

Emerging Issues for Drinking Water and Drinking Water Industry

by

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Six emerging drinking water issues will be discussed. They include:

1. **Supply and infrastructure needs (repairs, replacement and expansion costs) for public water systems,**
2. **Widespread nutrient enrichment of surface water that is beginning to indirectly impact water quality and drinking water treatment costs,**
3. **New source water protection strategies, with emphasis on watershed-based land conservation practices versus enhanced water treatment technologies to protect drinking water quality,**
4. **Privatization of drinking water utilities with international marketing and commercialization of drinking water supplies,**
5. **Growing concern for chemicals that originate from water treatment processes, chemicals that leach from plumbing, chemicals from various fuel products, chemicals from health/personal care products for humans and animals, and ubiquitous chemicals coming from plastics, detergents and other widely used industrial and commercial products, and**
6. **Consumer needs for dealing with all the information and misinformation about drinking water quality, sources, properties, testing requirements, and treatment needs (some of this is nothing but scams).**

NOTE: An issue related to all of the above could be the role that good science plays versus politics, ideology, environmental advocacy and maybe even human greed, in maintaining a cheap and plentiful supply of good quality drinking water for humans on earth.

Background Information

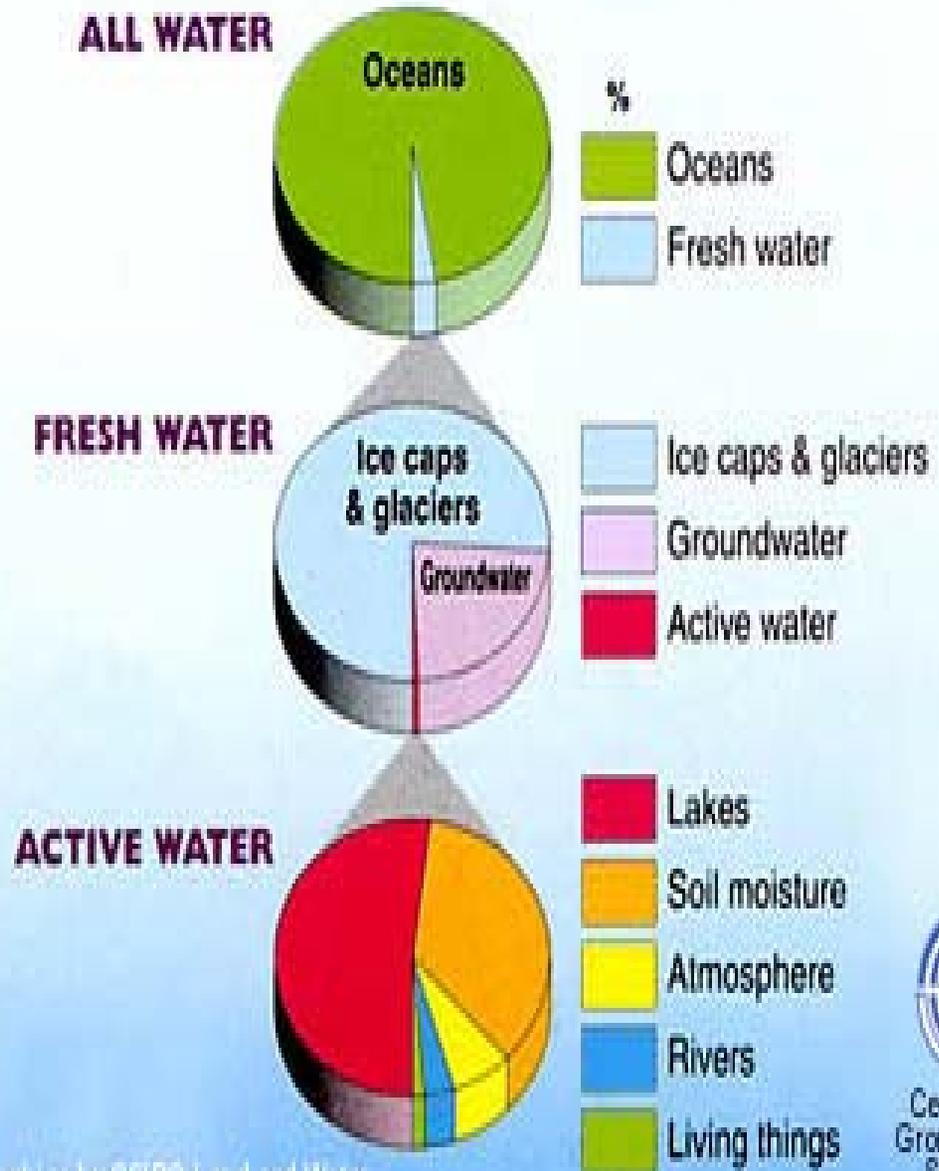


**The earth
is a water
rich planet.**



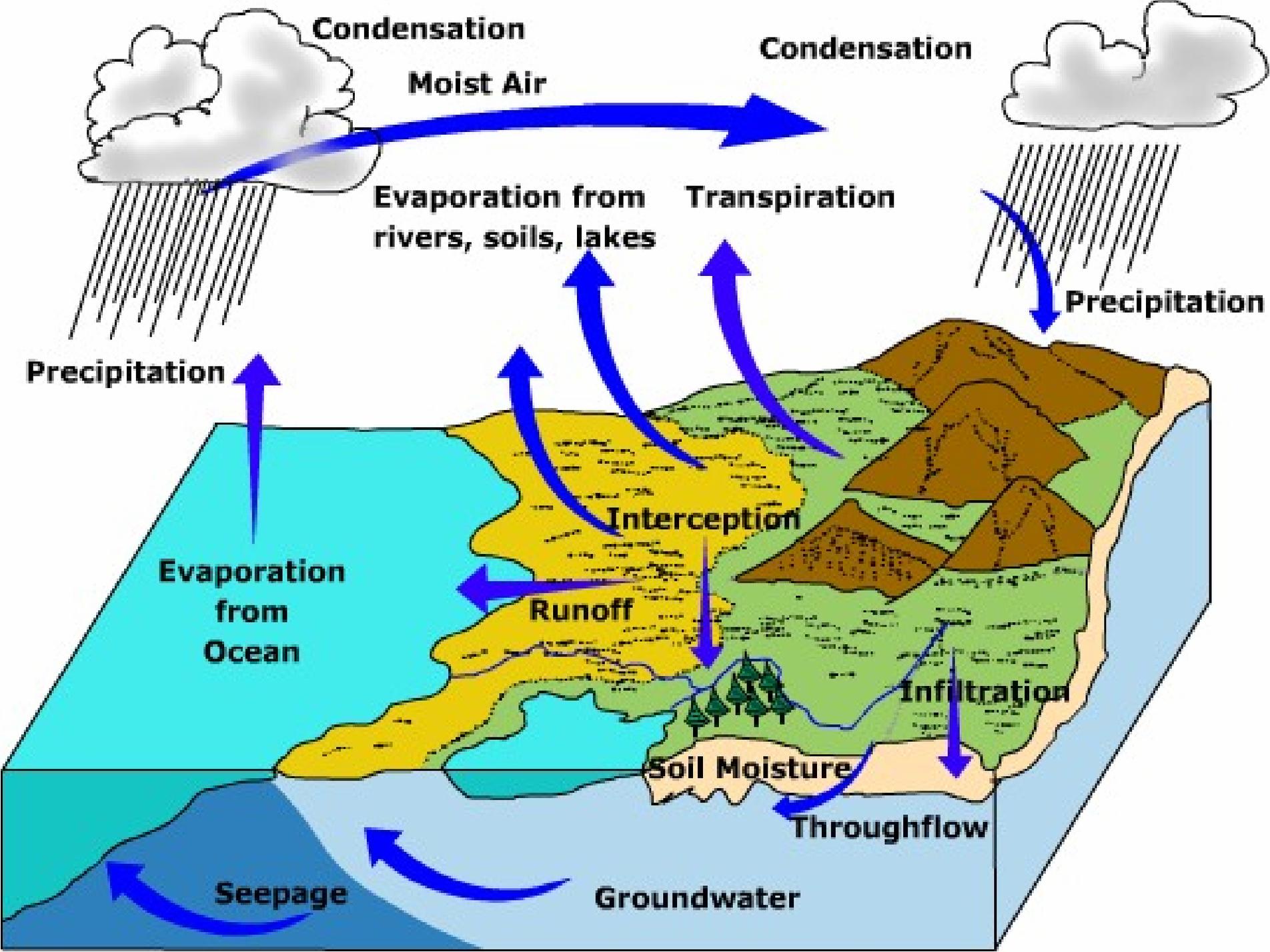
Most of earth's water is salt water so active fresh water is becoming more limited and more valuable.

World Water Distribution



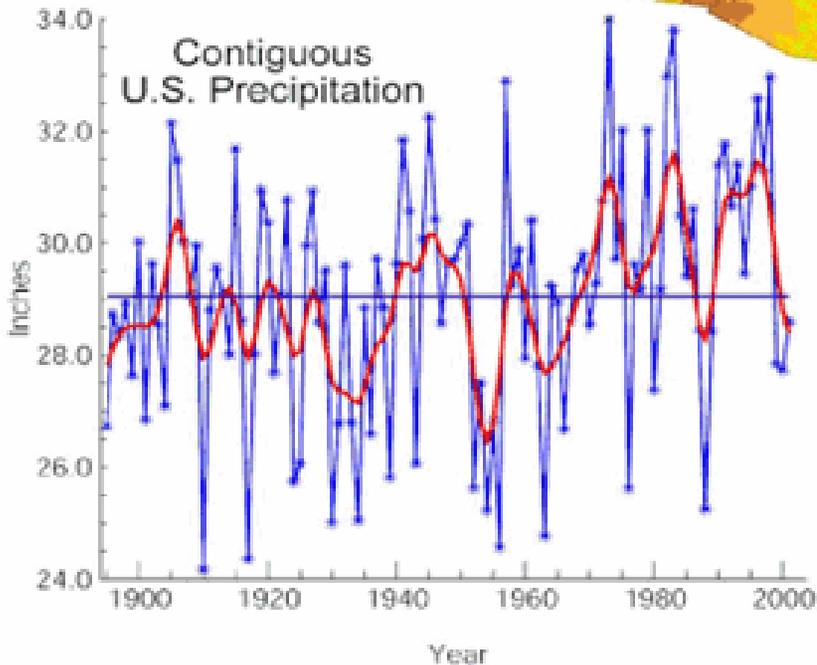
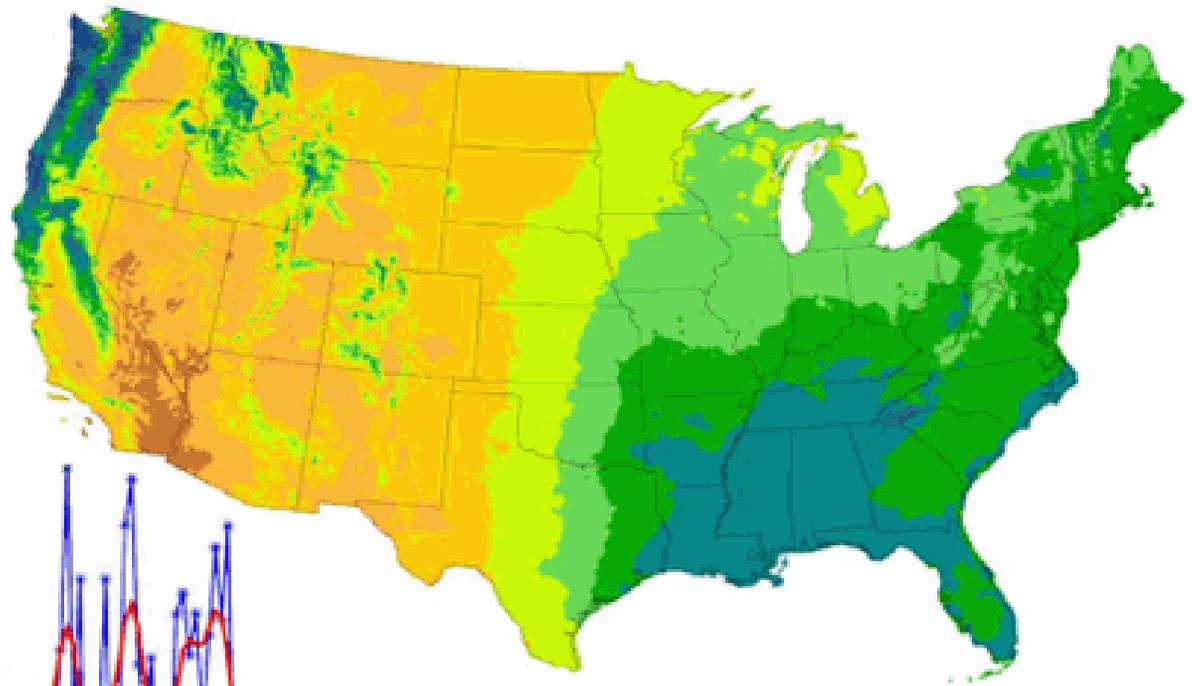
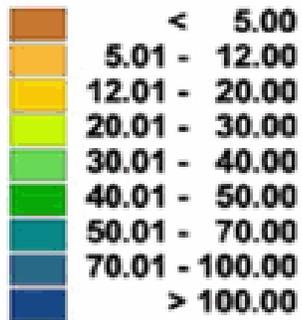
Desalination of seawater is the only source of fresh water in some places like Jubail, Saudi Arabia.



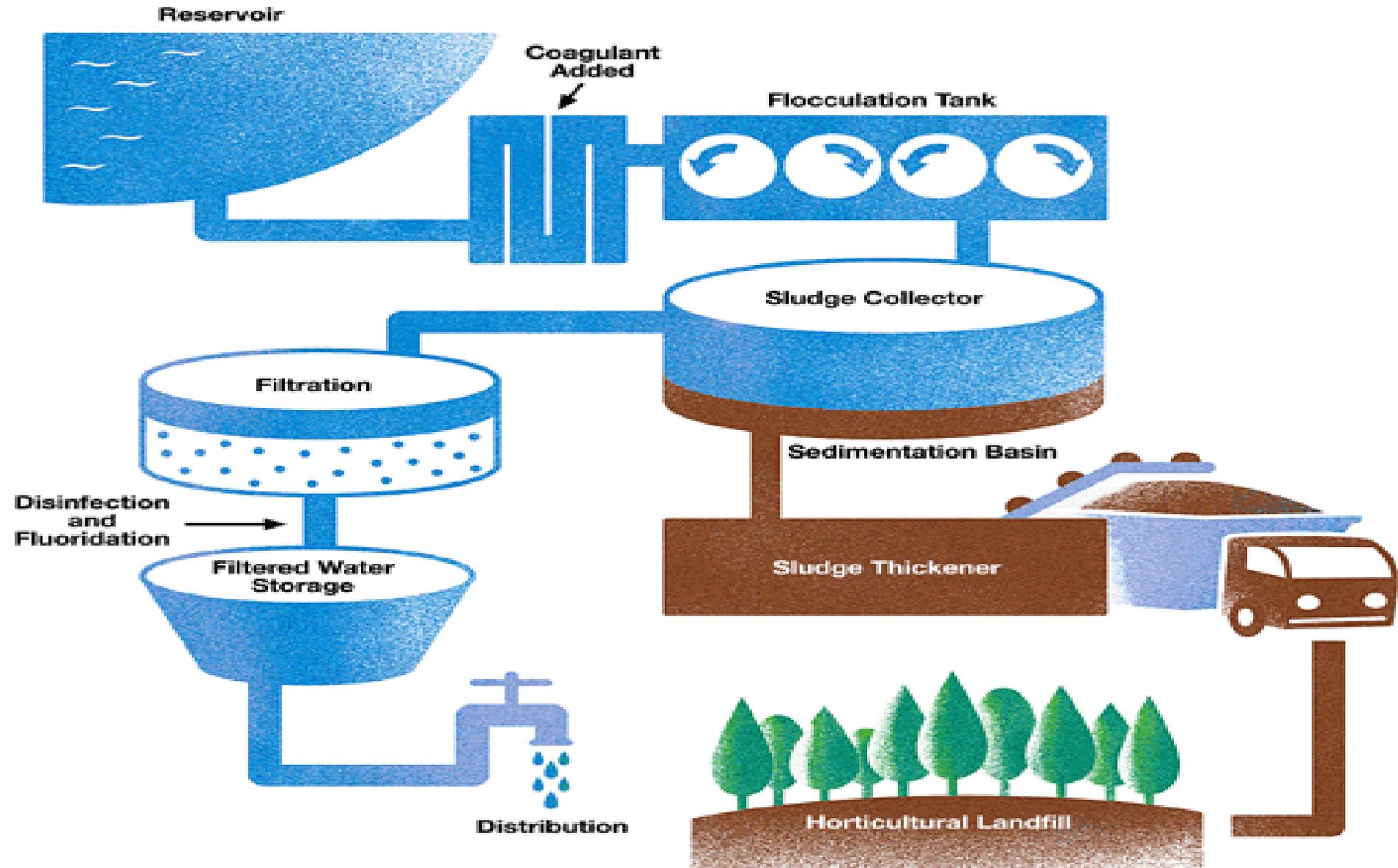


MEAN ANNUAL PRECIPITATION

Inches



Typical drinking water system that uses surface water as its source.



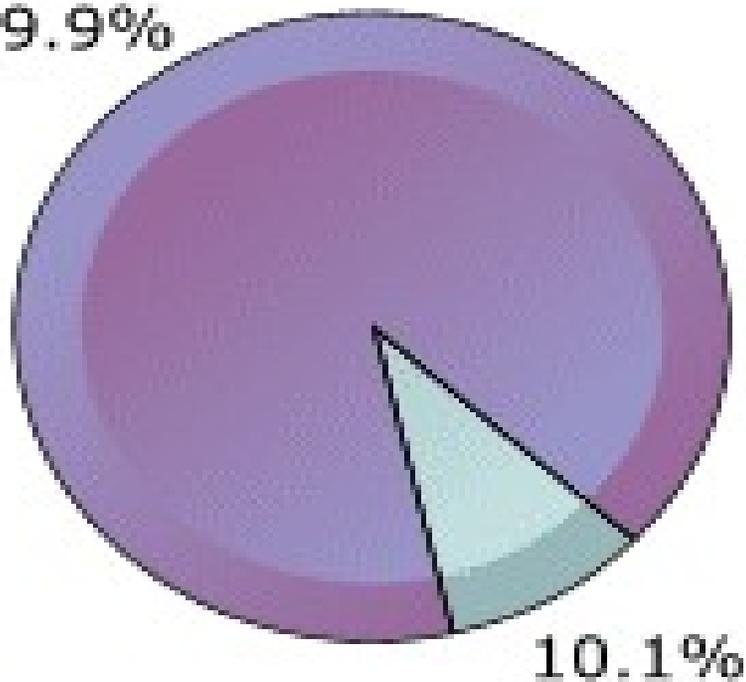
Where do we get our drinking water?

- **Public water systems**
- **Private water systems, mostly wells**
- **Packaged water, mostly bottled water**



Public systems or private supplies?

