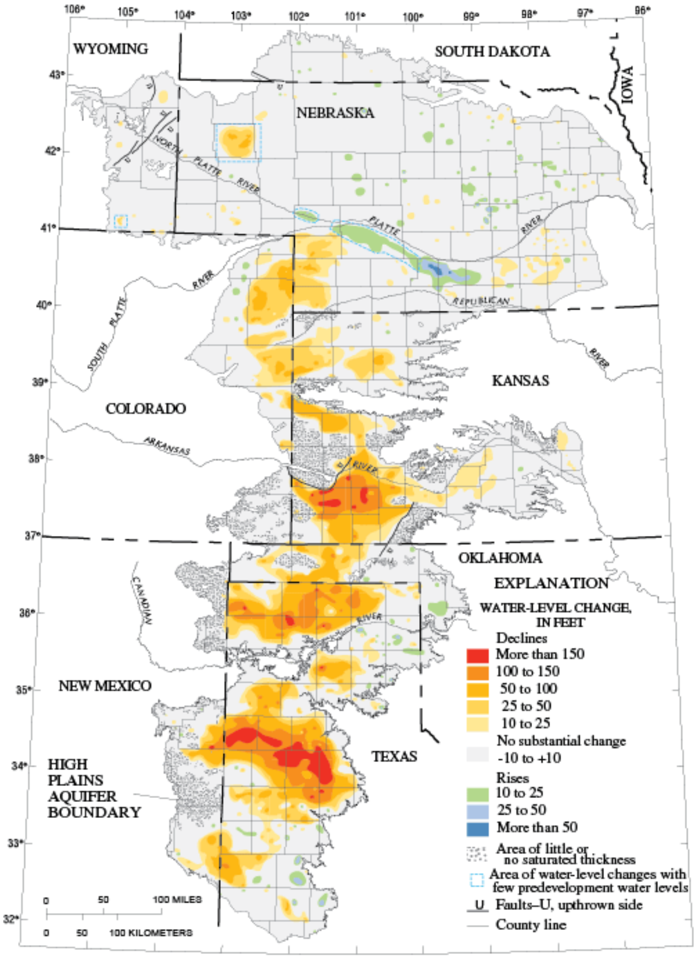
The Ogallala Aquifer (also called the High Plains Aquifer) provides water for South Dakota, Nebraska, Colorado, Wyoming, Kansas, Oklahoma, Texas, and New Mexico. It was first tapped in 1911.

Since 1950, nearly 80 wells per year have been sunk into it to meet demand for fresh water. It currently provides 30% of all U.S. farm irrigation and 70% of the water used daily in Kansas. Since 1980, water levels have dropped as much as 150 feet, depleting 6% of the aquifer. U.S. Geological Survey data indicates that the average saturated thickness (thickness containing water) of the entire aquifer in 1992 was about 190 feet. In Nebraska, the average saturated thickness was 340 feet, but in Kansas, it was only about 90 feet.[7] Some estimates calculate that 6% of the Ogallala will be used up every 25 years and that it is being depleted at a rate of 12 billion cubic meters per year.[8]

For the semi-arid landscape of the High Plains, it means that when the water is gone, the wheat, corn, and soybeans will shrivel ... and the ground itself might begin to collapse.

Yes. Collapse.

The technical term is "subsidence." Underground water helps to hold up the ground surface. If too much water is lost, it affects the surface ground. For example, some cities use aquifers as underground reservoirs. While it seems a sensible approach, it can have bizarre consequences. In the Los Angeles area so much water is pumped in and out of underground aquifers that much of the landscape rises and falls more than 4 inches each year, heaving the ground up and down 100 times further than normal seismic activity. From fall to early spring, officials pump water into underground aquifers for storage, raising the ground. In summer months, the ground shrinks as the aquifer is drained to water lawns, wash cars, top off swimming pools, bathe, and satisfy the thirst of LA's 14 million residents.[9]



U.S. Geological Survey map of water levels dropping in the Ogallala Aquifer since 1980

Some aquifer soils are kept in place by ground-water fluid pressure. If more water is pumped out than can recharge the aquifer, the ground around the area begins to slump, forming a cone-shaped depression. In this instance, porous subsurface soils ultimately collapse and compact and are then unable to hold as much water as before.[10] Sinkholes develop when caverns that held the water can no longer bear the weight of the ground above. They cave in, abruptly tearing holes in the ground surface. Sinkholes tend to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania but they also appear in areas where natural aquifers are manipulated for water storage.[11] Sinkholes are sudden, unpredictable, and can range in size from a foot across and five feet deep to 100 feet or more wide and 300 feet deep.

This sinkhole developed in Winter Park, Florida, in 1981.

Because of the way they are using the aquifers, Los Angeles' water officials may wind up destroying not only a safe place to store the city's water, but parts of the city itself.

But, how safe has the water been, anyway?

Bitter Waters: Five Pervasive Poisons

America has some of the most majestic rivers in the world, moving billions of gallons of water thousands of miles down mountainsides, across plains, and through forests to the ocean. Chances are you've driven by one and seen the birds and fish that depend on their wide, brown waters for survival.

But, would you drink from one?

While many cities utilize groundwater wells for some of their water supply, nearly two thirds of all U.S municipal drinking water comes from rivers and lakes because demand has depleted the aquifers they depended on in years past. River and lake water, however, is not as pristine as water from aquifers. Agricultural waste and factory chemicals have been dumped into rivers and lakes for a century or more.

DDT: Found in Every Human Being

One of the most infamous chemical pesticides, DDT (dichlorodiphenyltrichloroethane), was

extensively used in the 1940s and 1950s because it seemed perfectly safe to animals but deadly to insects. Farmers used it on crop fields, in barns, and in feedlots to kill insects. Cities sprayed it around schoolyards to kill mosquitoes. DDT is a colorless, crystalline solid with a weak, chemical odor. While it resists dissolving in water, it dissolves easily in fats and oils. This means that DDT readily accumulates in the tissues of animals. Even worse, it concentrates by a factor of 10 million times as it travels from water to plankton to small fish, on up the food chain to larger fish and birds. DDT is also readily absorbed into soil and can remain potent for up to 30 years.

While DDT is not outright toxic to animals, the higher concentrations that accumulate in animals have disastrous side effects. In the case of the bald eagle, for example, DDT caused eggs to form with thinner and thinner eggshells. As a consequence, fewer eagle chicks were hatched and the bald eagle very nearly went extinct in the 1960s and 1970s. Though banned from use in the U.S. in 1972, California condors still show concentrations that affect their eggs because their prey feeds at the Montrose Chemical Superfund cleanup site.

Among humans, DDT has a 6- to 10-year half-life (the concentration drops by half every 6 to 10 years) and in 2005, the Centers for Disease Control detected DDT in all humans, although levels showed they were dropping. DDT has been linked to diabetes, as well as developmental neurotoxicity in infants, and miscarriages.