Percentage of the U.S. Population on Public Water Systems

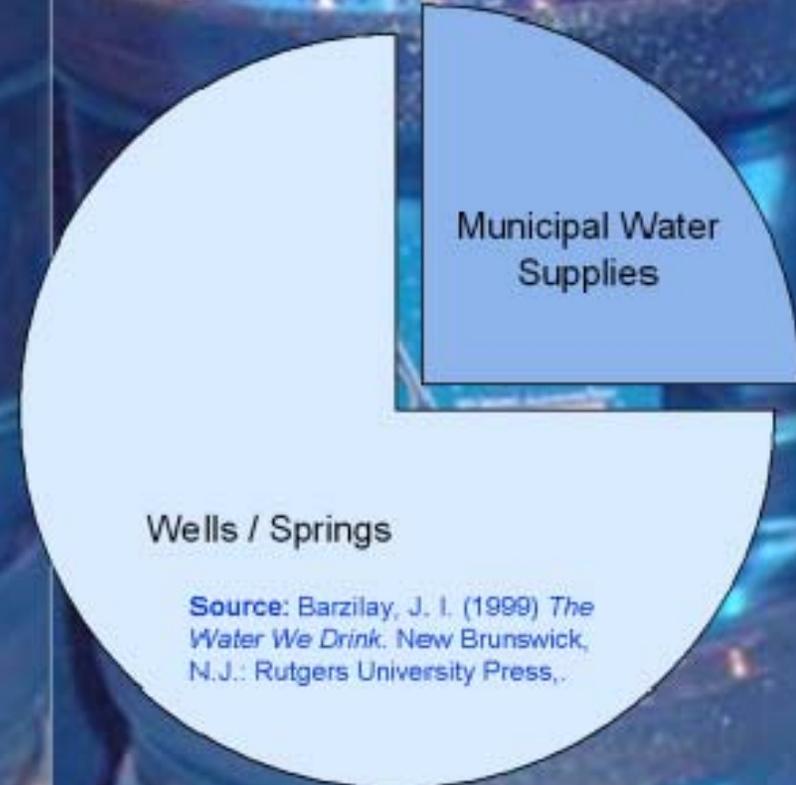


 P.W.S. Population
 Private Well Population



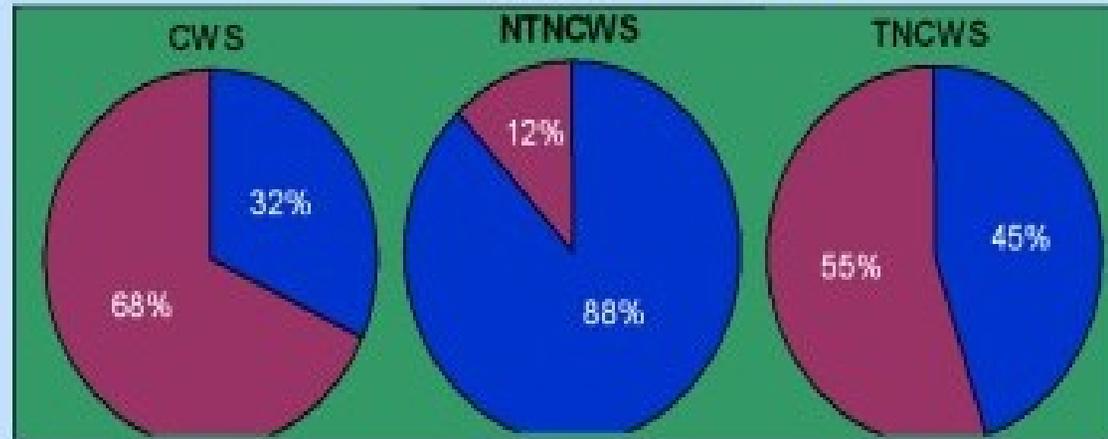
Where does bottled water come from?

Several different types of bottled water exist, including: artesian, mineral, spring, distilled, and sparkling—different types are distinguished by factors such as mineral content, carbonation, and source. Seventy-five percent of bottled water of U.S. origin comes from protected or uncontaminated wells and springs; while twenty-five percent originates from municipal water supplies.



Source: Barzilay, J. I. (1999) *The Water We Drink*. New Brunswick, N.J.: Rutgers University Press.

% of U.S. Population Served by Groundwater and Surface Water by PWS Type



Where does U.S. public tap water come from?

Different from state to state and system to system.

Public Water System (PWS) Types

Community Water System (CWS): Supplies water to the same population year-round (e.g. homes); at least 15 connections or 25 individuals

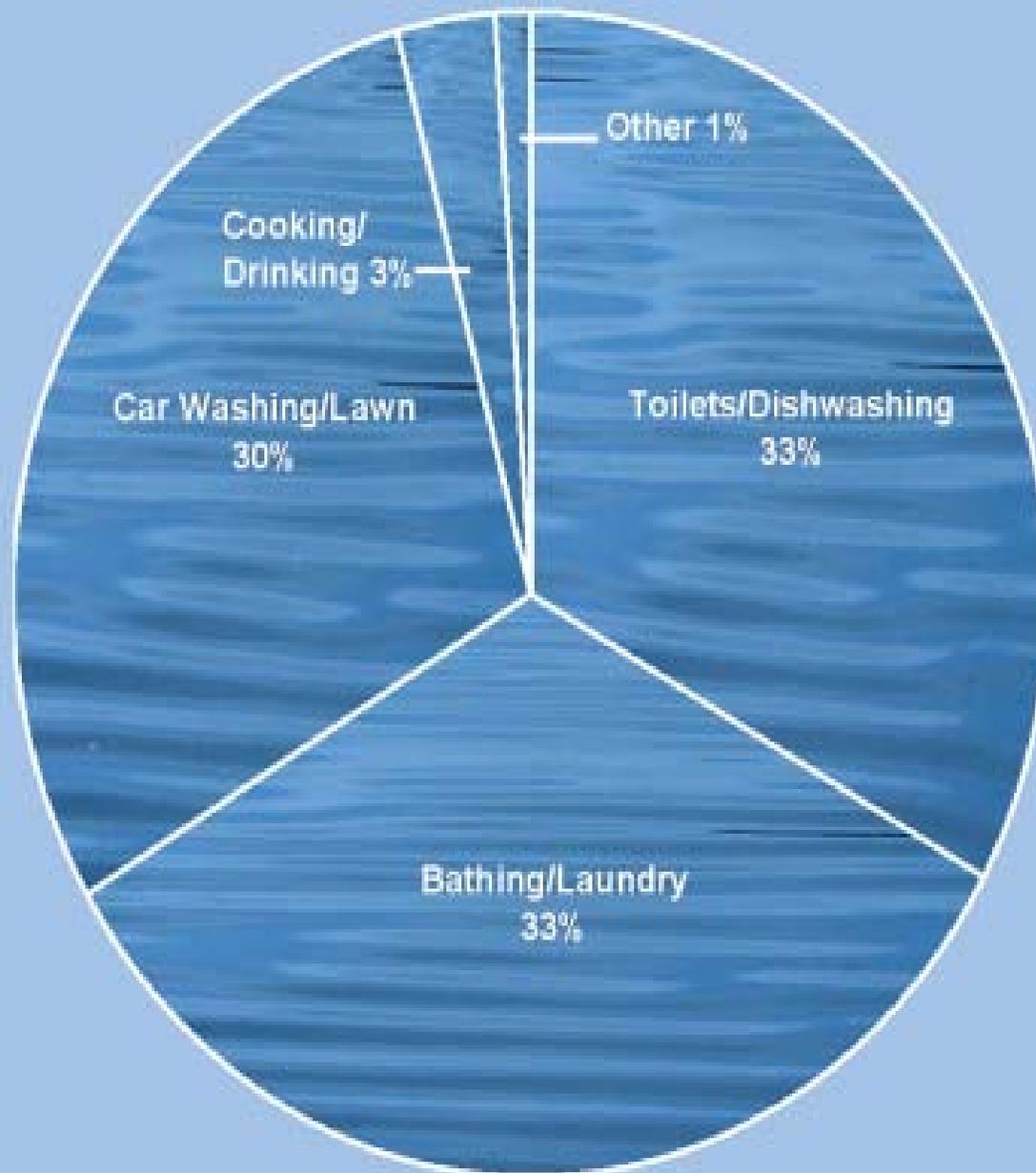
Non-Transient Non-Community Water System (NTNCWS): Regularly supplies water to 25+ of the same people at least 6 months of the year (e.g. schools, office buildings)

Transient Non-Community Water System (TNCWS): Provides water in a place where people only remain for short periods of time (e.g. gas stations, campgrounds)

■ Groundwater
■ Surface Water

Data Source: US EPA (2004). FACTOIDS: Drinking Water and Ground Water Statistics for 2003. http://www.epa.gov/safewater/data/pdfs/factoids_2003.pdf

How do we use water in the U.S.?



As of 1994, average daily water consumption per individual in the U.S. was 84.5 gallons.

Actual individual uses vary substantially based on geographic location and climate, type of dwelling, and other factors. Most (96%) of the treated water we receive from public water systems is used for non-drinking/cooking activities.

Data Source: Naiman, J.R., Magnuson, J.J., McKnight, D.M., Stanford, J.A. (1995) *The Freshwater Imperative: A Research Agenda*. Washington, D.C.: Island Press.

1. Drinking Water Infrastructure Needs -- Survey and Assessment: Third Report to Congress (EPA 816-R-05-001, June 2005)

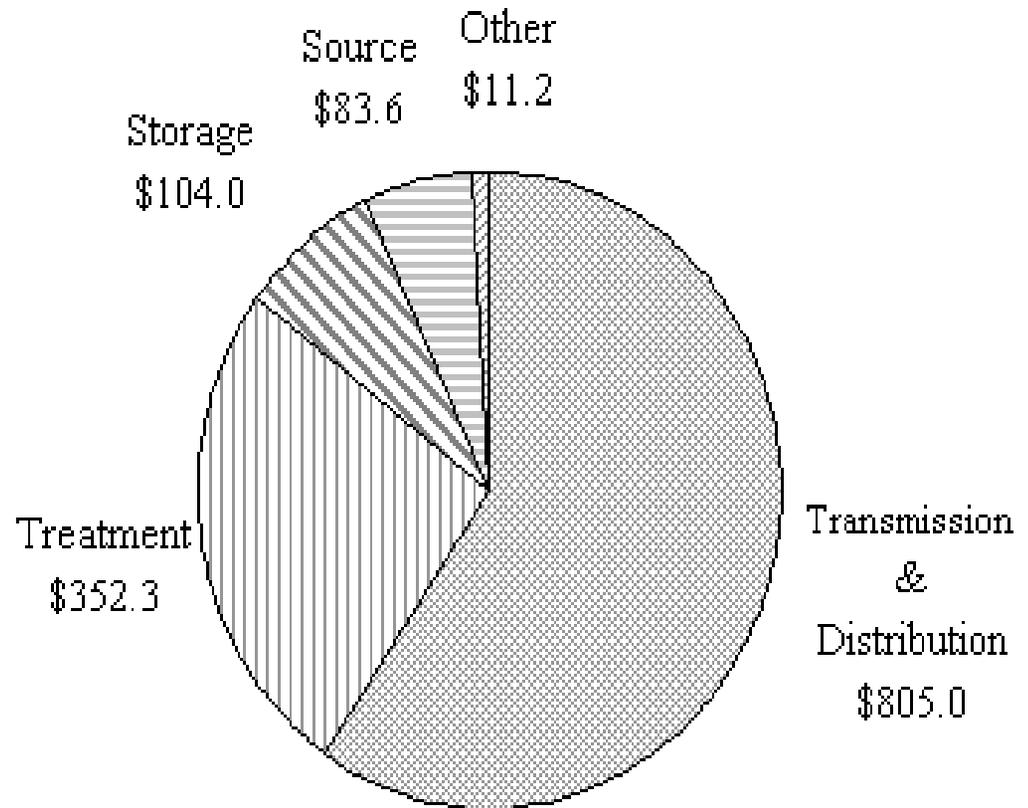
The U.S. and its territories need a \$276.8 billion investment in drinking water infrastructure over the next 20 years just to ensure continued compliance with specific Safe Drinking Water Act regulations.

**Wastewater infrastructure needs that would help protect drinking water for the same 20-yr period have been estimated by the American Society of Civil Engineers (ASCE) in 2005 to be around \$390 billion.
(<http://www.asce.org/reportcard/2005/page.cfm?id=145>)**

**Water utility
infrastructure
needs/costs
for next 20
years in
Connecticut
(\$1.36 billion)**

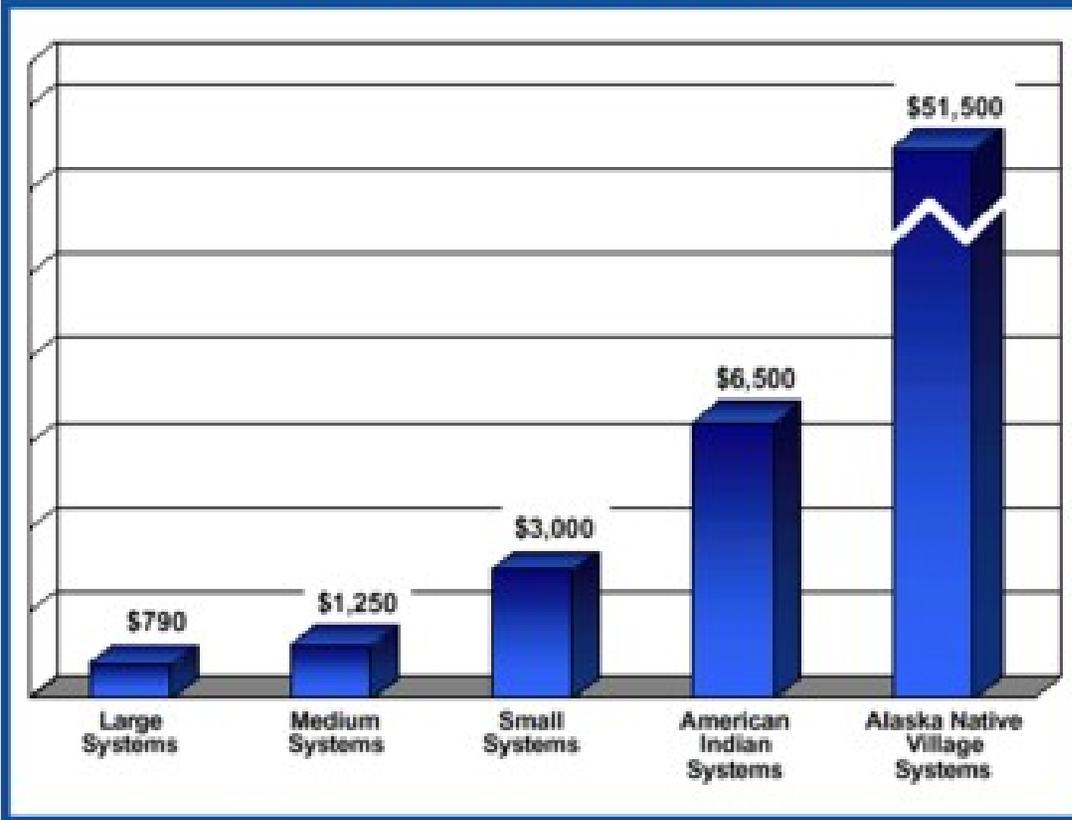
**WATER UTILITY
INFRASTRUCTURE NEEDS-
20 YEARS**

(In Millions of Dollars)



How much will infrastructure repair and replacement cost for water systems of different sizes?

Average 20-Year Per-Household Need
(in January 1999 dollars)

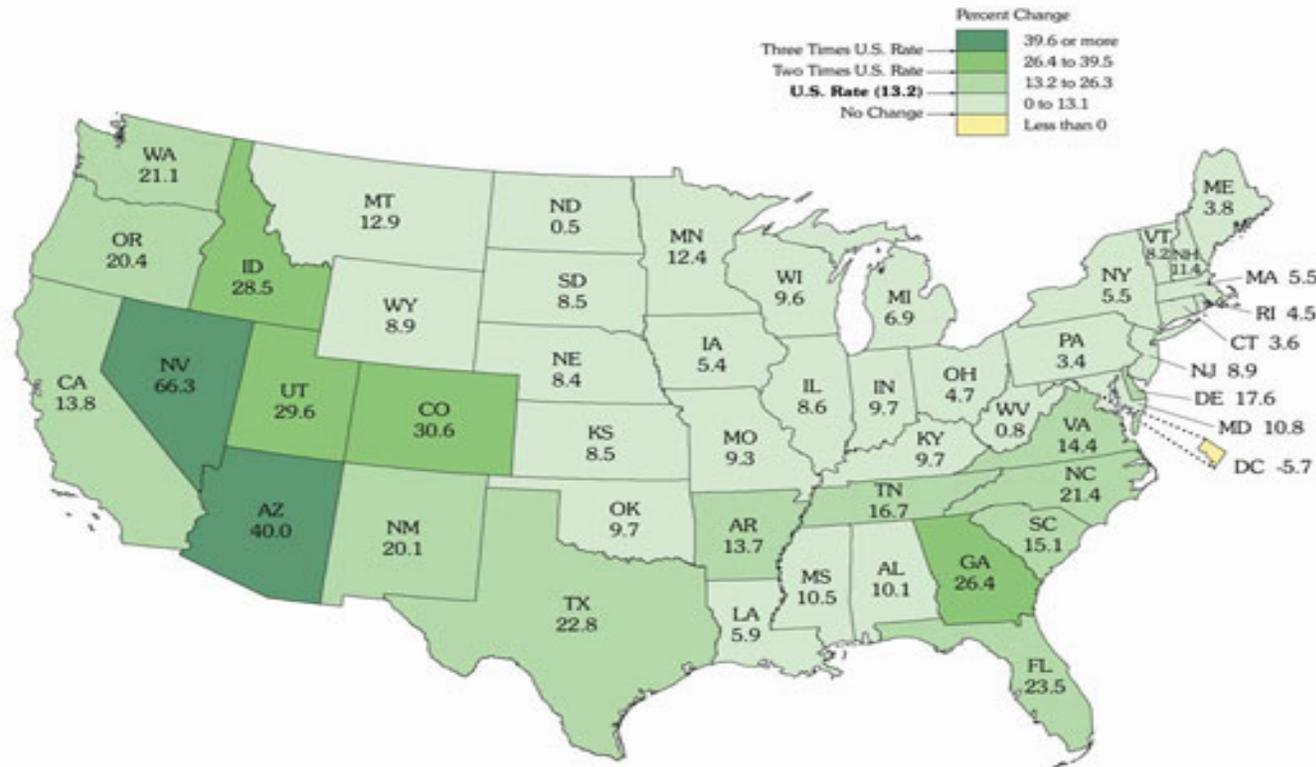


According to the American Water Works Association (AWWA), we are entering a period of unprecedented need for drinking water infrastructure repair and replacement. AWWA (2001) estimates that household impacts of infrastructure maintenance and replacement will be two to three times greater in smaller systems than in larger systems. Per-household impacts on certain small systems (i.e. American Indian and Alaska Native village systems) are estimated to be between eight and sixty-five times as great as in large systems.

Where will the greatest infrastructure needs be within the next 20 years?

Demographic Changes: Population Has Grown Fastest in the West, Particularly in the “Public Land States”

Percent Change in Resident Population for the 48 States and the District of Columbia: 1990 to 2000



- Darker areas denote faster growth rates.
- Nevada (66%) and Arizona (40%) lead the nation.
- Intermountain states average about 30%.

2. Nutrient Enrichment Issues

Mississippi River Basin



This map is not to scale.

There are nitrate and nitrite standards for drinking water but increased levels of alga toxins, DOC and increased incidence of microbials are emerging concerns for nutrient enrichment of fresh, surface water sources designated to supply drinking water.



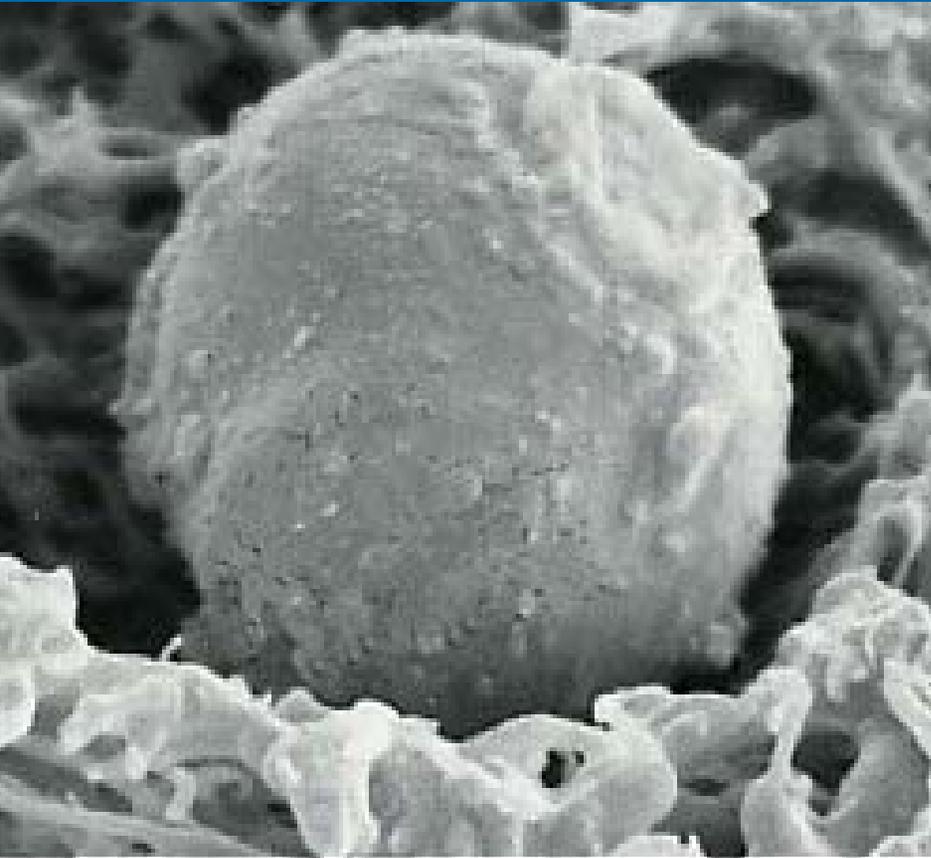
Blue-green algae affects odor and taste of water but also produces highly potent toxins (hepatotoxins, neurotoxins, endotoxins and other non-specific toxins).



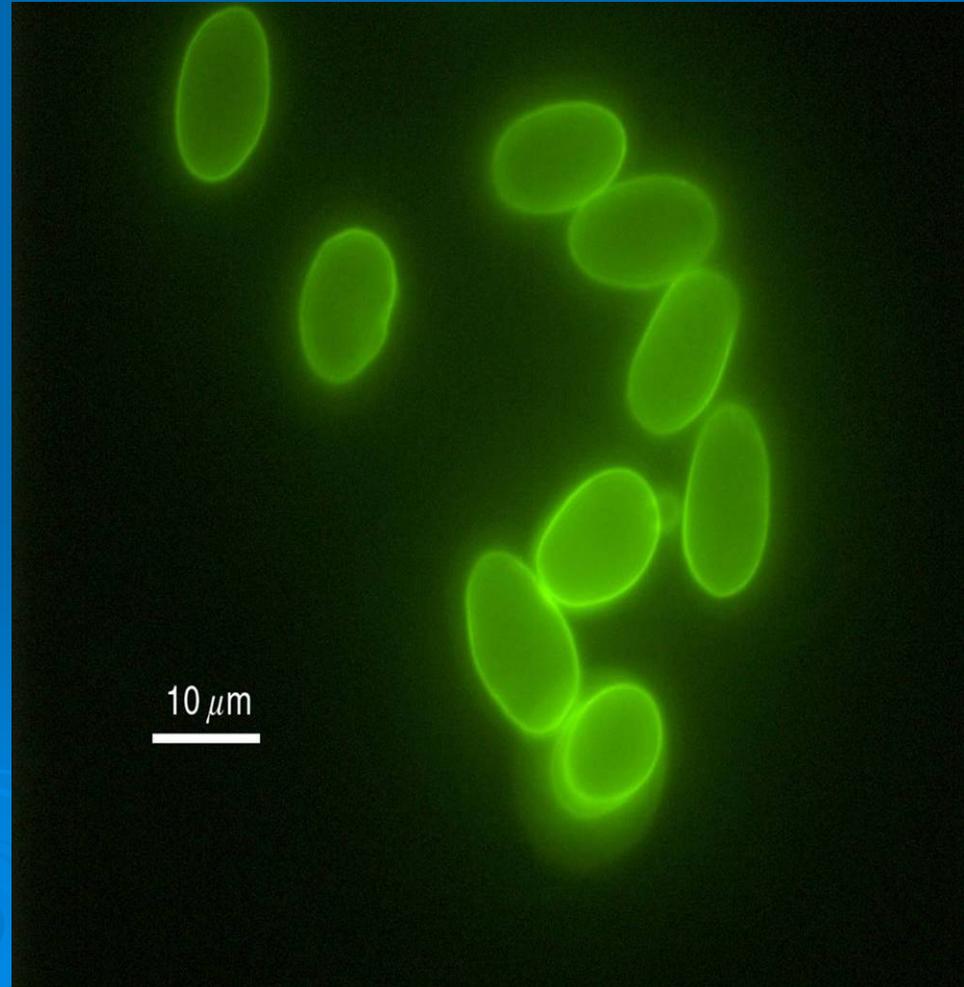
**Algae bloom
on Lake Trafford**

Photo by J. Schardt
2002
Florida D.E.P.

Nutrient enrichment and increased protozoa seem to be related. Cryptosporidium oocysts on the left and Giardia cysts on the right are hard to kill using conventional chlorine disinfection methods.



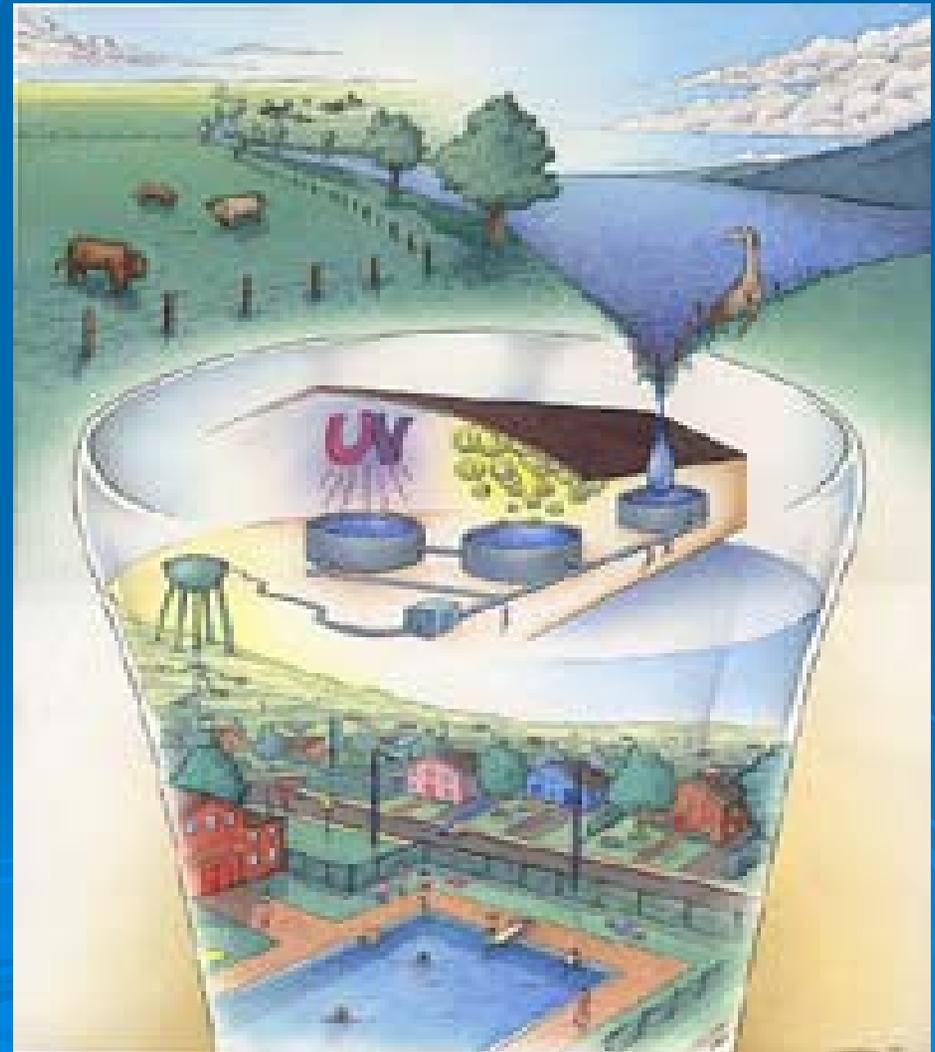
Cryptosporidium Oocyst



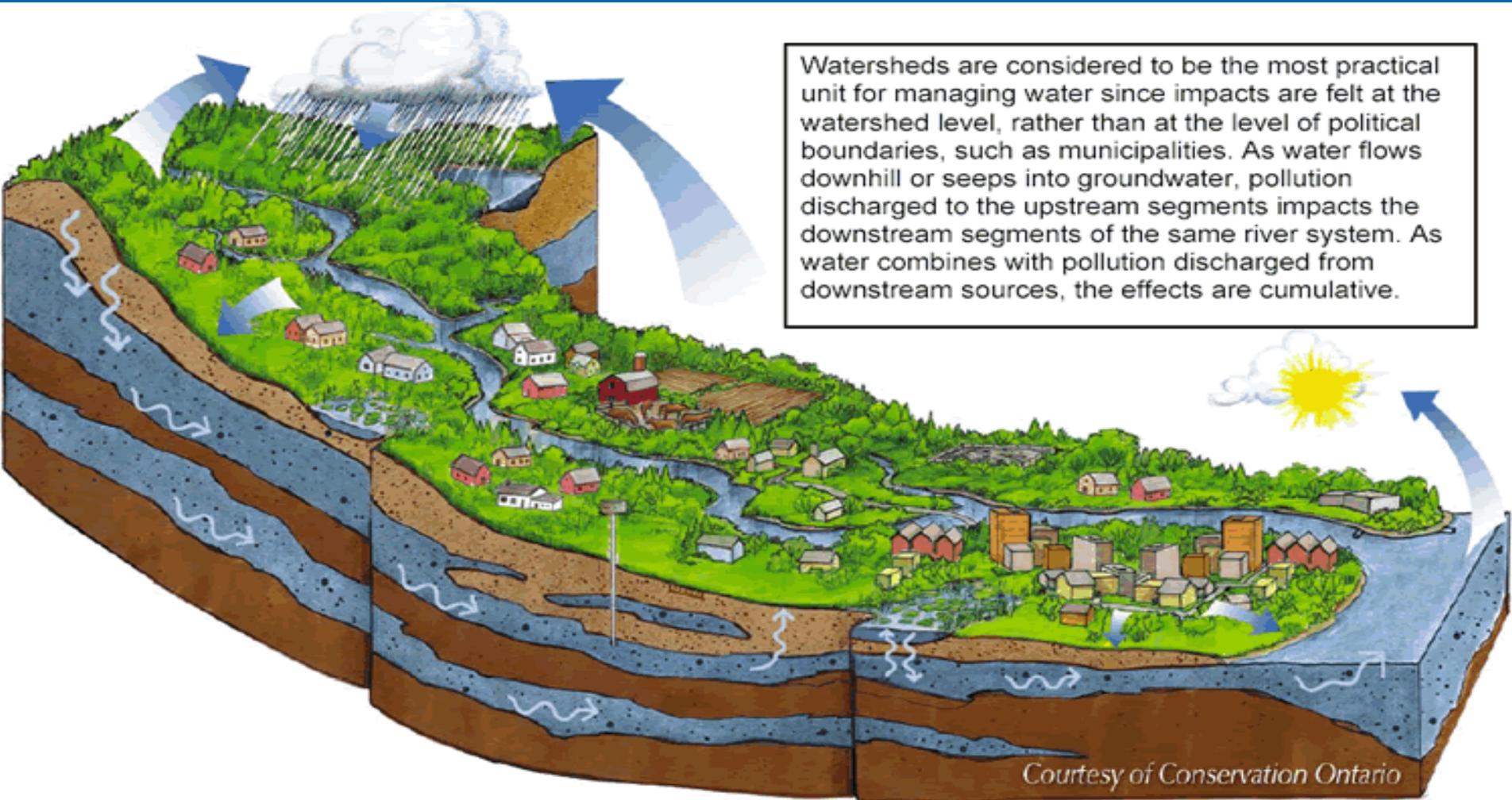
3. Source Water Protection Issues

Three-step Multi-barrier Approach to Protecting Public Drinking Water Supplies

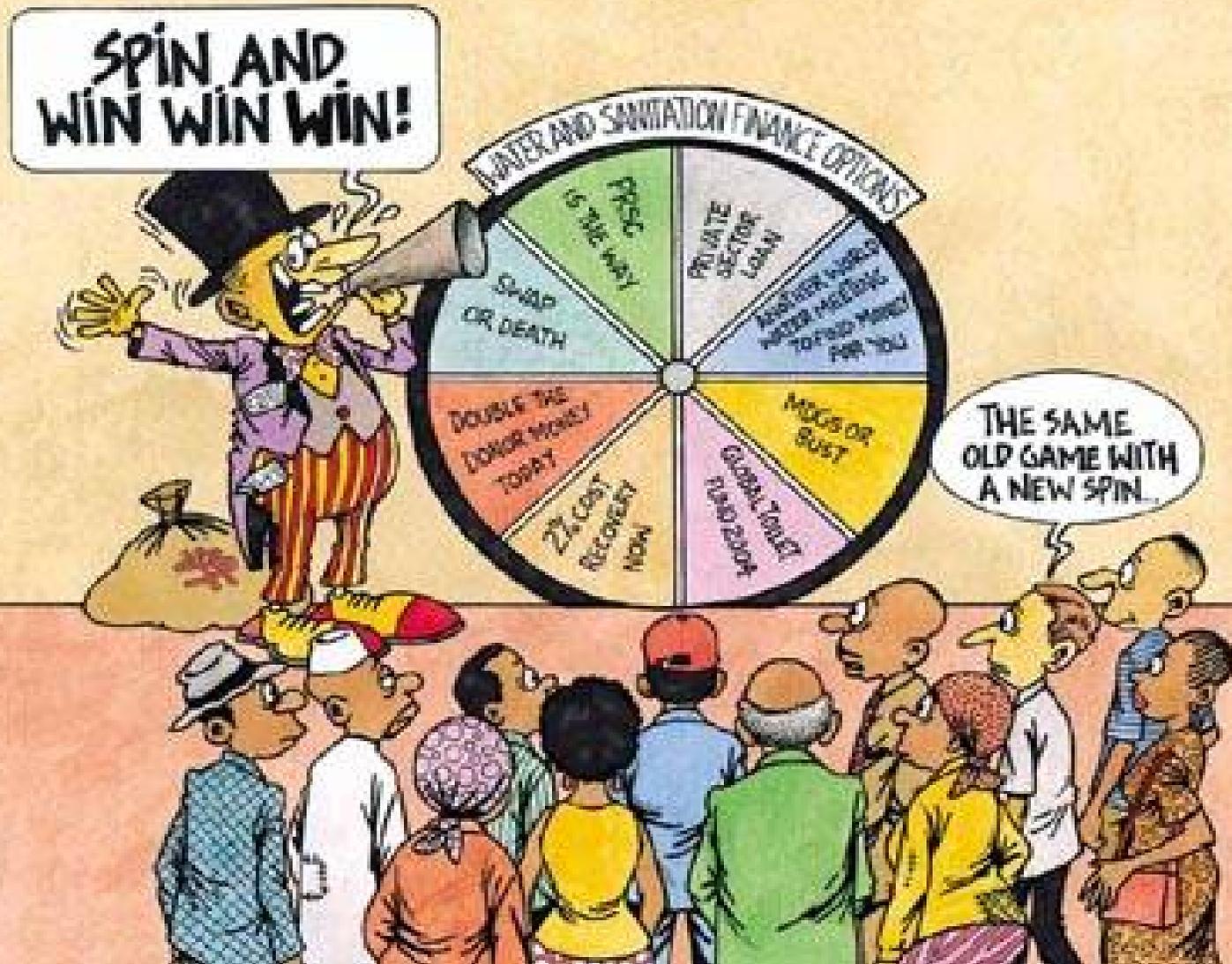
1. Source water protection
2. Drinking water treatment
3. Maintaining and protecting distribution systems



Effective watershed management is the key element in maintaining a good supply of clean drinking water. Watershed-based pollution prevention is proving to be more cost effective than continuous upgrades to water treatment plants to meet drinking water quality needs.