"In 2005, the Centers for Disease Control detected DDT in all humans. DDT has been linked to diabetes, as well as developmental neurotoxicity in infants, and miscarriages."

Because DDT (and other organochlorides) does not dissolve in water, it tends to remain in one place where it is easily absorbed by the organic content of the soils. It can persist in that place for years. However, there are some contaminants that do very well in water. They spread anywhere. One such contaminant is hexavalent chromium.

Hexavalent Chromium: The "Erin Brockovich" Chemical

Hexavalent chromium, or "chromium VI", is used for leather tanning, fabric dyes, explosives, stainless steel, and corrosion resistant coatings found in tanks and pipes. Between 1952 and 1966, Pacific Gas and Electric (PG&E) used hexavalent chromium to prevent rust inside its cooling towers at its natural gas compressor site near Hinkley, California. Coolant water was stored between uses in unlined ponds, which allowed the contaminated solution to seep into the groundwater, creating a toxic plume two miles long and nearly a mile wide.

"At least 31 U.S. cities are contaminated with what has become known as the 'Erin Brockovich chemical.' At least 74 million Americans in 42 states drink chromium-polluted tap water."

Among factory workers, hexavalent chromium is known to be a carcinogen, particularly when inhaled, but it is also known to damage the digestive system and kidneys. In 1993, a legal clerk named Erin Brockovich researched illnesses in Hinkley linked to hexavalent chromium and helped sue PG&E. In 1996, PG&E settled the case for $333 million – the largest direct action lawsuit in U.S. history.[12]

Unfortunately, Hinkley isn't the only town with carcinogenic drinking water. Since that time, the Environmental Working Group has found 31 U.S. cities that are contaminated with what has become known as the "Erin Brockovich chemical." At least 74 million Americans in 42 states drink chromium-polluted tap water. Chief among the most contaminated towns are Norman, Oklahoma; Honolulu, Hawaii; and Riverside, California.[13] While the EPA has yet to set a safe level for hexavalent chromium in water, an EPA draft toxicological review found that hexavalent chromium in tap water is "likely to be carcinogenic to humans."[14]

Recent research has shown that hexavalent chromium in drinking water can pass more of the substance than was previously thought possible into the tissues of the gastrointestinal tract, blood, liver, kidneys and spleen. Current proposed levels in California are 0.06 parts per billion (ppb). The recently measured level in Norman, Oklahoma was 200 times higher: 12.9 ppb.

In the meantime, Brockovich began investigating a case of contaminated water in Midland, Texas where hexavalent chromium has been used for hydraulic fracking of natural gas shales.[15] At this writing, over 40 families in Midland are without safe drinking water. The contamination, which has already spread 1.5 miles from ground zero, is spreading through the aquifer at 1000 feet per year. Despite the dangers of fracking, the Energy Policy Act of 2005 exempted hydraulic fracking from the Safe Drinking Water Act.

Perchlorate: The Culprit Behind the Thyroid Disease Epidemic?

Watch any kid's face explode with wonder when they watch fireworks on the Fourth of July. Then tell them they have just seen one of the deadliest toxic substances fly over their heads. Perchlorate, the explosive main ingredient of solid rocket and missile fuel, is used in fireworks, flares, pyrotechnics, ordnance, and explosives.[16] Every time they are used, perchlorate is released into the air and water around them. The chemical contaminates drinking water supplies, groundwater and soil in hundreds of locations in at least 43 states and affects 20 million Americans. It interferes with the thyroid gland by decreasing production of thyroid hormones, which are needed for prenatal and postnatal growth and development. In adults, the thyroid regulates metabolism and mental function. Hypothyroidism is fast approaching epidemic proportions in the United States, affecting an estimated 27 million Americans.[17]

"Perchlorate lasts indefinitely in the environment. A 2010 study of 500,000 California newborns reported disrupted thyroid function in infants whose mothers had been exposed to drinking water with at least five parts per billion (ppb) perchlorate."

Perchlorate lasts indefinitely in the environment. It has been found in the big water fountain of seven states: the Colorado River. A 2010 study of 500,000 California newborns reported disrupted thyroid function in infants whose mothers had been exposed to drinking water with at least five parts per billion (ppb) perchlorate. In January 2011, California adopted 1 ppb as its standard. Massachusetts is the only other state with a perchlorate standard: 6 ppb. Only recently has the Environmental Protection Agency agreed to begin regulating perchlorate. Its standardization process is expected to take two years.[18]

Volatile Organic Compounds: You Can't Avoid Them

A rainbow in the sky after a storm usually promises a nice sunny day ahead. But an iridescent rainbow on wet pavement is far from good news. It means that gasoline or another toxic volatile organic compound will be making its way into the local water supply.

Volatile organic compounds (VOCs) include gasoline, paints, and plastics. Many are present in the average American home and in the form of solvents such as glue, paint thinners, and lubricants. The U.S. Geological Survey (USGS) estimates that 42 million Americans use groundwater that either has been contaminated or is at risk for low-level contamination by VOCs. The three most common are chloroform, perchloroethene (a solvent), and the fuel additive methyl tert-butyl ether (MTBE).[19]

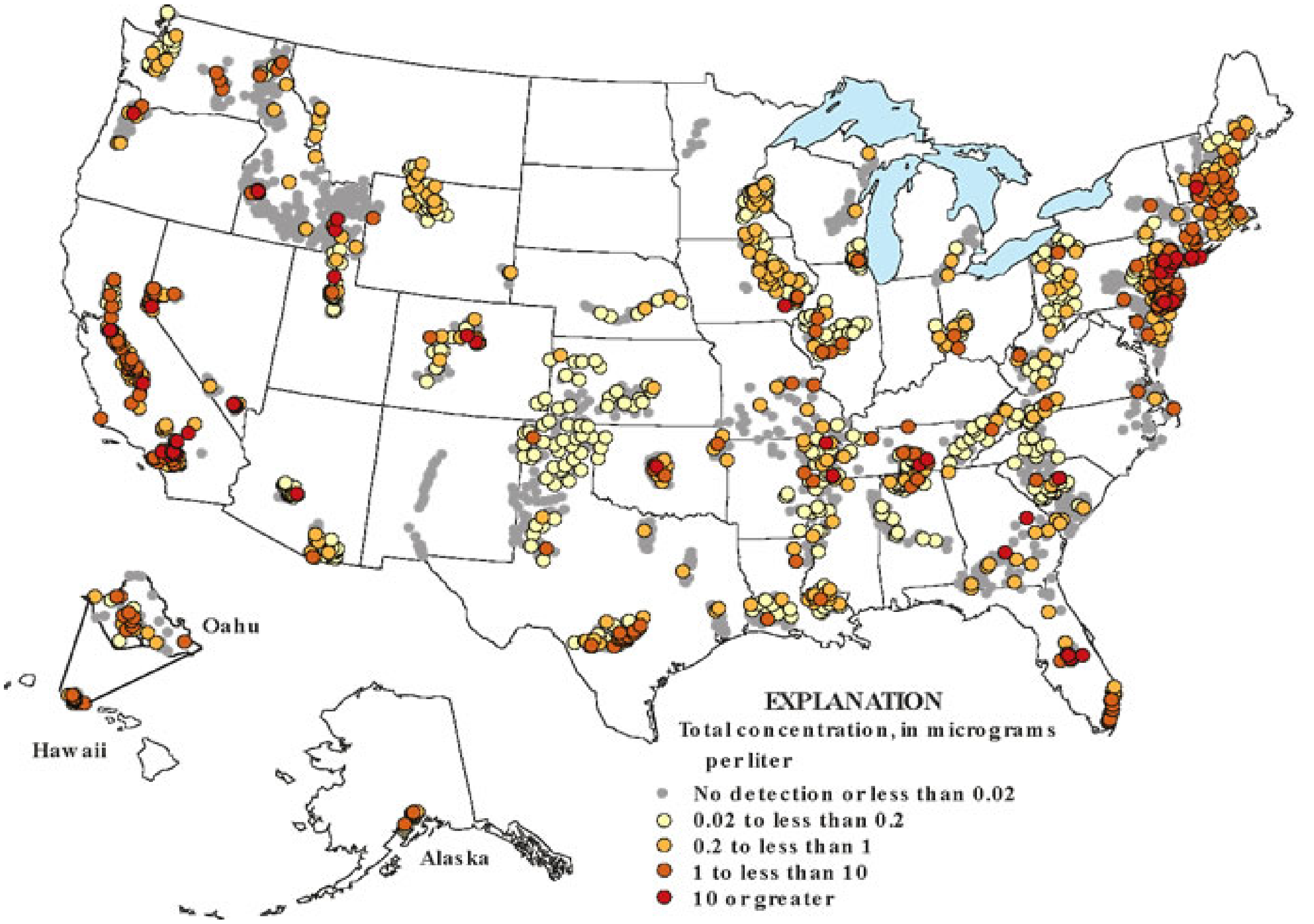
Chloroform is the most frequently detected compound during USGS testing. It's detected more frequently in urban areas, wet climates, areas with septic system use, and Resource Conservation and Recovery Act (RCRA) hazardous-waste facilities. It is a byproduct of water municipal treatment where chlorine is added as the final step to killing bacteria before releasing it into the environment. Chloroform forms as chlorine-containing compounds break down. It can also form from chlorinated swimming pool water or water used with household cleaning products containing chlorine such as bleach.

Since chloroform is very volatile, most of it formed by chlorination evaporates into the air as it is released into lake or streams. However, chloroform that seeps through soil into groundwater can remain unchanged for many years. Aquifer contamination also happens when chlorine is poured directly into a private well to "shock" the system and kill harmful bacteria. Once in the aquifer, chloroform forms and spreads over long distances into other water outlets.

Inside your body, chloroform circulates to all parts of your body, such as fat, liver, and kidneys. Because it is volatile, it leaves quickly once exposure ends. Chloroform affects the central nervous system (brain), liver, and kidneys after a person breathes air, drinks liquids, or eats foods containing large amounts. Breathing 900 ppb for a short time induces fatigue, dizziness, and headache. The same exposure over a long period of time can lead to liver and kidney damage. One study showed liver enlargement in 17 of 68 workers exposed to chloroform at concentrations of 10 to 200 ppm for 1 to 4 years.[20] There is no conclusive evidence of miscarriages in humans, but miscarriages and birth defects occurred in pregnant mice and rats exposed to 300 ppm. There was also abnormal sperm formation in males at this exposure level.

Long-term consumption of chloroform in chlorinated water caused colon and urinary cancers in mice and rats.[21] Because of this link, the EPA has listed chloroform as a possible carcinogen.

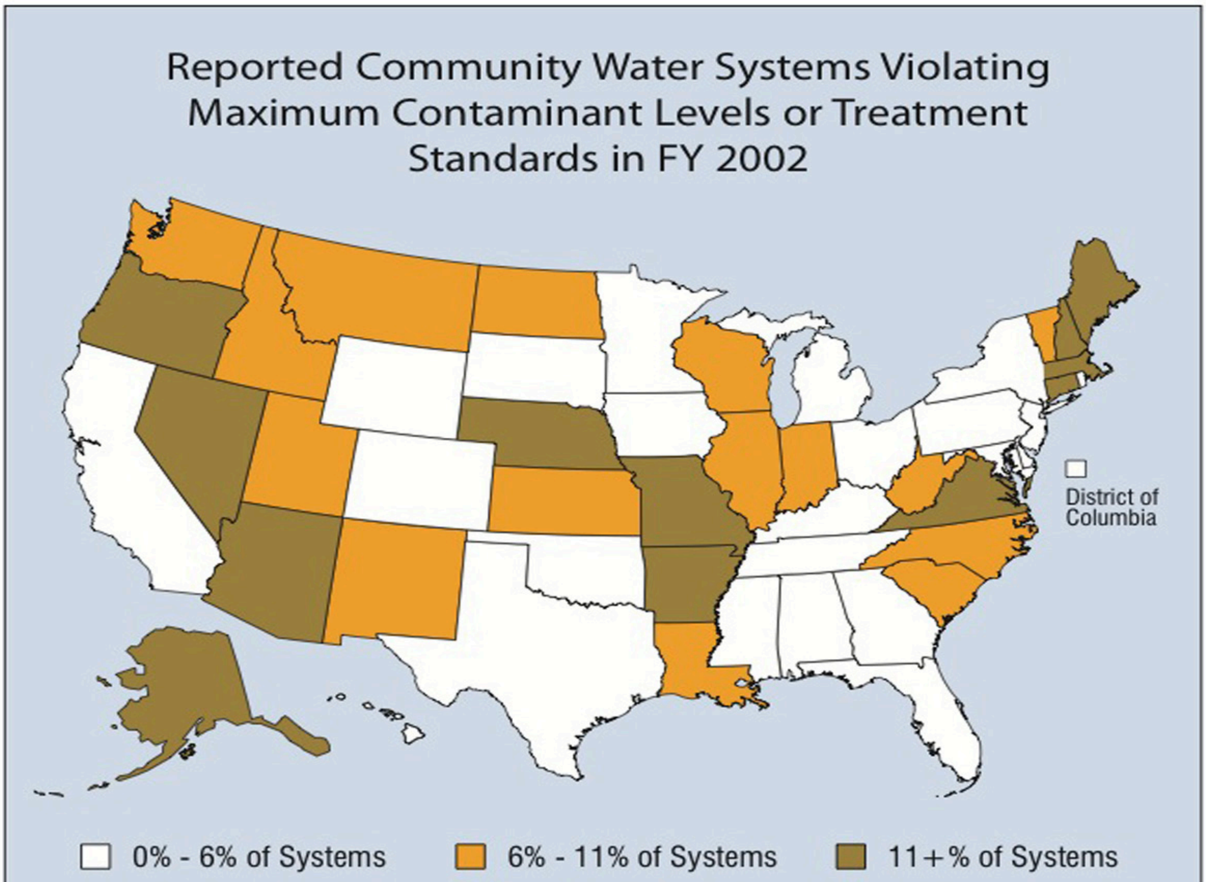
A 14-year long USGS study of 932 public supply wells that drew from 30 regionally extensive aquifers showed that chloroform was present in 64% of their samples.[22]