4. Water Marketing Issues

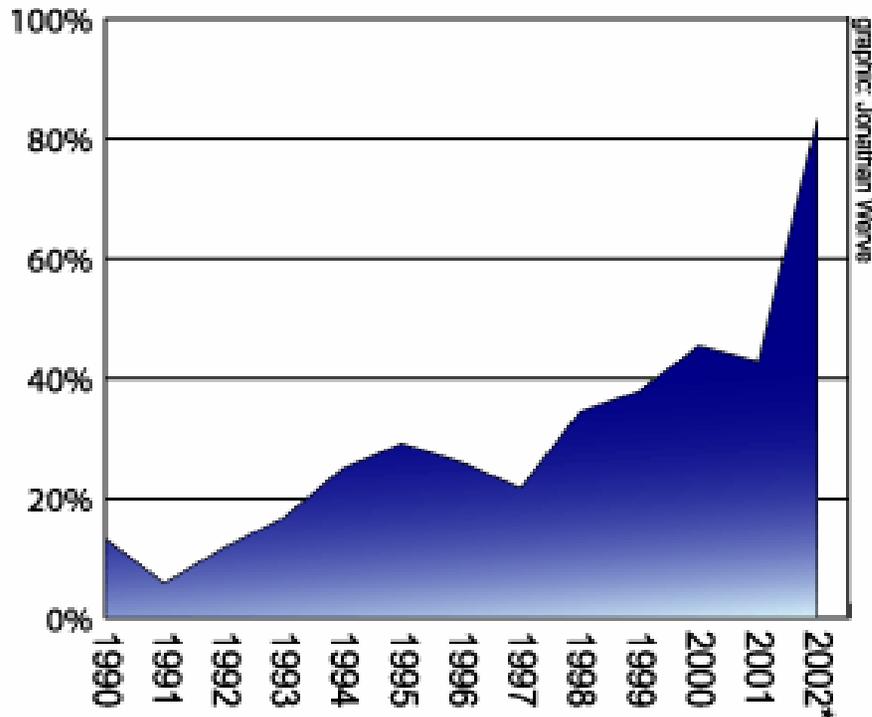


**Freshwater is predicted to be the oil
of 21st century.**



Commercialization and Anti-privatization Movement

Percent of water loans requiring privatization by year

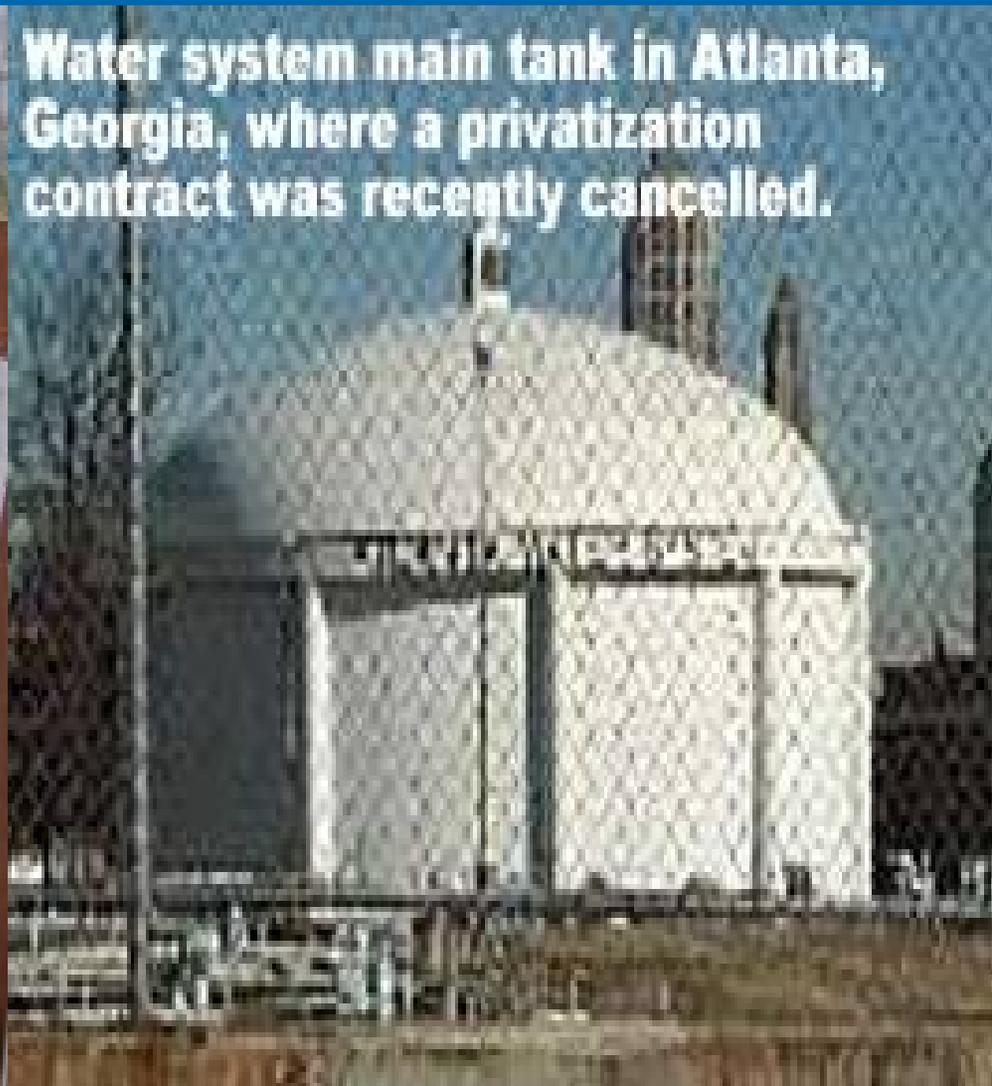


*Data from Jan. 1, 2002 through Nov. 1, 2002

Source: World Bank and Center for Public Integrity analysis



Push for Privatization Continues Even with Failures



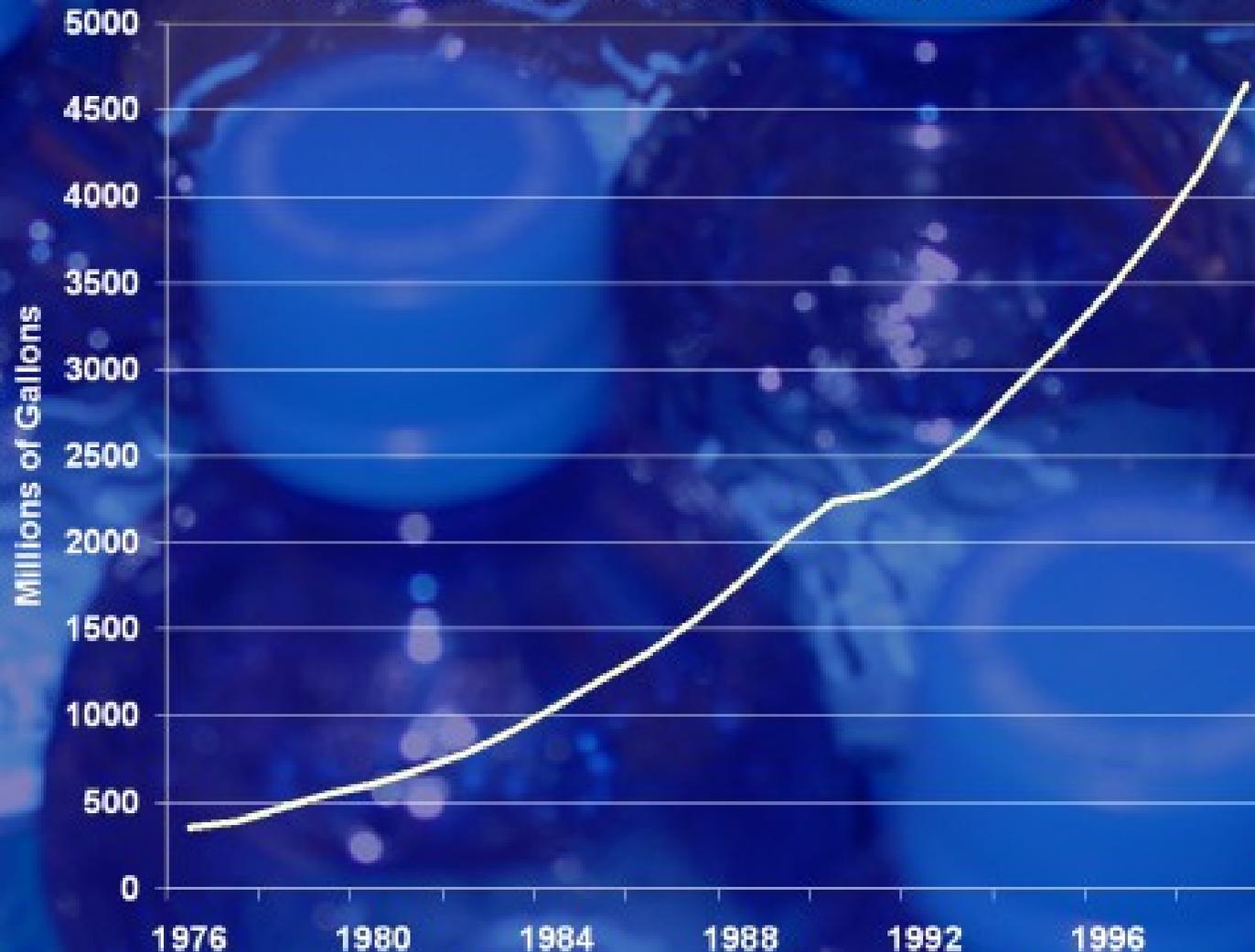
Water system main tank in Atlanta, Georgia, where a privatization contract was recently cancelled.

Some commercialization of drinking water is linked to packaged and bottled water industry.



How has bottled water consumption in the US changed over the past few decades?

Annual U.S. Bottled Water Consumption (1976-1999)



Data source: International Bottled Water Association (IBWA) US Bottled Water Market Volume, Growth, Consumption 1976-1999.
<http://www.bottledwater.org/public/volume%20growth%20and%20consumption.htm>

How much does bottled water cost?

Cost per Gallon of Selected Bottled Waters



Data Source: Personal observation. Dahl's Foods, Clive, Iowa. (December 2004)

Anytime water (ATW) and fill your own bottle machines.



5. Chemical Contaminant Issues:

There is a growing concern for certain types of chemical contaminants in our drinking water.

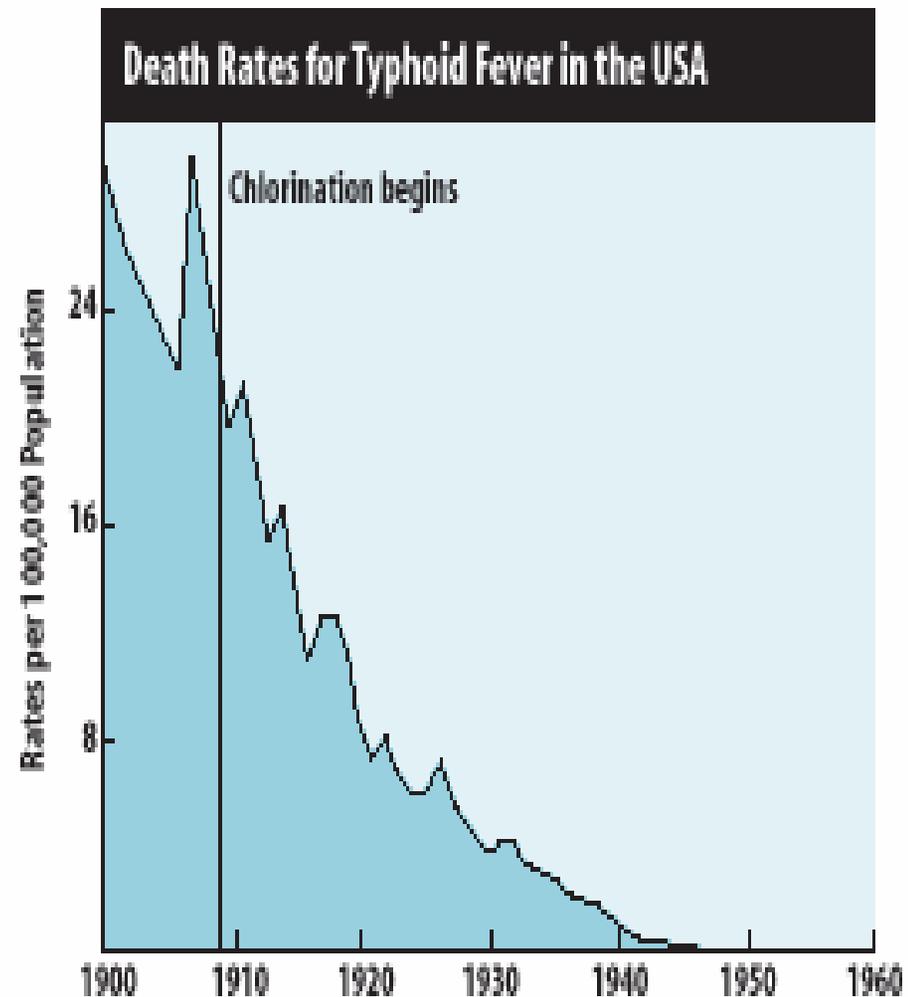


Chlorine and Chlorination Byproducts

Top Five 20th Century Achievements Contributing to the Quality of Life

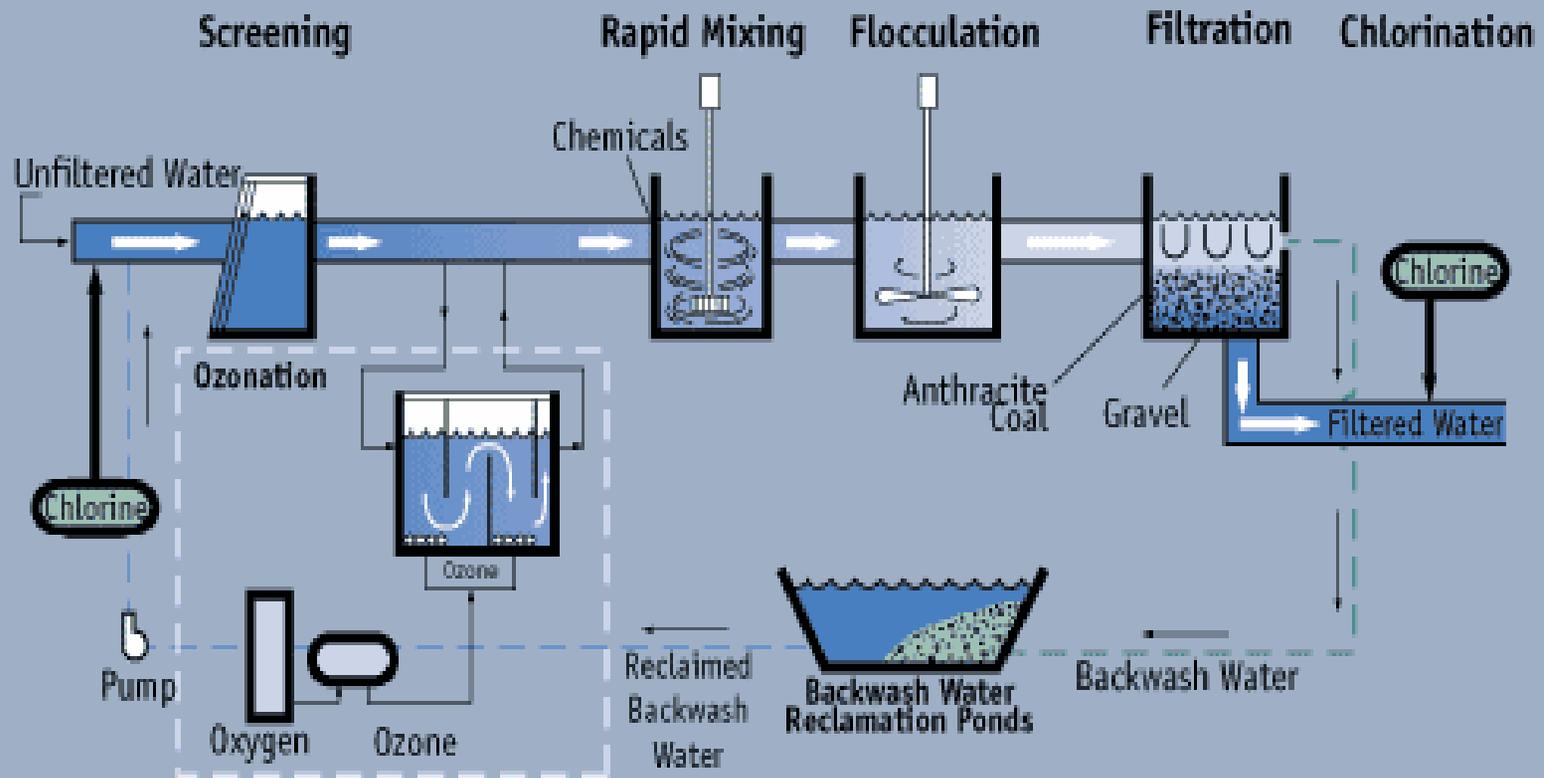
- 1  Electrification
- 2  Automobile
- 3  Airplane
- 4  Safe, Abundant Water
- 5  Electronics

Figure 1-1



Pre-chlorination for removal of organics is being eliminated and carbon filtration being added.

The Treatment Process



Prechlorination Replaced by Ozonation in Newer Plants as at LA DWP

Growing interest in non-chlorine based disinfection, even for private water systems.



A large variety of ozone systems are now available.

TYPICAL RESIDENTIAL OZONATION RECIRCULATION SYSTEM



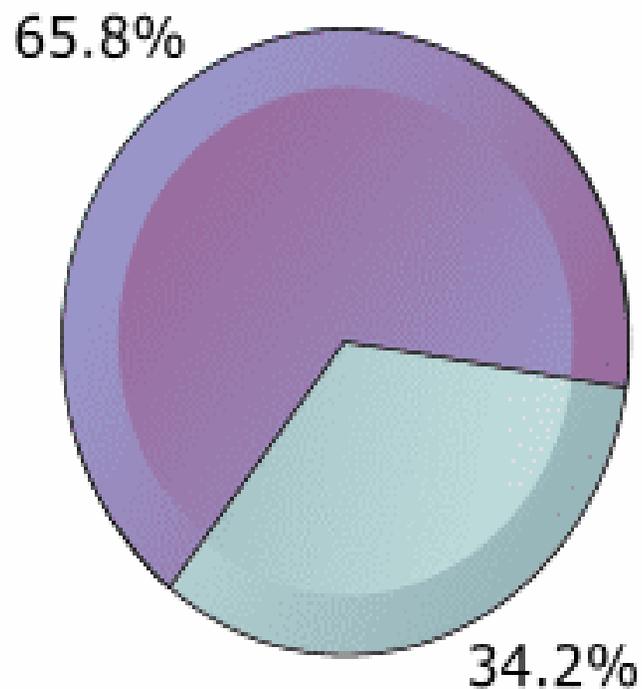
Even hand-held disinfection units are now on the market.