And then there are cleaning solvents. The problem with chemicals used as cleaning solvents is that they need to be strong enough to dissolve a variety of organic stains. As a result, they are powerful substances that don't just go away very easily. Perchloroethene (PCE), also called tetrachloroethylene, is one of the most common of these solvents found in groundwater. It is a colorless, nonflammable liquid with a sweet, ether-like odor that is used for dry cleaning fabrics and degreasing metals. It dissolves greases, oils, and waxes without affecting fabrics or leaving a corrosive residue on metals because it readily evaporates and breaks down. PCE is also used to make chlorofluorocarbons, and as an insulating fluid and cooling gas in giant electrical transformers. It is an ingredient in aerosols, solvent soaps, printing inks, adhesives, sealants, paint strippers, paper coatings, leather treatments, automotive cleaners, polishes, lubricants, and silicones.

Because PCE is volatile, it usually evaporates quickly. In water, however, it's another story. PCE dissolves only slightly in water and has a density of 1.66 grams per cubic centimeter (g/cm3). Water has a density of water of 1.00 g/cm3. This means that PCE sinks quickly below water and passes quickly below the water table. It can spread quickly into aquifers and may form concentrated pools below water if there is a large amount present. Plants and animals living in environments contaminated with PCE can store small amounts of the chemical.[23]

Currently, the Maximum Contamination Level (MCL) has been set at 5 (ppb). Long-term exposure may damage the central nervous system, liver, and kidneys. The American Cancer society says that studies demonstrate evidence of a possible increase in risk of lung, breast, and colorectal cancer among residents with the highest exposure to PCE.[24] However, some other studies have not found such a link – which makes any conclusions about cancer premature. The National Toxicology Program, which is made up of the National Institutes of Health, the Centers for Disease Control and Prevention, and the Food and Drug Administration, has classified PCE as "reasonably anticipated to be a human carcinogen." The National Research Council's report[25] meanwhile helped back the EPA's February 9, 2011 reclassification of PCE as "a likely human carcinogen."



Map courtesy of the Environmental Protection Agency
www.epa.gov/safewater

One of the most commonly detected compounds in both urban and rural areas is the gasoline additive MTBE (methyl tert-butyl ether). MTBE is a volatile, flammable and colorless liquid that mixes easily with water. In the U.S. it has been used in gasoline since 1979 as an anti-knock additive to replace tetra-ethyl lead. Because MTBE mixes so well in water, when gasoline with MTBE is spilled at gas stations by customers pumping gas or leaked from the station's underground storage tanks it very easily flows into ground water and down into aquifers. If your water tastes and/or smells like turpentine, then MTBE is present at levels around or above 20-40 parts per billion (ppb).

In 1996 the city of Santa Monica, CA, learned that two of its drinking water well fields, Charnock and Arcadia, were contaminated with MTBE at levels as high as 610 ppb and 86 ppb respectively. The two well fields were shut down. Residents and the city were faced with the task of replacing 50% of their drinking water supply.[26]

Little is yet known about the long-term effects to human health, but the substance was banned for use in fuels as of 2002.[27] Currently, MTBE is classified as a potential human carcinogen at high doses.[28] USGS tests indicate tens of thousands of MTBE-contaminated aquifer water wells are distributed across the country.

Organic Wastewater Contaminants: Drugs in Your Water

According to the Environmental Protection Agency, "At least 36 states are anticipating local, regional, or statewide water shortages by 2013, even under non-drought conditions."

In March 2002, the USGS released an alarming study. In 139 waterways in 30 states, downstream from treatment plants and animal feedlots, minute amounts of antibiotics, hormones, pain relievers, cough suppressants, disinfectants and other products were present. The study, National Reconnaissance of Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in Streams of the U.S., 1999-2000[29], showed that 82 of 95 organic wastewater contaminants (OWCs) were present in over 100 streams tested. Specifically, the most commonly detected OWC's were as follows:

- coprostanol (fecal steroid)
- cholesterol (plant and animal steroid)
- N,N-diethyltoluamide (DEET insect repellant)
- caffeine (stimulant)
- triclosan (antimicrobial disinfectant)

- tri(2-chloroethyl)phosphate (fire retardant) and
- 4-nonylphenol (nonionic detergent metabolite).

Of these 95 contaminants, thirty-three are known or suspected to be hormonally active (e.g. oral contraceptives). Forty-six are pharmaceutically active (e.g. anti-depressants), indicating that these drugs are not being fully neutralized by water treatment plants.[30]

In September 2008, the Associated Press National Investigative Team revealed after a five month study that a vast array of pharmaceuticals – from antibiotics to sex hormones – had been detected in the drinking water supplies of 24 major metropolitan areas.[31] Over the past five years, the number of U.S. prescriptions has risen 12% to a record 3.7 billion, while non-prescription drug purchases held steady around 3.3 billion. Veterinary drugs also play a role. Pets are now treated for arthritis, cancer, heart disease, diabetes, allergies, dementia, and even obesity. Feedlots tack ear implants onto to cattle that slowly release trenbolone. Trenbolone is an anabolic steroid used by some body builders that cause cattle to bulk up prior to sale. But not all this hormone circulating in a steer is metabolized. A German study showed 10% of the steroid passed right through the animals.

While these pharmaceuticals were detected in very small concentrations (1ppb or less) and do not have any exposure ratings, two or more of these chemicals are typically found together. The USGS report found 34% of its test streams held 10 or more OWCs. This fact is particularly ominous because it is not known how these substances' chemical interaction in drinking water might affect their toxicity. Nor is it known what the long-term effects of low-level consumption of hormones or anti-depressants – or combinations of these and other medications – might be.

Sudden Destruction: Accidental Spills

The slow drip-drip of rocket fuel, solvents, and pharmaceuticals trickles into the water supply over time. But they're not the only substances that can poison the water. The water supply is also threatened by spills of various kinds. Spills typically, but not always, dump large amounts of contaminants during a single event.