The Benefits and Hazards of Fluoridation

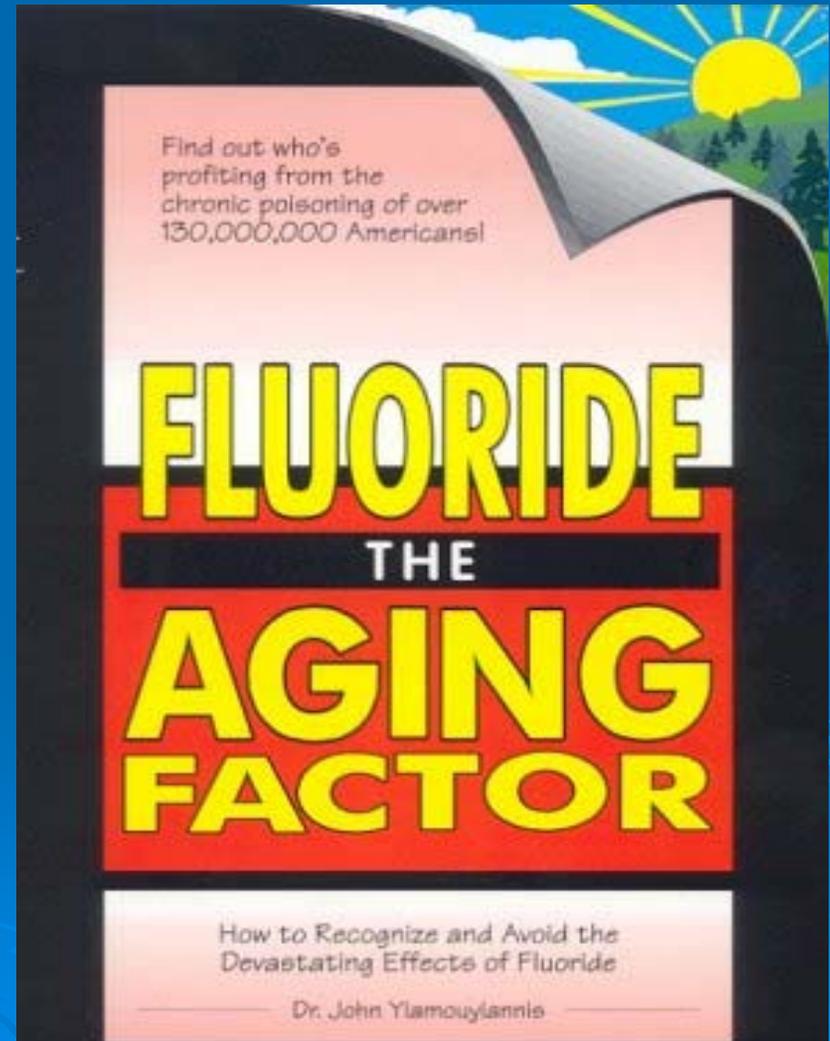
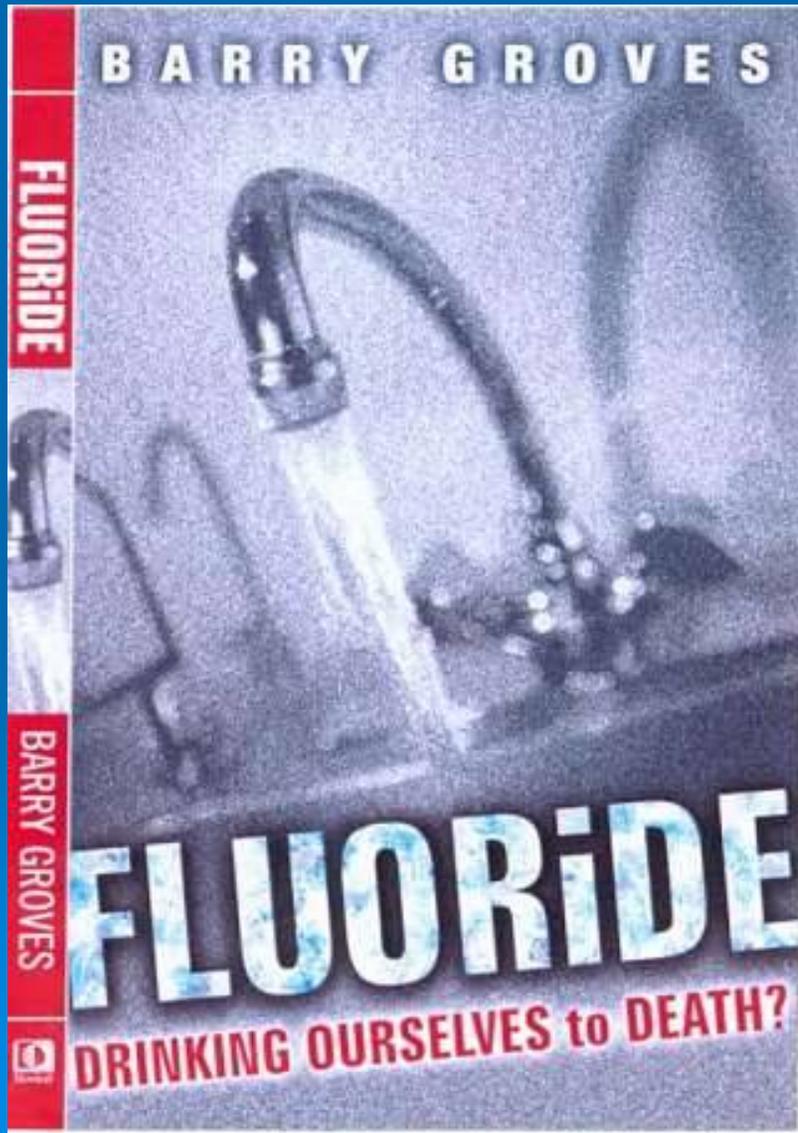


Percentage of U.S. Population on Public Water Systems Receiving Fluoridated Water



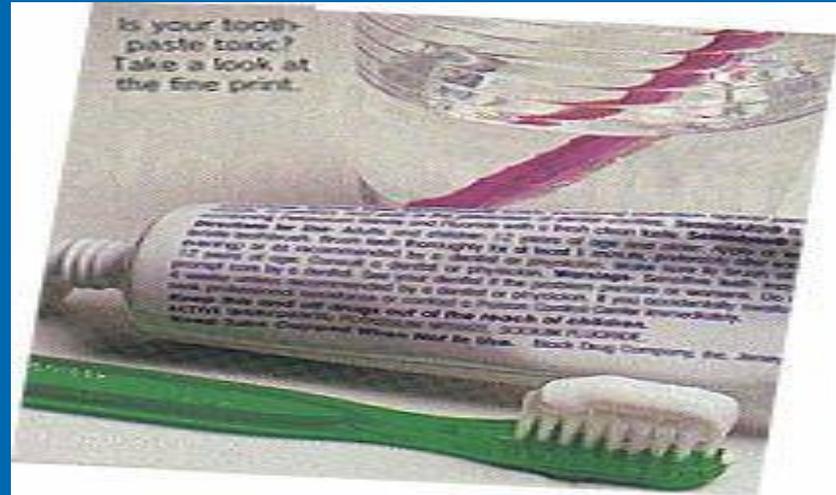
■ Fluoridated
■ Nonfluoridated

Strong Anti-Fluoridation Movement



Politics vs. Ideology vs. Science vs. Economics

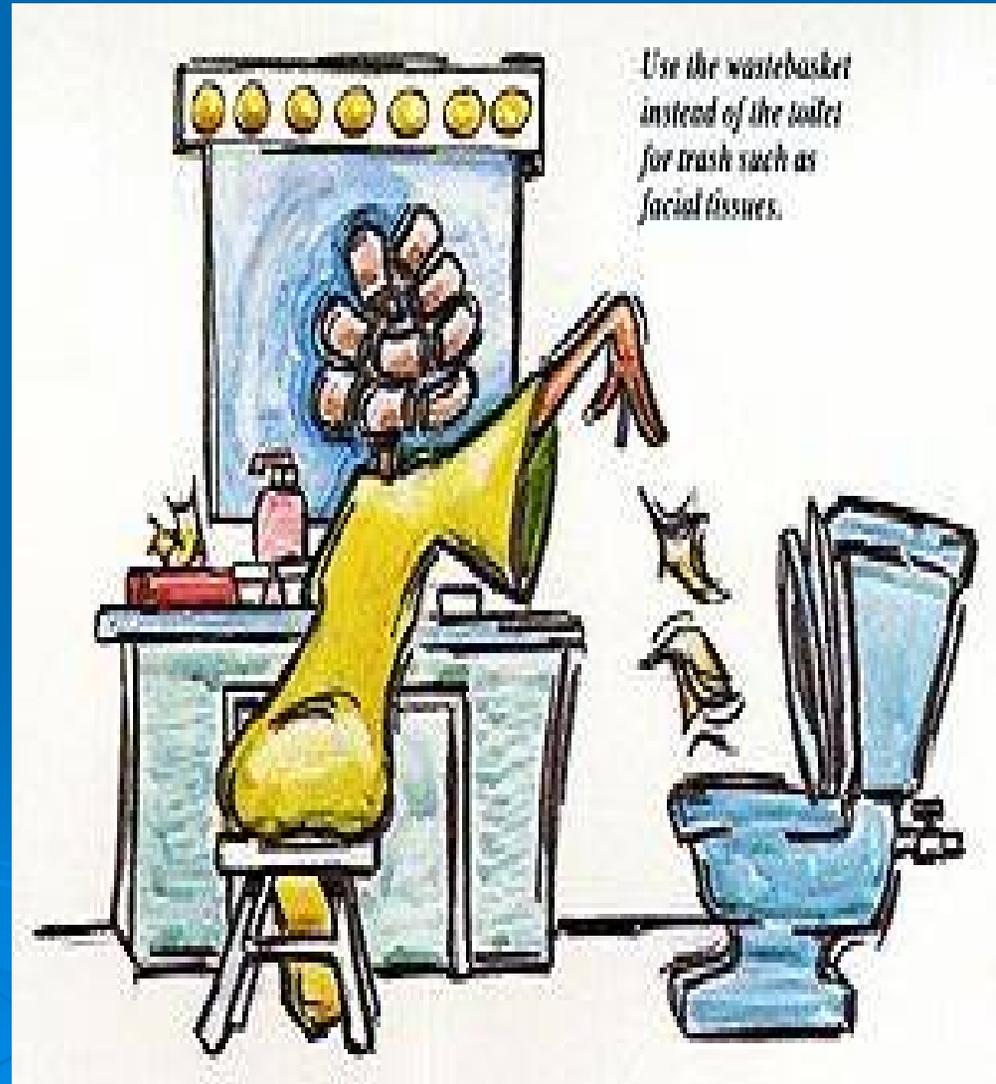
Fluoride
toothpaste
(\$1.25)



Fluoride-free
toothpaste
(\$13.50)



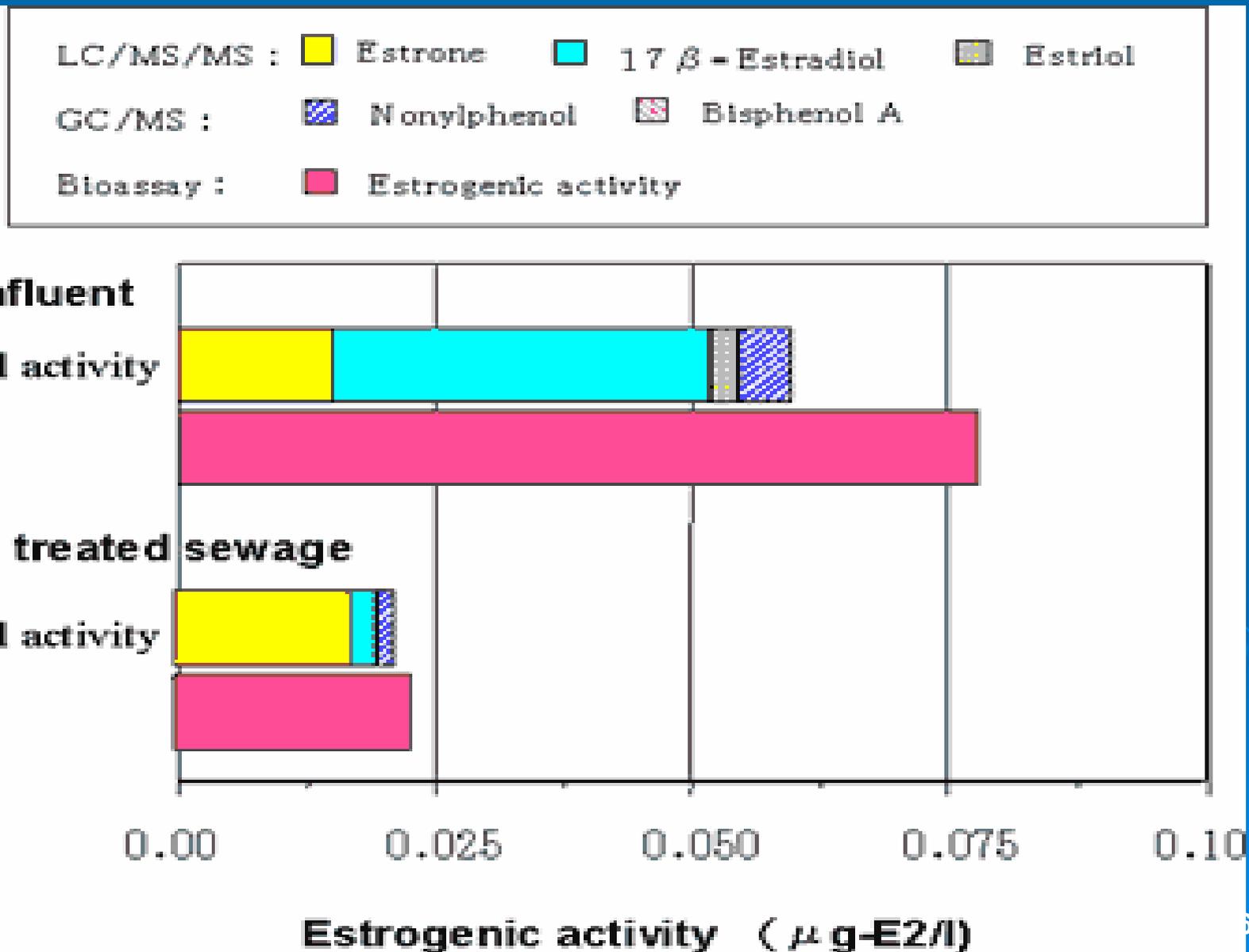
From outdoor privies to out of your site and out of your mind.

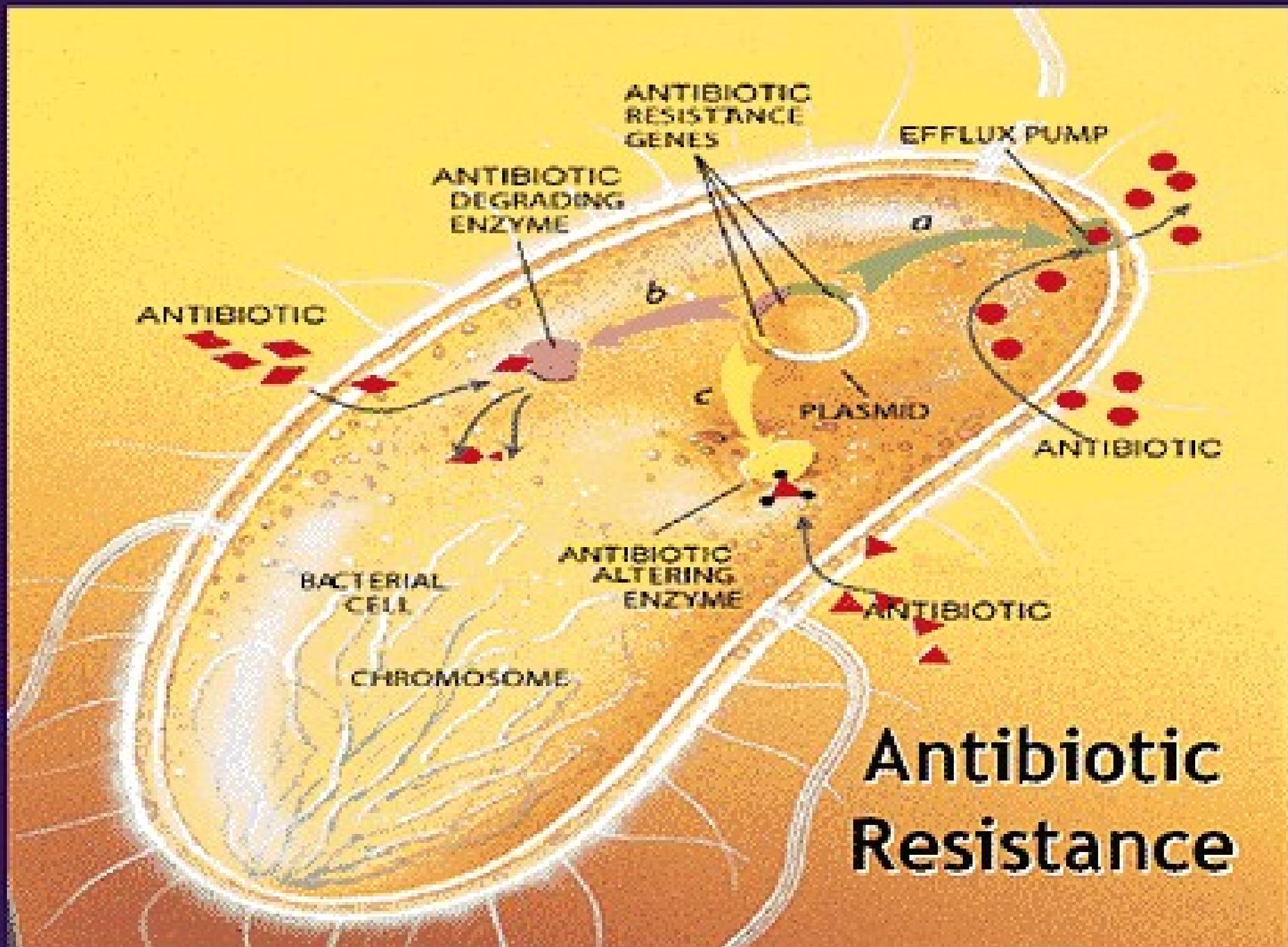


**From toilet to sewer plant to a river
and on to someone's mouth.**



Chemicals in wastewater may not be destroyed prior to stream discharge.





Antibiotic Resistance



SKILCRAFT

Dermata B

485-86-37400-0



Antibacterial
Hand Soap

ANTIBACTERIAL HAND SOAP

*Liquid soap in pouches
Cleans effectively
For use in wall mounted
dispensers*

27 FL OZ (800 ml)



SKILCRAFT

**ANTIBACTERIAL
HAND SOAP**

Chemical name: *Triclosan*
Active ingredient: *Triclosan*
Net weight: 800 ml

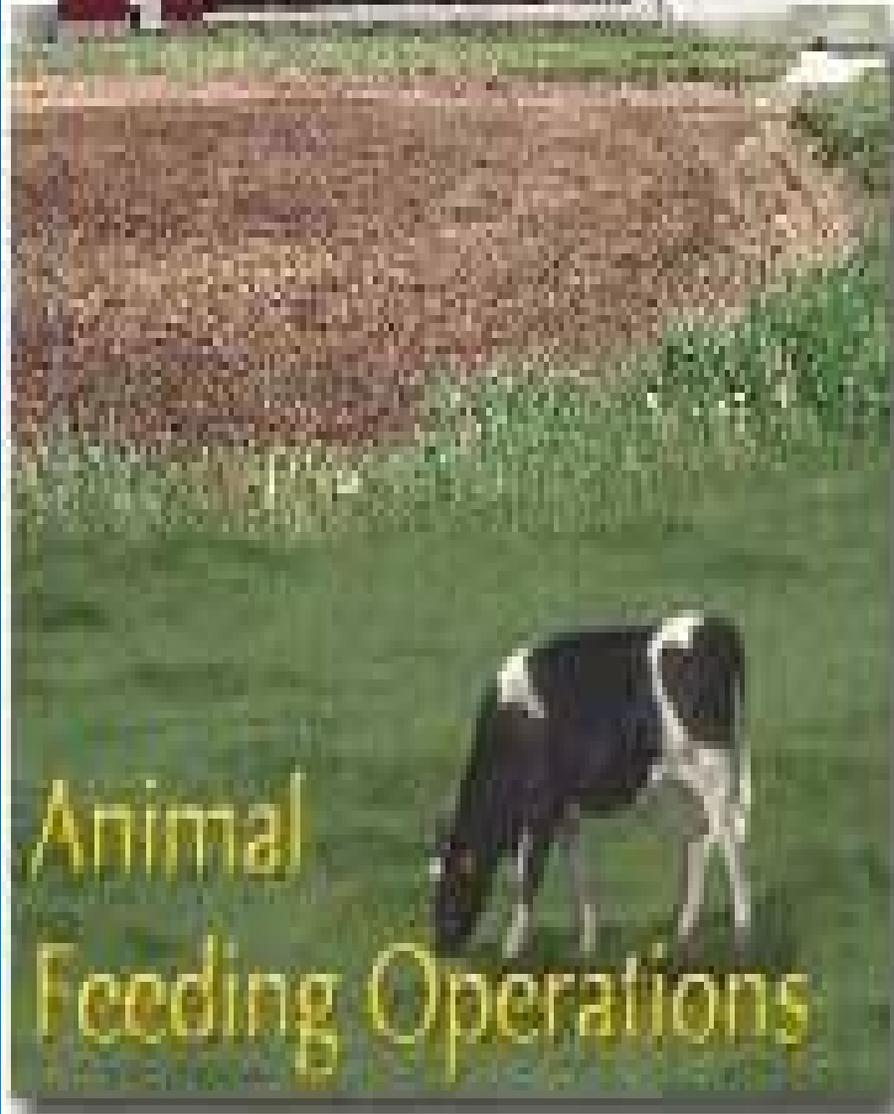
DIRECTIONS: For use in wall mounted dispensers
throughout the day.

PRECAUTIONS: Avoid contact with eyes.
If contact occurs, flush with water. Do not use
if you are allergic to any of the ingredients.
Keep out of reach of children.

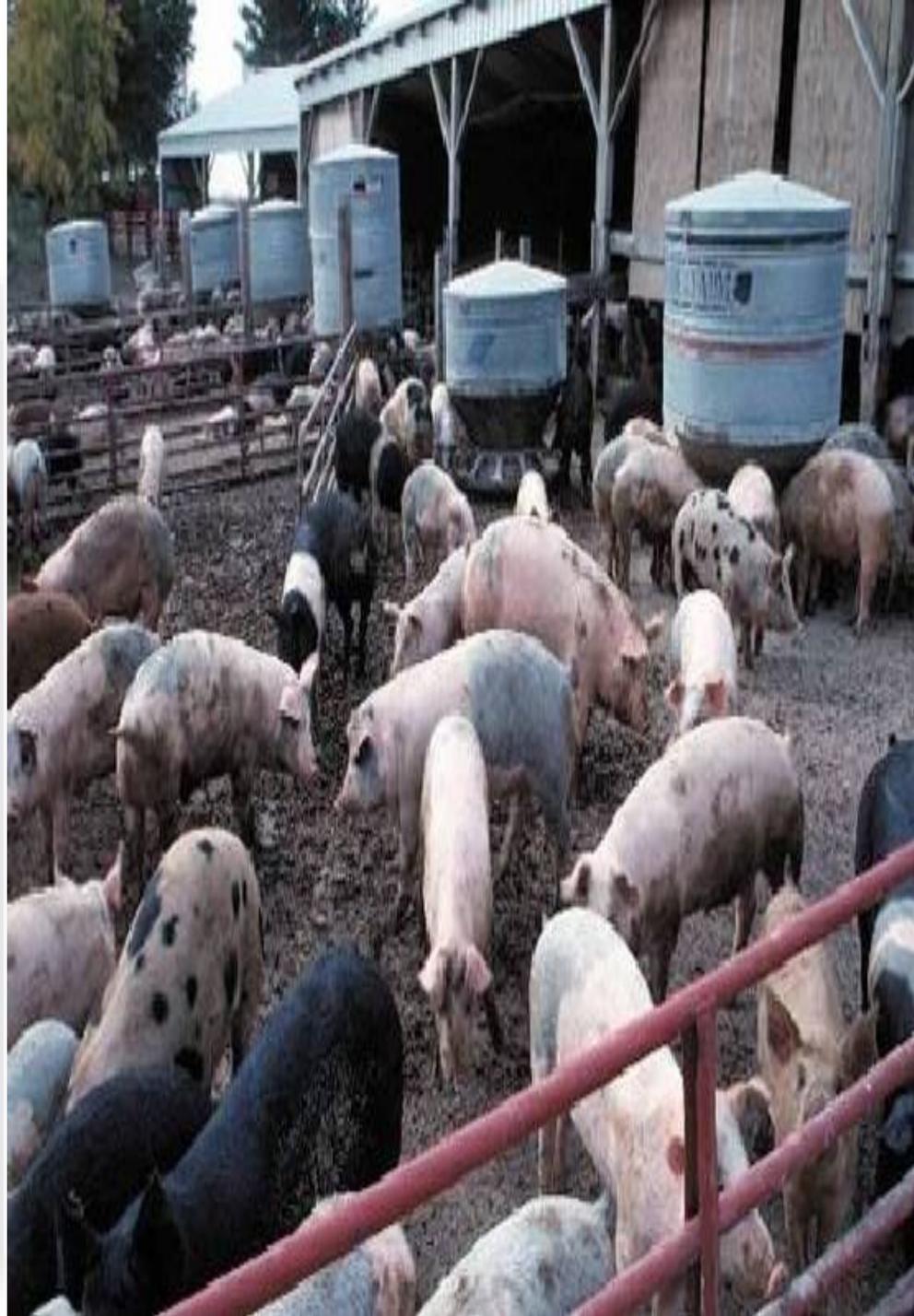
INGREDIENTS: *Triclosan*, *Sodium Lauryl Sulfate*, *Water*, *Hydroxyethyl Cellulose*, *Propylparaben*, *Sodium Chloride*, *Phosphate*, *Sodium Hydroxide*, *Perfume*.



AFOs



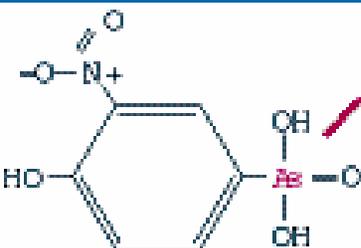
Animal Feeding Operations



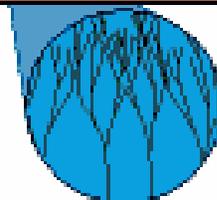
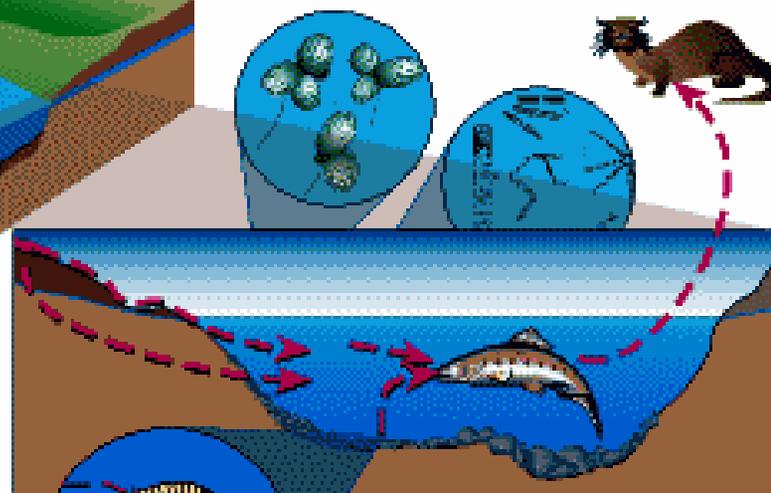
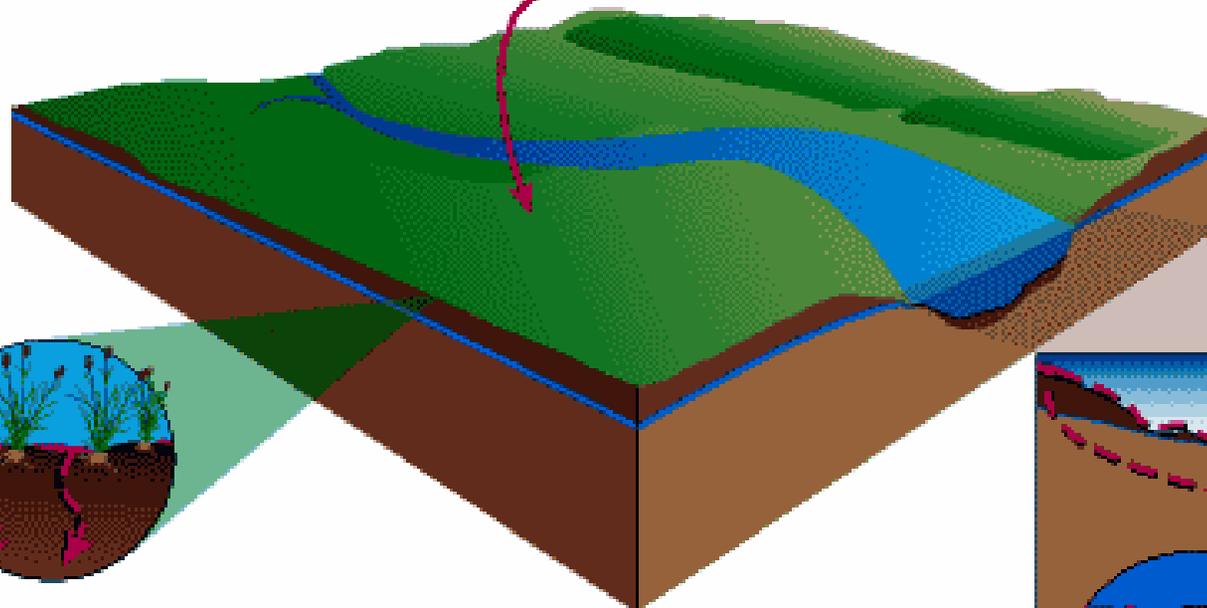


To boost the growth of closely confined swine, U.S. farmers buy feed containing subtherapeutic doses of any of 21 antibiotics.

Is arsenic in poultry litter reaching surface water sources?

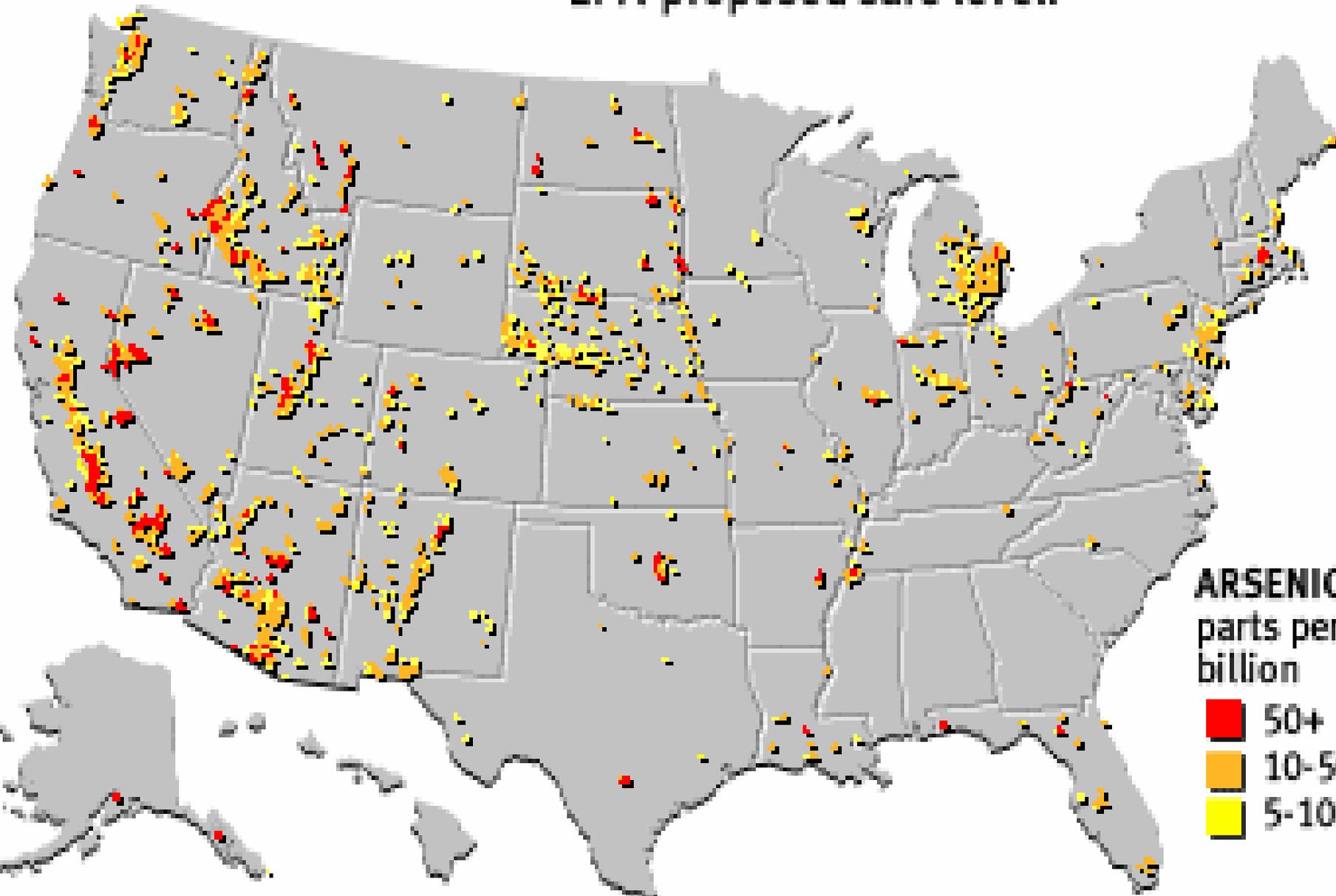


Roxarsone
3-nitro-4-hydroxyphenylarsonic acid



Tainted water

Areas with arsenic above the EPA-proposed safe level.



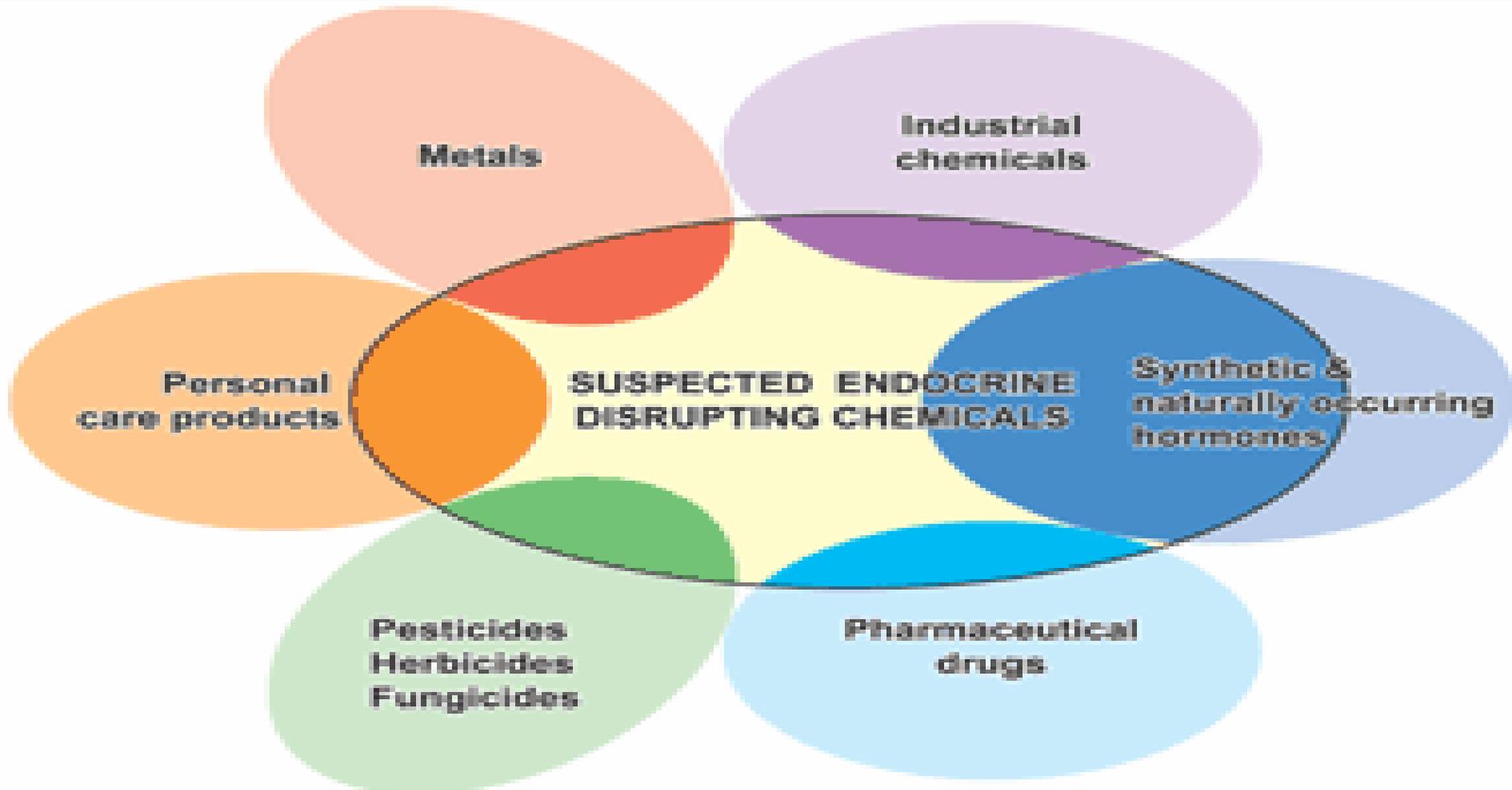
ARSENIC
parts per billion

- 50+
- 10-50
- 5-10

SOURCE: USGS

MSNBC

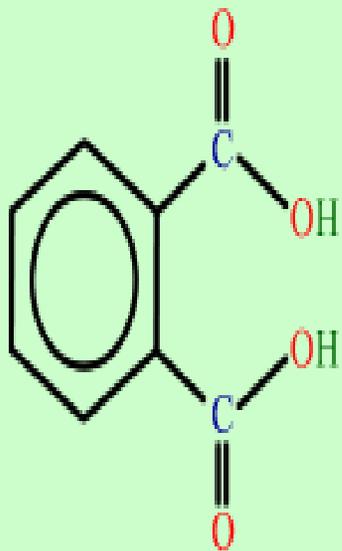
Endocrine disrupting chemicals can have impacts at very low concentrations.



Some chemicals from the "families" above are potentially endocrine disruptors

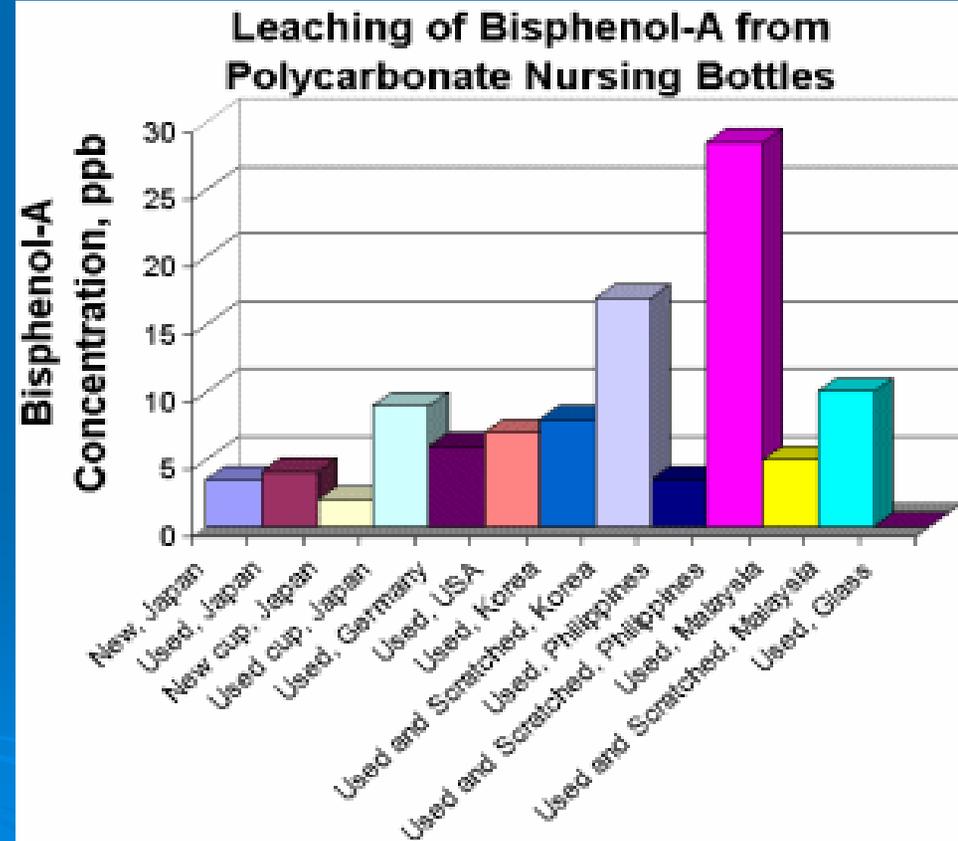
Plastics, plastics everywhere and many are potential sources of endocrine disrupting chemicals.