Derailments: Carcinogenic Cargo

100 tons of high-sulfur coal. 10,000 gallons of diesel fuel. 30,000 gallons of ethanol. 25,500 gallons of benzene. 17,000 gallons of pressurized chlorine gas. 17,600 gallons of corn syrup. 20,800 gallon of hydrochloric acid. 18,000 gallons of sulfuric acid. No, these amounts are not the amounts hauled by a whole train. They are the capacities of individual railroad freight cars.[32]

Railroads use "unit trains" to transport raw material in bulk to industries. Instead of having one or two different kinds of cars in a train, there can be up to 100 of one car type, hauling one type of cargo such as coal or corn syrup or ethanol. A 100-car unit train of coal heading to a power plant would move 10,000 tons. A 50-car unit train of corn syrup or ethanol would transport between 880,000 and 1,500,000 gallons. Unfortunately, when a derailment happens to a unit train and there's a spill, it's not just a few hundred gallons. It's thousands of gallons.

Railroad tracks are laid on raised roadbeds with ditches on either side to channel rain runoff away from the tracks. These ditches eventually connect with gullies or creeks, or seep into the ground water below the surface. During the first minutes of a big derailment, thousands of gallons of hazardous material can wash down these ditches and wind up in the local water supply.

The effects on ground water from massive spills last for years. On Sunday, December 6, 1970, the town of LeRoy, Genesee County, New York was shaken when a Lehigh Valley freight train derailed. One ton of cyanide crystals spilled onto the ground as well as 35,000 gallons of the metal degreaser trichloroethene (TCE) from two ruptured tank cars. TCE odors were detected 8 days later in the basement of a building 200 yards away from the crash. In spite of clean up efforts by the Lehigh Valley railroad, TCE was discovered in two private wells in November 1971. By 1990, TCE had contaminated 50 wells affecting 2,515 people within a 4-mile radius of the original site.[33] Leroy has been an EPA Superfund site for over 40 years.

But derailments don't happen all that often … right?

Wrong. Because there are more cars and more powerful engines that pull longer trains, there are *more* derailments. In 2006, the Federal Railroad Administration reported 2,194 derailments involving 728 cars carrying hazardous materials.[34] By 2010, derailments dropped to 1,197 with 406 cars carrying hazardous materials. Even though there are fewer accidents, there is still an average of three derailments every day. Recently, on February 6, 2011, 28 tank cars, each containing 30,000 gallons of ethanol, derailed and exploded in northwest Ohio. The fire burned furiously for two days, consuming most of the estimated 840,000 gallons of fuel. While the EPA reacted swiftly in setting up chemical booms to stop the ethanol's spread in a nearby creek, it is not yet known how much may have seeped into the ground. Ethanol fuel is also sometimes denatured by adding benzene. Benzene is a known carcinogen.

There are an average of three derailments every day in the U.S., releasing thousands of gallons of hazardous materials that make their way into our water supply.

Manure Spills: There Goes the Neighborhood

Wastes from farm animals are never treated. Smaller livestock operations compost manure and spread it on crop fields or meadows to fertilize the ground. Large agri-biz operations that generate millions of gallons of animal waste are another story. This manure, loaded with antibiotics and growth hormones, is stored in pits below animal confinement sheds for later processing or pumped into lagoons to break down and decompose. Unfortunately, as the saying goes, “effluent happens”.

Manure lagoons provide an inexpensive way of treating huge amounts of animal waste. Waste from the cattle sheds and milking parlors is pumped through pipes into the lagoon. However, lagoons are exposed to weather and are affected by erosion and burrowing animals. Piping that is not buried deep enough below the frost line can freeze and burst and leak into the ground water supply.

In Walkersville, Maryland, a manure lagoon pipe at a nearby dairy burst and contaminated the town's water supply in 2008.[35] On August 15, 2005, three million gallons of liquid cow manure poured into the Black River when a reservoir wall at one of New York's largest dairy farms gave way. Roughly a fourth the size of the 1989 Exxon Valdez oil spill, the contaminated waters affected several communities in the Adirondack region.[36] A 21 million-gallon manure lagoon at a dairy farm outside Snohomish suffered a "catastrophic failure" in April of 2010. It released large quantities of manure into the surrounding fields, and then into French Slough and the Snohomish River.[37]

Giant manure lagoons like these can contaminate the water supply with E. coli bacteria and animal hormones

Both hog and cattle manure spills are fairly common, although cattle manure spills seem to be more prevalent because dairy farms are more widespread. Cow manure is likely to contain E. coli bacteria, which can make people ill. Symptoms can appear within hours or days after infection and include diarrhea, vomiting and fever. Fortunately, under normal operating conditions, most municipal water systems can successfully kill E. coli bacteria. The residual hormones, however, are another story. And all bets are off when a tidal wave of Guernsey Goo is heading downriver for their water intakes.

Runoff: Muddying the Waters Even More

> *"Fertilizers, insecticides, and herbicides are sprayed on crop fields and eventually wash down into water supplies."*

One thing that can make spills harder to clean up is rain. Whether it's a chemical solvent spill from a derailed tank car or manure from a feedlot lagoon, rain can wash contaminants into nearby rivers and groundwater. But spills aren't the only contaminants rain carries into your drinking water. Fertilizers, insecticides, and herbicides (or weed-killers) are chemical compounds that are sprayed on crop fields and eventually wash down into water supplies.

Atrazine is both an agricultural and home herbicide used to kills broadleaf plants and grassy weeds. It is sprayed to control weeds in corn, sorghum, and Christmas trees.[38] In the United States, atrazine is one of the most widely used herbicides, with 76 million pounds of it applied each year, primarily in eastern Nebraska, Iowa, Illinois, Indiana, and Ohio – all of which are major watersheds for the Missouri, Ohio and Mississippi river systems.[39] Atrazine does not dissolve well in water, and it is a common and widespread contaminant in rivers, reservoirs, and aquifers.

Concentrations as low as 0.1 ppb have been shown to alter the development of sex characteristics in male frogs, depleting testosterone and increasing estrogen, chemically castrating three-quarters of the exposed male frogs, and turning one in ten into fully functional females with the ability to mate and lay eggs.[40] Among humans, it is an endocrine disruptor, possibly carcinogenic, and has an epidemiological connection to low sperm levels in men. In human fetuses, when exposure coincides with the development of the brain and reproductive organs, timing may be even more critical than the dose. Five epidemiological studies published in peer-reviewed journals have found evidence suggesting that small amounts of atrazine in drinking water, including levels considered safe by federal standards, may be associated with birth defects — including skull and facial malformations and misshapen limbs.[41] Also of great concern is the potential for atrazine to act synergistically with other pesticides to increase their toxic effects.

Fertilizers are another agricultural waste found in runoff and is mostly comprised of nitrates. Septic systems, animal feedlots, industrial waste, and food processing waste also leak nitrates. Nitrates ($-NO_3$ compounds) in high levels can poison infants, giving them "methemoglobinemia" or "blue baby syndrome." This is because the baby's skin turns blue or lavender from the body being unable to process enough oxygen. High nitrate content in water may also contribute to birth defects in pregnant women and people with heart or lung disease may be more sensitive to toxic nitrate effects.[42]

Up until the mid-1970s, landfills or dumps were just open pits where people brought their garbage. It wasn't until the mid-1970s that ground water testing indicated that toxic substances such as mercury, lead, bacteria, viruses, benzene, motor oil, and other VOC's were exiting the landfill through rain water run off. Landfills have since been re-engineered, and use thick rubber linings to catch and help siphon off leachate. However, many old landfills and forgotten dumps are still disgorging gallons of toxic substances into river and groundwater and will do so for years.

And then there's mine runoff. Mining is a Pandora's Box. It can bring precious and useful metals from deep within the earth, but it can also release toxic heavy metals into the water supply. Some mine runoff is toxic enough to kill off all aquatic wildlife, along whole sections of streams and rivers.

The Iron Mountain Mine Superfund site in northern California originally opened in the 1860s for iron, silver, gold, copper, zinc, and pyrite. After closing in 1963, mine waste (tailings) and the open pit of the mine itself have caused rain runoff of mineral and metals (sometimes green or yellow liquid) to surge into streams and ground water. When pyrite is exposed to water and oxygen, it forms sulfuric acid. This harsh acid reacts to mineral in the mountain and leaches out copper, cadmium, iron, zinc and other metals. In spite of efforts by the U.S. Bureau of Reclamation, these metals and the sulfuric acid make their way into the upper Sacramento River system, affecting about 70,000 people.[43]

Other mines, such as coal mines, release similar corrosive metal-contaminated runoff into lakes and rivers. These can contain arsenic, lead, mercury, and chromium. In addition to being carcinogenic, these affect the brain, liver, kidneys, skin, bones, and teeth. Even small amounts of lead can cause significant health problems, especially in children. Problems range from behavioral problems and learning disabilities, to seizures and death. Children six years old and under are most at risk.

Sewers: Your Worst Pipe Dream

When sewer systems were first installed throughout the United States in 1855, they were hailed as being the most significant improvement of the century for the country. At the time, they were a miracle compared to the muck and raw sewage left to pool in the gutters of city streets. A century and a half later, however, they had become an expensive polluting curse for 40 million people in 32 states.[44]

Combined sewage systems collect raw sewage from household sewer mains and storm water runoff from street drains. Under normal circumstances, rainwater will join the sewage stream and flow to the public wastewater treatment plant. But in times when there is a lot of rain or flooding, and the wastewater treatment plant cannot handle the volume, the water containing both rain water and sewage is allowed to be released directly into streams or rivers as a "combined sewer overflow."[45]

"According an EPA report, combined sewer overflows are a major water pollution concern for 772 cities."

With city populations on the rise, and more sewage entering the waste stream, it takes less and less rain water to overburden the system. Where a combined sewer overflow in a rainstorm was once rare, it has now become a regular necessity. Though these types of systems are no longer being built in modern subdivisions or other communities, there are many cities in Maine, New York, Pennsylvania, West Virginia, Ohio, Indiana, Michigan, and Illinois that still rely on them. According to an EPA report, combined sewer overflows are a major water pollution concern for 772 cities. Although some major cities like New York City and Philadelphia have combined sewer overflow (CSO) systems, most communities with CSO problems have fewer than 10,000 people.[46]

An estimated 75,000 sewer outflows totaling 3-10 billion gallons of untreated wastewater and rainwater occurs in the U.S. annually. In addition to human and animal wastes, it contains microbial pathogens, suspended solids, chemicals, and trash. Out-flowing wastewater also carries nutrients that deplete dissolved oxygen in seawater. This poisons shellfish beds and beaches. EPA estimates about 3,500–5,500 gastrointestinal illnesses each year are caused by sewers spilling pollution into swimming waters. Other estimates suggest hundreds of thousands of people each year are sickened by microbial pathogens (viruses and parasites) in drinking water supplies.

The EPA estimates that the nation's drinking water systems require an investment of $334.8 billion over the next two decades, with most of the money needed to improve transmission and distribution systems. $50.6 billion is needed to reduce the nation's combined sewer overflows volume by 85%. In 1987 Boston, Cambridge, Chelsea and Somerville had a total of 84 uncontrolled combined system overflows (CSOs) that discharged into Boston Harbor and into the Charles, Mystic, and Neponset Rivers. As of September 2010, 27 CSOs have been closed.[47] Average bacteria levels in the Charles have decreased 80%, while the Mystic and Neponset

Rivers have shown little or no improvement.[48]

Some communities have increased sewer rates to raise funds to upgrade their sewer systems. Some have chosen design short cuts that initially saved money and seemed inconsequential but ultimately proved dangerous. In Coralville, Iowa, the city's wastewater superintendent was injured while using a blowtorch to melt ice off a roof hatch of a sludge-holding building so workers could empty the tank inside. Since the holding building was not ventilated, methane from the tank had built up pressure below the roof. When the torch ignited the gas, it blew the roof off the building. The explosion was felt for miles.[49]

Most of America's sewer lines are over 100 years old and are falling apart. Upgrading the pipes to modern materials is extremely expensive. Also, the process is profoundly disruptive to neighborhoods and cities because often streets must be torn up and residents cannot flush their toilets. In some parts of the country, century-old sewer lines have been discovered that still use the original 19th century wooden pipes. Some lines are either poorly mapped or not mapped at all and are only discovered when they break – which can be a rude surprise given that some residential pumped systems handle 321,000 gallons of untreated sewage per day.

The enormous costs to install new sewers and treatment facilities force communities to seek federal aid. Unfortunately, that funding well is fast drying up. Federal spending cuts for the Clean Water State Revolving Fund, which provides low-cost loans primarily for sewerage infrastructure upgrades, are in the pipeline. On Feb 9, 2011, the House Appropriations Committee announced it would cut $700M from the fund.[50]

Your Tap Water: Fixed On Failure

As mentioned earlier, more and more municipal water systems are draining less water from aquifers and taking more water from local rivers, lakes, and reservoirs. The water utilities purify water through a series of steps. First they screen leaves, branches, and large pieces of trash. Next, settling allows solids suspended in the water to sink to the bottom of the tank. The water is then clarified, which allows evaporation of some dissolved compounds. The next step is softening and pH adjustment. Finally, the water is chlorinated.

"Over the years, more and more health problems have been linked to chlorine treatment."

Chlorination has long been an accepted means (and the cheapest) to ensure that drinking water is free of harmful bacteria, parasites, and algae. Over the years, however, more and more health problems have been linked to chlorine treatment.