(50 million tons produced in U.S. in 2003)

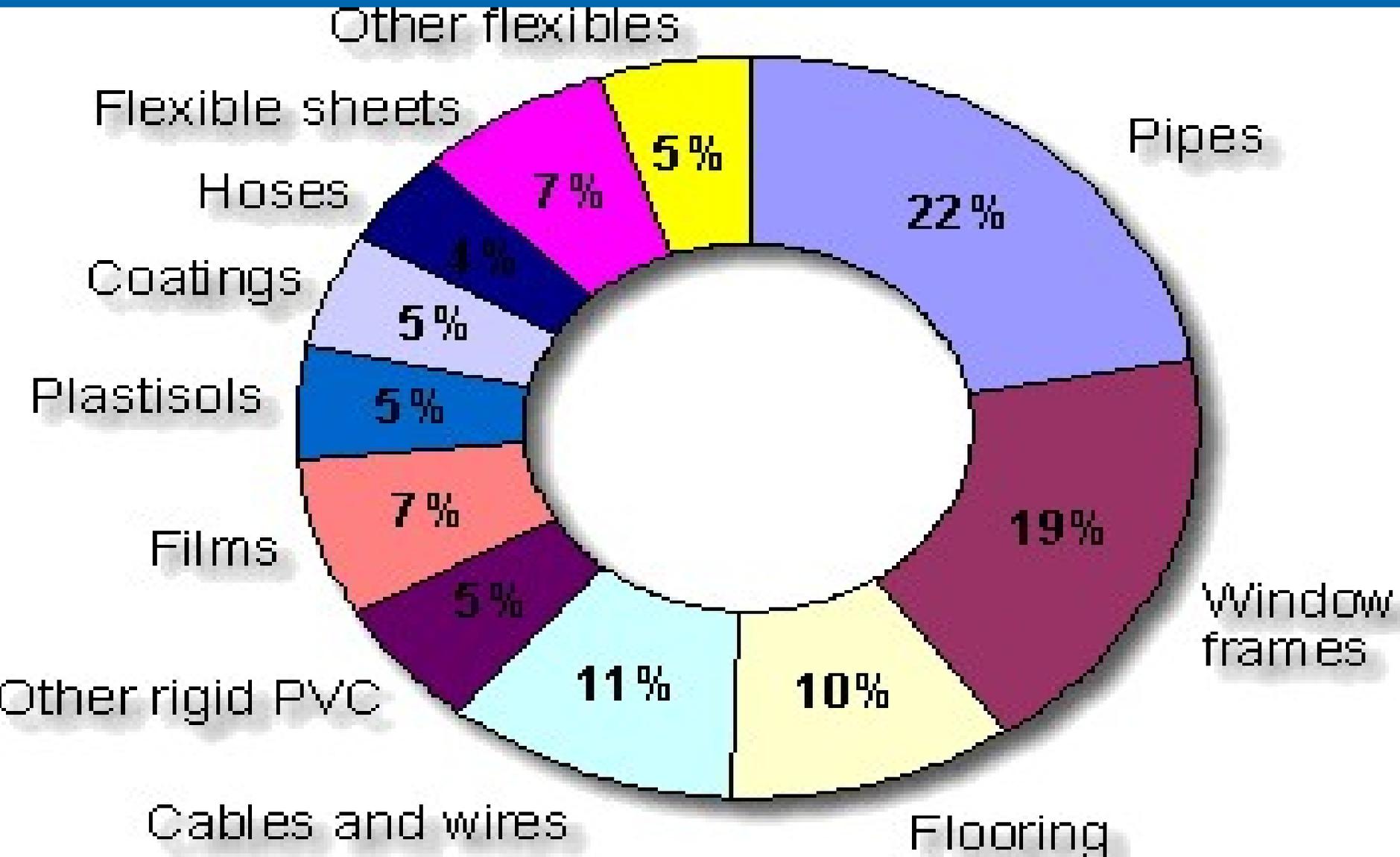


Many PVC plasticisers are esters of "phthalic acid"

1,2-benzenedicarboxylic acid
(phthalic acid)



Polyvinyl chloride is used everywhere, even in water distribution and home plumbing systems.



From Copper to Plastic and Back to Copper

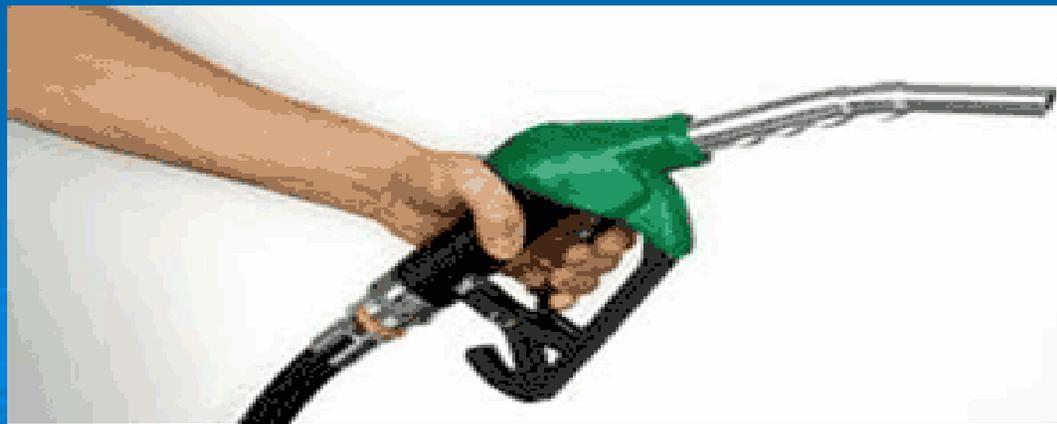
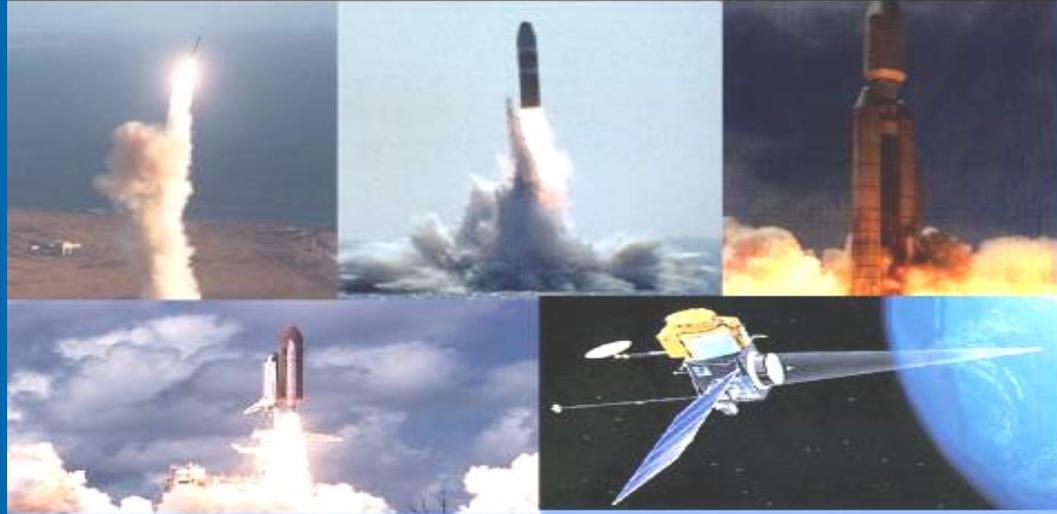


Groundwater and Fuel Product Contaminants

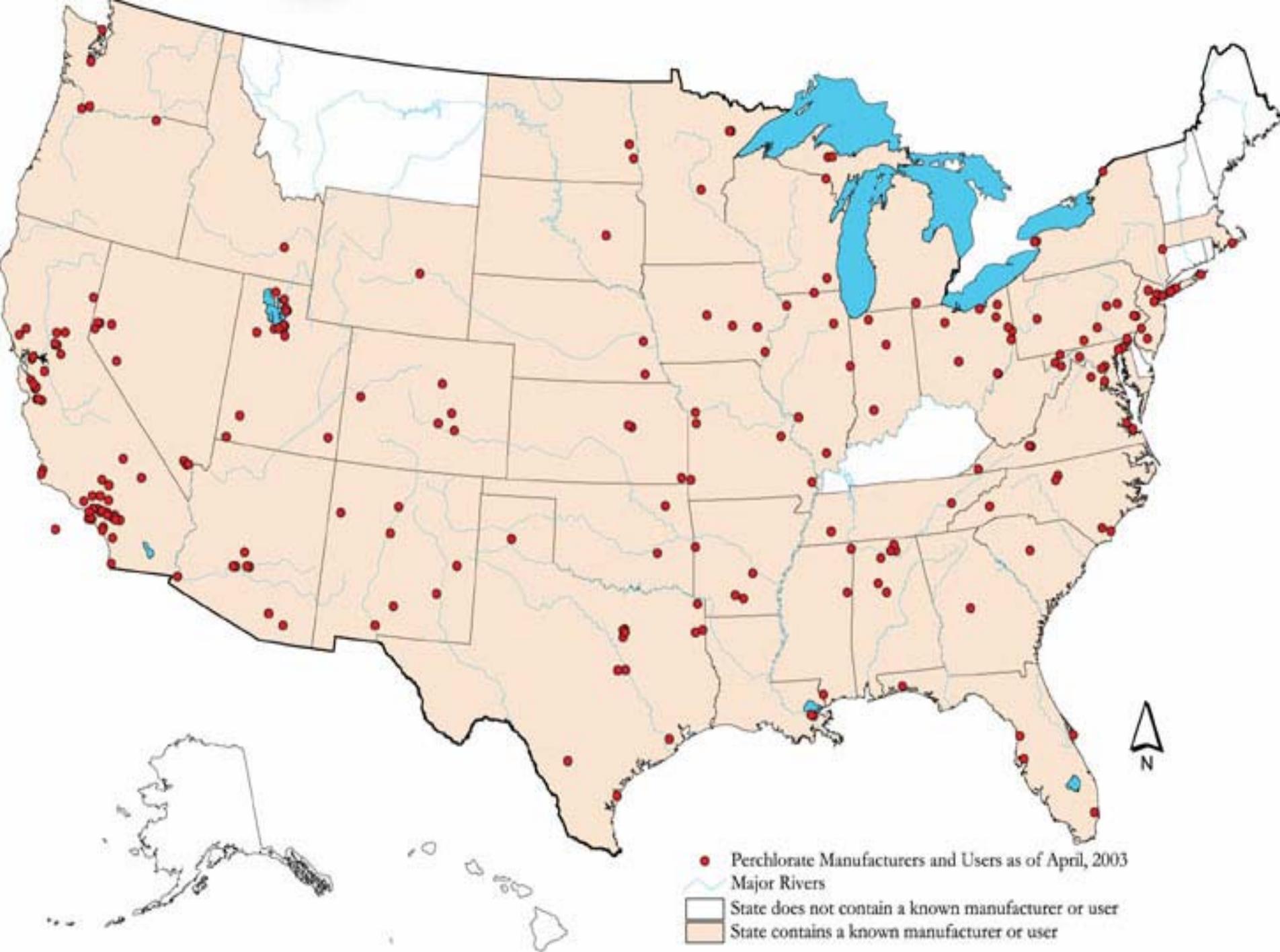
Perchlorate anion (K, Na, Ca, Mg, or NH_4ClO_4)

Methyl Tertiary Butyl Ether (MTBE)

**Ammonium Perchlorate - A National Technical Asset
Integral to Strategic Defense and Space Systems**



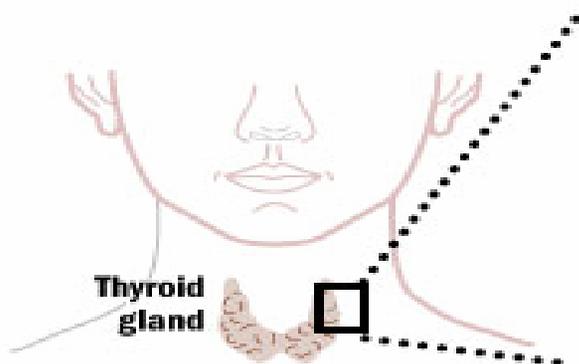
MTBE Contamination



Perchlorate: what is its potential health effect?

Perchlorate acts as an endocrine disruptor

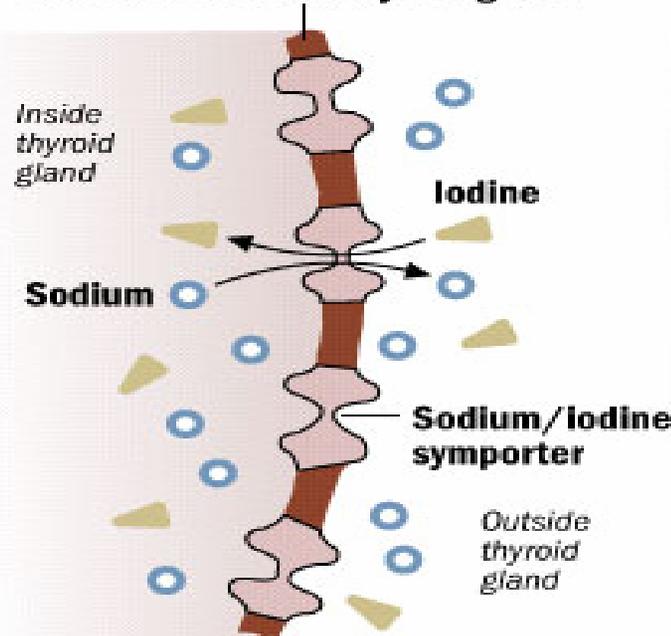
In the human body, perchlorate inhibits production of thyroid hormones, essential to normal organ development in babies, especially brain development.



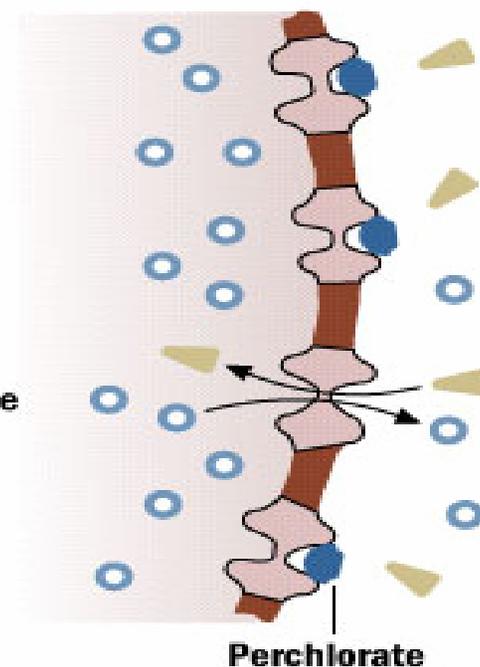
- 1** Iodide from foods, such as salt, enters the body.

Sources: Environmental Protection Agency; Environmental Working Group

Membrane of the thyroid gland

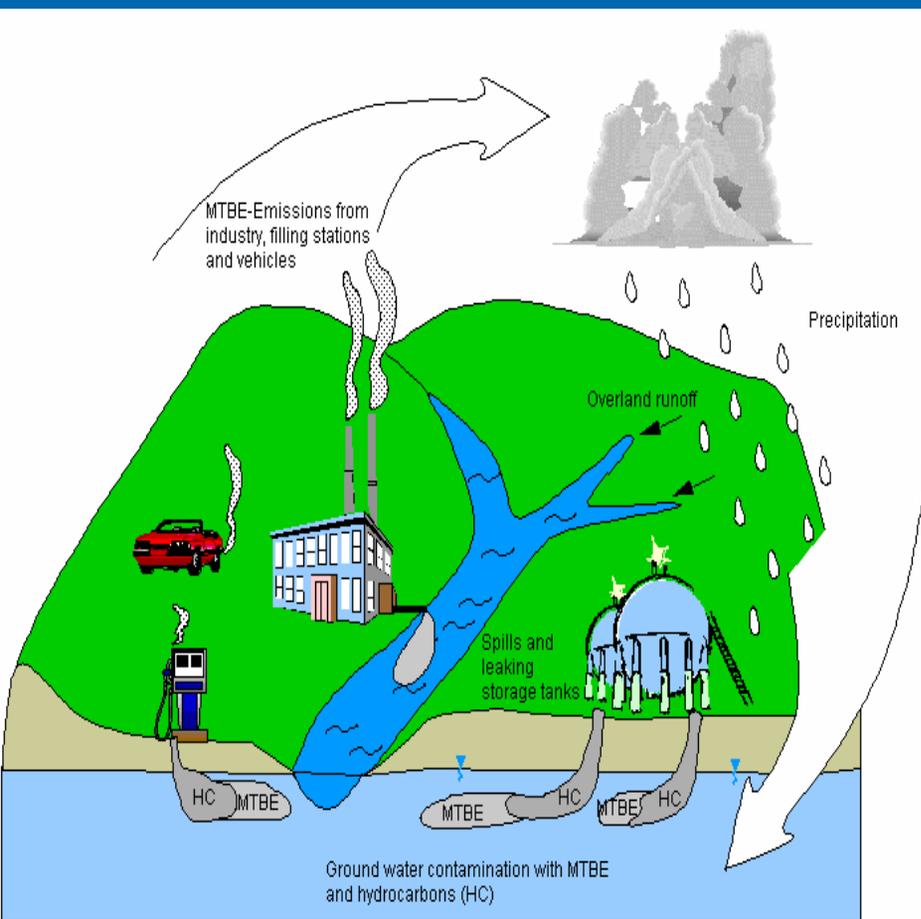


- 2** Iodide is transported into the thyroid by the sodium/iodide symporter (NIS) as sodium is transported out. The iodide is then used to produce thyroid hormones.



- 3** If perchlorate is ingested, it blocks the symporter, disrupting the uptake of iodide.