Chlorine can react with organic matter in the water and form dangerous, carcinogenic trihalomethanes, such as chloroform. Dr. Joseph M. Price, MD, argues in *Coronaries/ Cholesterol/Chlorine*, "Chlorine is the greatest crippler and killer of modern times. It is an insidious poison." Chlorinated drinking water has also been shown to elevate the average plasma cholesterol and serum thyroxine in 19 healthy men. This study conducted in the late 1990s "demonstrated that chlorine in drinking water at concentrations potentially consumed by humans may raise total plasma cholesterol and serum thryoxine."[51] In short, the chlorinated water from your tap maybe elevating amounts of bad cholesterol in your body that can ultimately give you a heart attack.

Purified tap water leaves the local treatment center and heads into the pumps and water mains. Whether it actually gets to your sink or not is beginning to look more and more like a matter of luck.

Many of America's drinking water mains, mostly iron, were installed around World War II. Nearly 70 years later, the EPA estimates 240,000 water supply mains break every year (700 per day), wasting millions of gallons of fresh water. Like sewer pipes, many of these are poorly documented when it comes to their location, depth, and composition. Nothing is known about their condition. Some small city utilities know they have leaky mains because of falling pressure and muddy water, but don't take action right away. They can't afford the cost of actively managing their aging water systems, and they can't afford to disrupt local business by digging up all the pipes.[52] Their default diagnostic repair plan? To wait for water mains to break. USGS calculates that 1.7 trillion gallons of water is leaked per year at an annual national cost of $2.6 billion.

Broken water mains are not only expensive to repair or replace, but they also cause millions of dollars in damage. In 2006, more sinkholes were reported in the U.S. than any other year and many of them formed when pipes broke underground and caused sinkholes.[53] The LA Times reported, "In Los Angeles, a broken water main created a sinkhole 30 feet deep and shut down half of Pacific Coast Highway near Malibu. At the same time, a broken sewer pipe shut down the adjacent beach." In 2009, a sinkhole swallowed an LA fire engine because a broken water main caused the already fragile ground to subside. That video is on YouTube.[54]

The one force that can thoroughly devastate a city water supply for weeks is not too many leaks or too little water. It's having too much water all at once. Flooding chokes the intakes of municipal water treatment centers with toxic run off, leachate, mud, fertilizers, herbicides, and bacteria.

It forces these contaminants into the ground water where they can pose problems for days. Since most water utilities are situated next to rivers, flooding can sometimes swamp pump buildings and water purifying processing areas, forcing them to close down. So, too, can floodwaters shut down sewage treatment plants, rendering them useless for weeks.

In 2008 Cedar Rapids, Iowa experienced a 500-year flood (flooding that only has a 1 in 500 chance of occurring per year). On June 13, the Cedar River crested at 31.3 feet above flood stage. Roughly 5,900 homes flooded and 10,000 residents were displaced. All but one of the city's 48 alluvial-aquifer wells flooded with polluted river water. Only through a massive sandbagging effort was the last well kept pumping. Water usage restrictions were imposed. Bathing and laundry were banned for five days.

Meanwhile, the wastewater plant was closed and sealed. The entire city was without sewer service. Flushing the toilet sent raw waste into the Cedar River or out on the streets. The wastewater plant would not be working again for 73 days and only then at partial capacity.[55]

What many people in Iowa and the upper Midwest learned that year is that they *all* get back what they *all* put into their water. What are your neighbors sharing with you in yours?

Water Traders: Is Privatization the Only Solution?

Water infrastructure is failing. Water treatment plants do not have the technology to protect citizens from 21st century contaminants. As municipalities, states, and the federal government run out of funds, investment in long-term, sustainable solutions is almost non-existent. Citizens are clamoring for legislation to clean up our waters, but they must do battle with corporate lobbyists with far deeper pockets. As the future of clean water looks increasingly grim, privatization may offer a glimmer of hope. But at what price?

In the 1990s a handful of multinational corporations began buying out public utilities and acquiring water rights. In some places, such as Bolivia, these rights included water in aquifers and water from the sky (rainfall). Over the years, corporation-owned water rights have turned a free natural resource into a profitable commodity worth hundreds of billions of dollars. Today, around 7% of the world's population relies on multinational companies to provide them with safe drinking water.

In Bolivia, South America's poorest country, the water deal arranged by the World Bank with Bechtel Corporation of San Francisco gave the American company the right to seize the homes of those who could not pay their bills.[56]

In England and Wales, privatization of water utilities led to a 46% increase in price, decreased investment, and threats to public health through non-payment cut-off. Profits doubled in eight years for the private companies, including Enron, which had bought the British Utility Wessex Water.[57] In 2009 a French company, Veolia Water (spun off in 2000 from Vivendi Entertainment) made over $17 billion, including recent water deals with China and Russia. GDF Suez, another French water utility company, made $772 million in profits in 2010, much of it from its U.S. subsidiary, United Water Resources, which services seven million Americans.[58]

With official United Nations figures showing that one billion people lack access to clean drinking water, and more than double that number lack proper sanitation, water is fast becoming a commodity more valuable than oil. In April 2010, the Secretary-General of the Organisation for Economic Co-operation and Development (OECD), Angel Gurria, said, "Putting a price on water will make us aware of the scarcity and make us take better care of it."[59]

Likely because of severe drought conditions, Australia has been a pioneer when it comes to water rights. It is currently the only nation to have a national water rights trading market. The state of California isn't far behind, however. It, too, has set up water trading markets, though on a smaller, regional scale. Will the rest of the world soon follow?

Liquid Fear: Water in the Age of Terrorism

Following the terrorist attacks of September 11, 2001, the U.S. government quickly identified the American water supply as a potential target for terrorist attacks and sabotage. The National Council for Public-Private Partnerships cited in its December 2001 *Technical Security and Countermeasures White Paper for Water* four areas for caution: Physical Damage, Damage to Chemical Storage Areas, Contamination with Biological or Chemical Agent, and Cyber Terrorism.[a] Since then, billions of dollars in lights, fencing, locks, sensors, and alarms have been installed at local drinking water utilities and wastewater plants. But has it been enough?

Judging by the numerous acts of vandalism at water utility properties in recent years, it has not.

In March 2006, two teenagers cut through barbed wire and an alarm system to enter a Massachusetts water utility.[b] Inside, they deposited a 5-gallon container of foul-smelling liquid atop a water storage tank. On May 12, 2010, vandals put rocks, brush, and construction debris in a sewer line in Austin, Texas, causing a 250,000 gallon raw sewage spill that contaminated private wells nearby.[c] On February 11, 2011, vandals opened several fire hydrants in Newport, Minnesota, causing water pressure to drop. As a result the city water system raised line pressure, pumping at a higher than normal rate. The high pressure cracked a water main, leaving 30 homes without water.[d]

Acts like these underline that, despite the commitment of federal and state legislative and law enforcement agencies, the water infrastructure is still very vulnerable. As these three limited incidents show, there was ample opportunity for a small-scale chemical or biological attack. Even though, as *Jane's Chem-Bio Handbook* states, "municipal water supplies are very difficult to contaminate to cause widespread casualties," the disruption and fear following a limited attack still accomplishes a terrorist's goal.

Water utilities rely on Supervisory Control and Data Acquisition software (SCADA) to help monitor and control water filtration, valve releases, chlorination, and distribution. Because of the systems they control, SCADA systems are running all the time without backup or redundancy. Unfortunately, too, SCADA systems are far from perfectly secure and are continually undergoing fixes and patches to keep hackers out.

In the meantime, ITSecurityPortal.com lists under its security trends for 2011: "There will be more targeting of SCADA facilities for ransom/extortion purposes as well as or even rather than out-and-out espionage/sabotage."[e] In other words, a hacker on the other side of the globe can turn the water utility's controls against itself. Once in the system, a hacker can shut off all water flow or contaminate it with wastewater ... unless the municipality pays a ransom.

References:

a. http://www.ncppp.org/inthenews/waterwhitepaper.shtml

b. http://www.thebostonchannel.com/r/8332815/detail.html

c. http://weareaustin.com/fulltext/?nxd_id=64035

d. http://www.piercecountyherald.com/event/article/id/33072

e. http://www.itsecurityportal.com/itsecurity_news.asp?articleid=265707&arttitle=IT%20security%20trends%20predictions

References:

1. http://water.nationalacademies.org/basics_part_3.shtml
2. http://www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx
3. http://www.epa.gov/watersense/pubs/supply.html
4. http://dailyreckoning.com/peak-water/#ixzz1BzIXfQXb
5. http://www.latimes.com/news/science/environment/la-me-newcolorado25-2008may25,0,864830.story
6. http://pubs.usgs.gov/ha/ha730/ch_a/A-introduction4.html
7. http://pubs.usgs.gov/ha/ha730/ch_d/D-text2.html
8. http://www.rra.dst.tx.us/gw/Ogallala_1.cfm
9. http://articles.latimes.com/2001/aug/23/news/mn-37349
10. http://pubs.usgs.gov/circ/circ1186/html/gw_storage.html
11. http://ga.water.usgs.gov/edu/earthgwsinkholes.html
12. http://en.wikipedia.org/wiki/Erin_Brockovich
13. http://static.ewg.org/reports/2010/chrome6/html/home.html
14. http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=221433
15. http://txsharon.blogspot.com/2009/07/midland-hexavalent-chromium.html
16. http://www.ewg.org/reports/rocketwater
17. http://thyroid.about.com/cs/basics_starthere/a/thyroid101.htm
18. http://www.washingtonpost.com/wp-dyn/content/article/2011/02/02/AR2011020205267.html
19. http://water.usgs.gov/nawqa/vocs/national_assessment/report/chapter1.html
20. http://www.osha.gov/SLTC/healthguidelines/chloroform/recognition.html
21. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=52&tid=16
22. http://pubs.usgs.gov/sir/2010/5024
23. http://www.epa.gov/chemfact/f_perchl.txt
24. http://www.cancer.org/Cancer/CancerCauses/OtherCarcinogens/IntheWorkplace/tetrachloroethylene-perchloroethylene

25. http://www.nap.edu/catalog.php?record_id=12863

26. http://www.uswaternews.com/archives/arcquality/6smonica.html

27. http://www.rense.com/politics6/mtbes.htm

28. http://www.epa.gov/mtbe/water.htm

29. http://pubs.acs.org/doi/abs/10.1021/es011055j

30. http://toxics.usgs.gov/pubs/FS-027-02/pdf/FS-027-02.pdf

31. http://www.usatoday.com/news/nation/2008-03-10-drugs-tap-water_N.htm

32. http://www.aar.org/~/media/aar/Files/natl_freight_capacity_study.ashx

33. http://www.epa.gov/region2/superfund/npl/0203481c.pdf

34. http://safetydata.fra.dot.gov/OfficeofSafety/Default.aspx

35. http://www.fredericknewspost.com/sections/news/display.htm?storyID=70618

36. http://www.nytimes.com/2005/08/15/nyregion/15dip.html?_r=1

37. http://seattletimes.nwsource.com/html/localnews/2011597899_manure14m.html

38. http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/atrazine-ext.html

39. http://en.wikipedia.org/wiki/Atrazine

40. http://www.sciencedaily.com/releases/2010/03/100301151927.htm

41. http://www.nytimes.com/2009/08/23/us/23water.html?_r=1&hp=&pagewanted=all

42. http://www.dnr.state.wi.us/org/water/dwg/nitrate.htm

43. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/CAD980498612!OpenDocument&Click=

44. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257666/

45. http://cfpub.epa.gov/npdes/faqs.cfm?program_id=5

46. http://www.epa.gov/nrmrl/pubs/600f07015/600f07015.pdf

47. http://www.mwra.state.ma.us/03sewer/html/sewcso.htm

48. http://www.mwra.com/harbor/html/soh_30.htm

49. http://www.kmtv.com/Global/story.asp?S=13905099

50. http://appropriations.house.gov/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=259

51. http://books.google.com/books?id=WZj3khOKMaIC&pg=PA301&lpg=PA301&dq=%22atherosclerosis%22+%22Robert+G.+Wones%22&source=bl&ots=dDiqcJ82PP&sig=kKsZt6DKX0WexykyfTiPb2Y4TtY&hl=en&ei=1DZYTb7bG4i6tgfKyrj0DA&sa=X&oi=book_result&-

ct=result&resnum=1&ved=0CBMQ6AEwAA#v=onepage&q=%22atherosclerosis%22%20%22Robert%20G.%20Wones%22&f=false

52. http://www.nytimes.com/2009/04/18/us/18water.html
53. http://www.latimes.com/news/opinion/commentary/la-oe-rooney28mar28,0,2169993.story
54. http://www.google.com/url?sa=t&source=video&cd=1&ved=0CDQQtwIwAA&url=http%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DMw1L2HVjR5I&ei=EahYTfrREIL98AbG9aizBw&usg=AFQjCNEAbvOFRf5SB9zVfVAPbhS66EHLEA
55. http://webcache.googleusercontent.com/search?q=cache:xZwRqLrvWboJ:www.grandforksherald.com/event/article/id/192667/+cedar+rapids+wastewater+treatment+plant+flood&cd=6&hl=en&ct=clnk&gl=us&client=safari&source=www.google.com
56. http://www.youtube.com/watch?v=xw5Fon_EjGw
57. http://en.wikipedia.org/wiki/Water_privatization
58. http://en.wikipedia.org/wiki/GDF_Suez
59. http://www.oecd.org/document/47/0,3746,en_2649_37465_36146415_1_1_1_37465,00.html