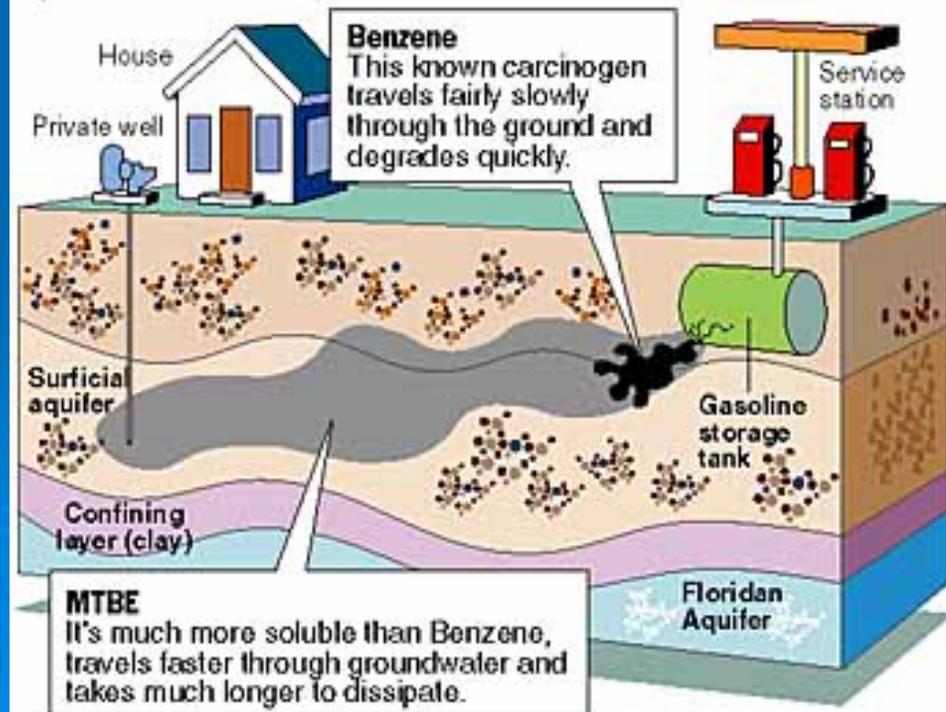
MTBE is in water everywhere but groundwater contamination is the primary concern.



Johann Wolfgang Goethe-University
Frankfurt 1999

Ironic pollutant

MTBE, an additive that makes gasoline burn cleaner, has fouled water wells in Florida and across the nation. A possible carcinogen, MTBE typically contaminates groundwater by leaking from underground fuel storage tanks. It spreads faster underground than virtually any other pollutant.

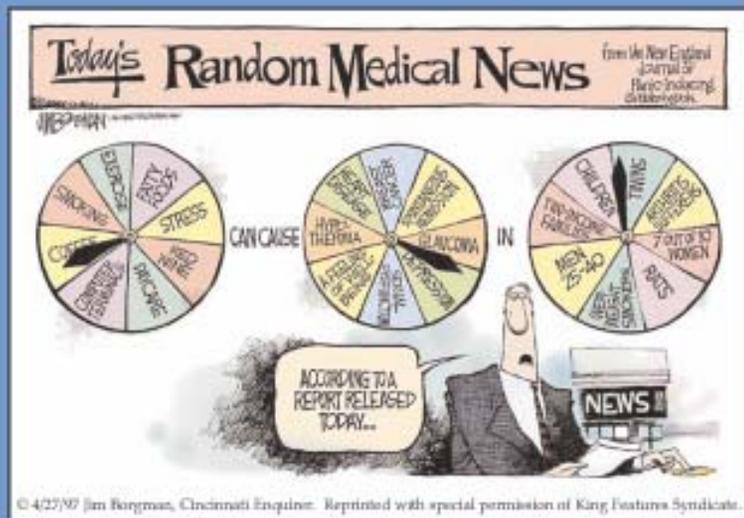


This individual was just told his drinking water contains halogenated organics.



Fear and stress cause health problems too, so understanding chemical exposure risk is important.

Confused? Overwhelmed? Worried about your health?
You're not alone....



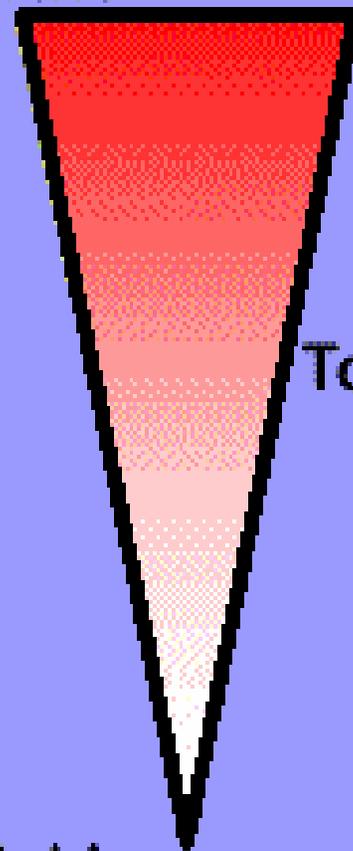
Risk In Perspective

*Insight and Humor in the
Age of Risk Management*

Dr. Kimberly M. Thompson

Harvard School of Public Health

High risk
Unacceptable

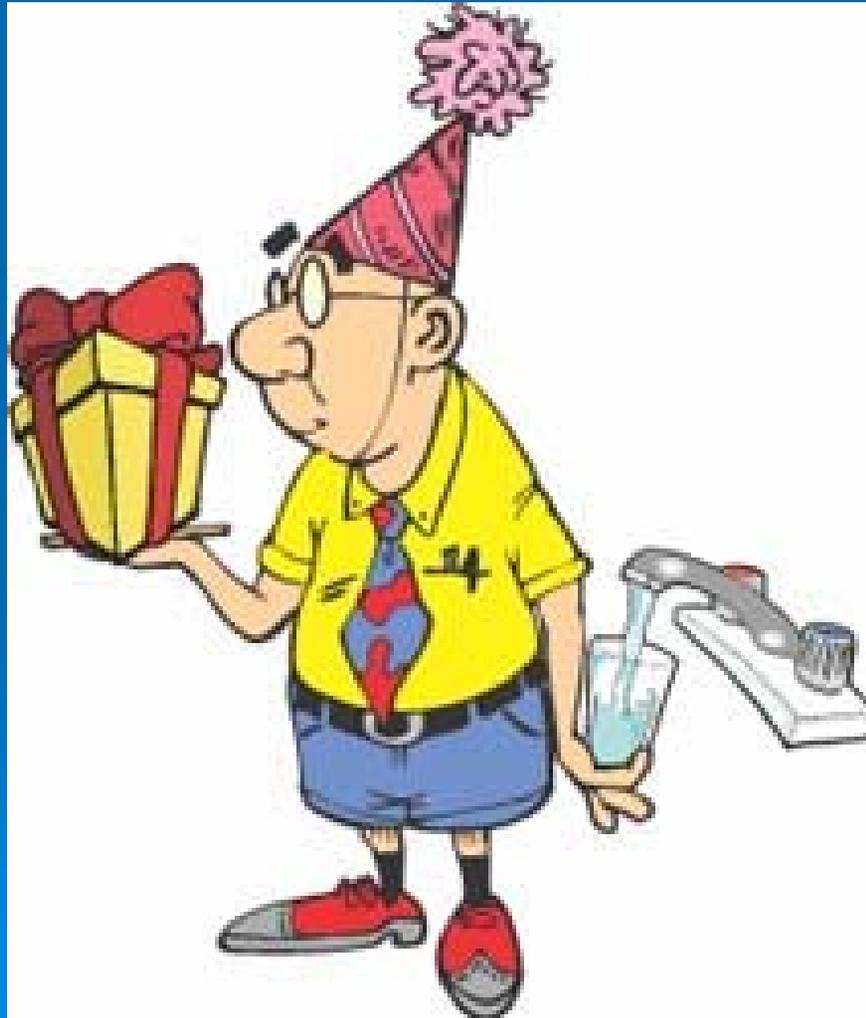


Tolerable

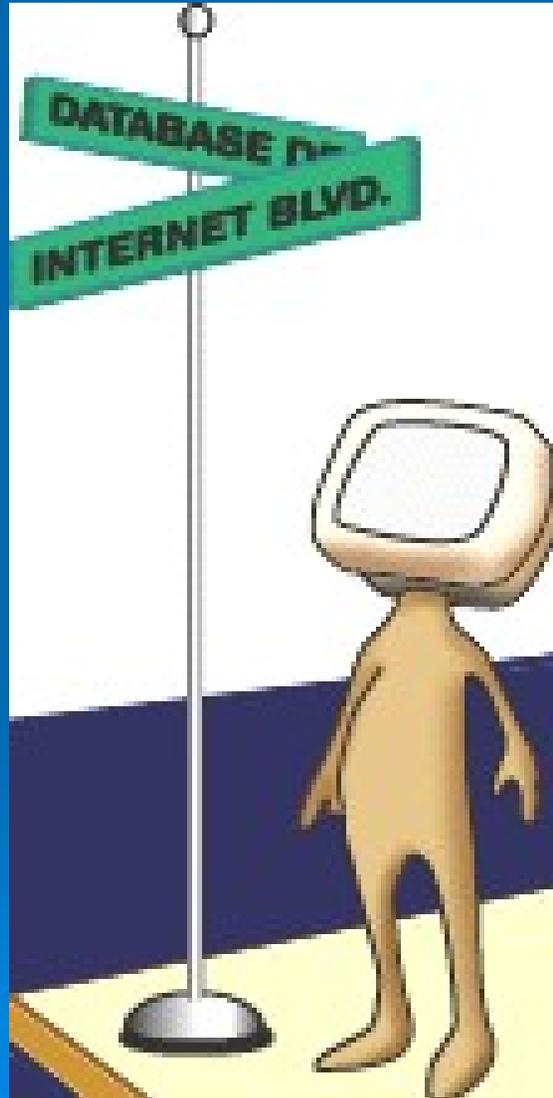
Acceptable

Negligible risk

6. Consumer Drinking Water Scams

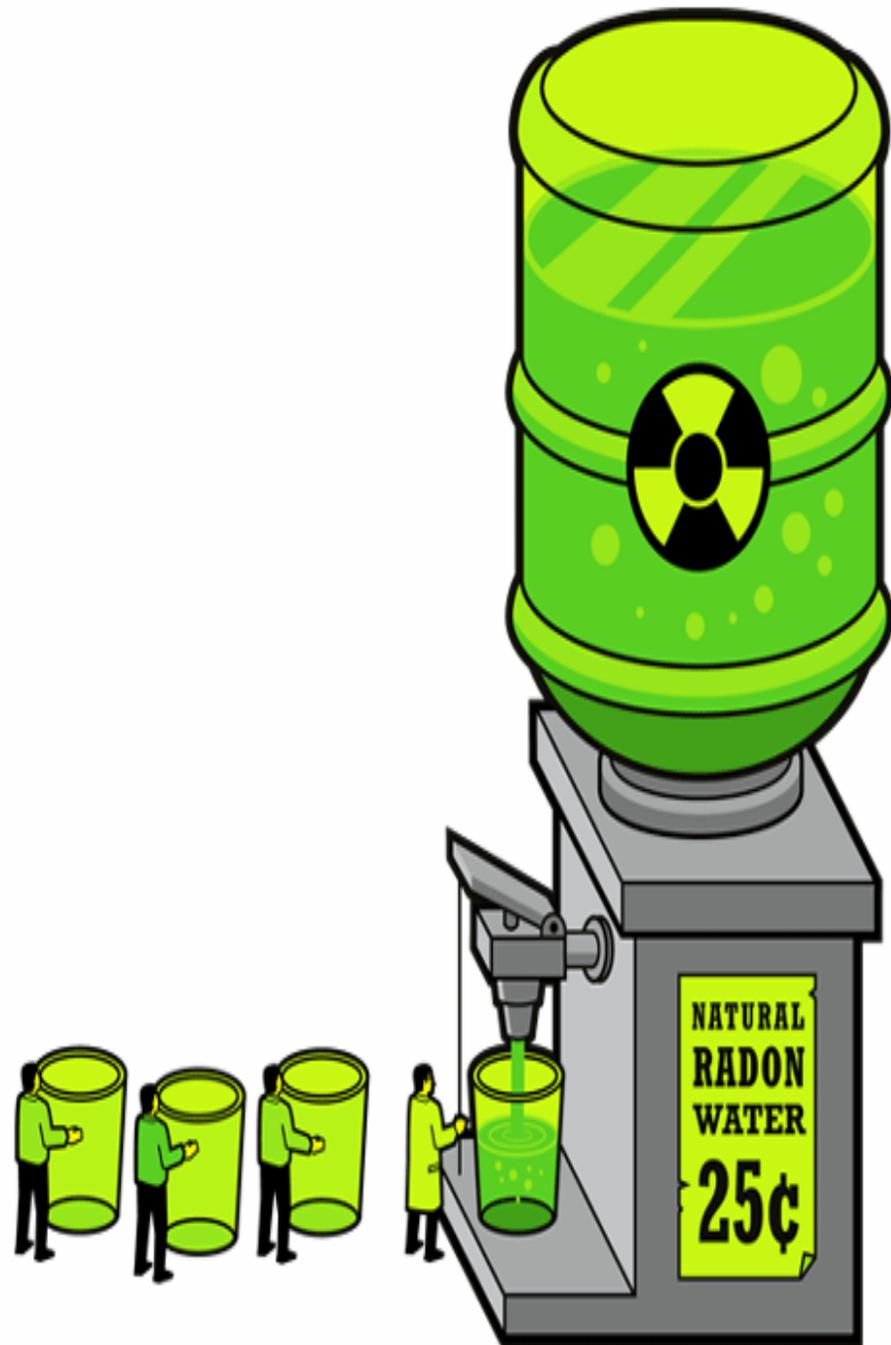


Many Scams Now Internet-Based



Radiation is natural
so exposure was
once considered
beneficial to one's
health.

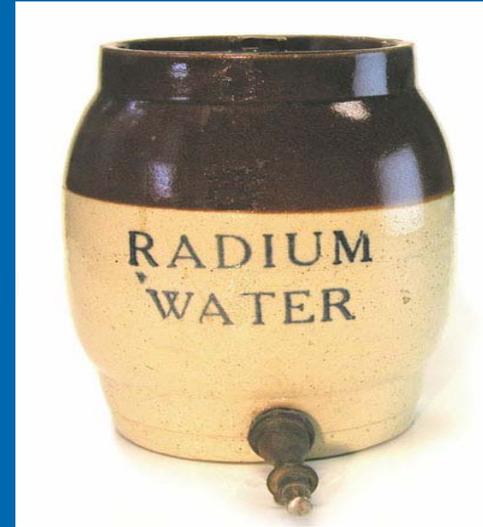
For that healthy glow
drink radiation was
once a very popular
slogan.



From Hot-Springs Therapy to Radium and Radon Water



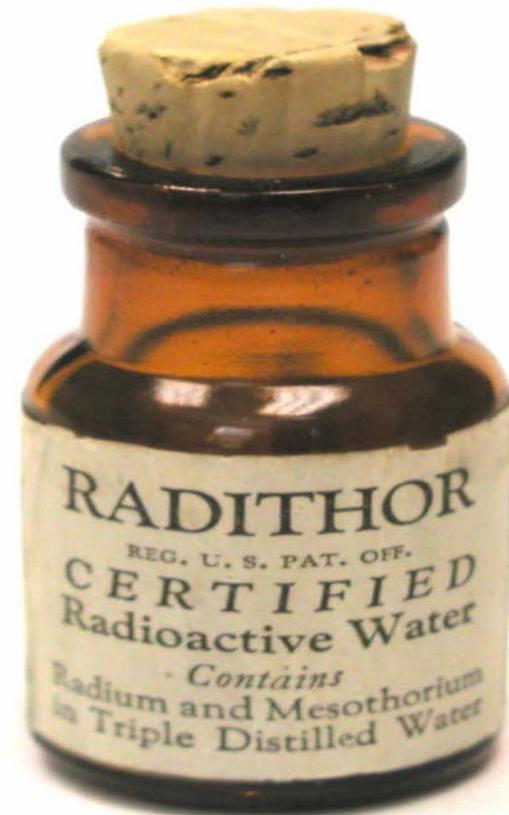
Radon or Radium Water Treatment Devices



Radium Water from Pills



Radon Water from Liquid Concentrate



The first bottled water scam may have been water sold to be radioactive that was not. (half-life of **radon** is just 3.8 days)



Modern Day Drinking Water Scams

- **Associated with bottled water**
- **Associate with health quackery nonsense**
- **Associated with water treatment**
- **Associated with water testing**
- **Associated with water supply**

Types of Bottled Water Scams

- All bottled water is not a scam
- Fraudulent vendor claims are scams
- Deception by sales persons are scams
- Special formulations are often scams



Bottled Water—the Good

- It is convenient and portable
- It is a good diet drink
- Healthier than many drinks containing sugar, caffeine and other additives
- Fits special niches (some are scams)



Bottled Water—the Bad

- Very expensive in comparison to tap water
- Does not necessarily taste better than most tap water
- Not necessarily safer than most tap water
- Some niche uses are scams
- Associated with health quackery scams
- Associated with marketing scams



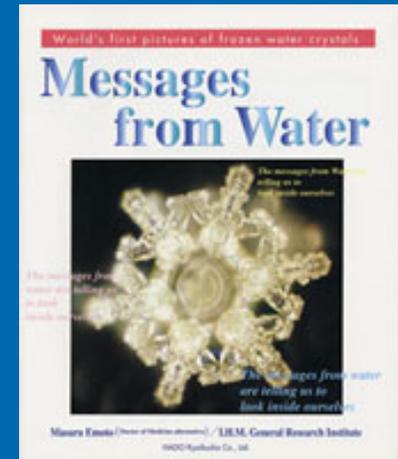
The
GREAT AMERICAN
Water Taste Test
National Rural Water Association



Water and Health Quackery

Bottled water is tied to many health quackery scams

- Structure-altered or clustered water
- Special oxygenated forms of water
- Specialized mineral waters
- Alkaline, ionic or ionized water
- Special energized forms of water
 - ✓ Treated with magnetism
 - ✓ Treated with some form of light
 - ✓ Treated with sound waves
 - ✓ Treated with electricity in some way
 - ✓ Treated with a special catalyst
 - ✓ Naturally occurring (some remote area)

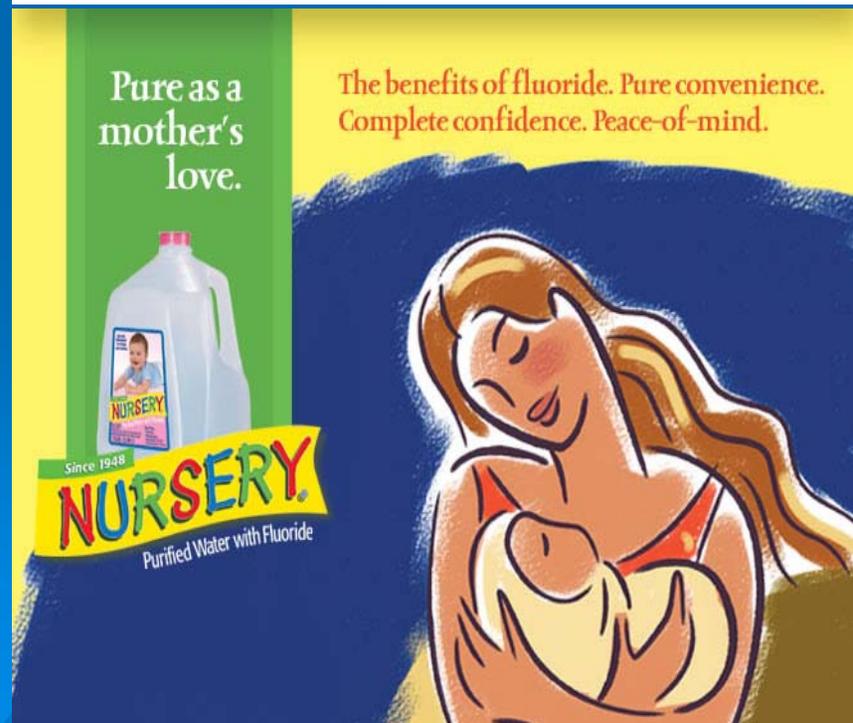


Bottled Water Health Quackery Scams

Oxygenated water nonsense

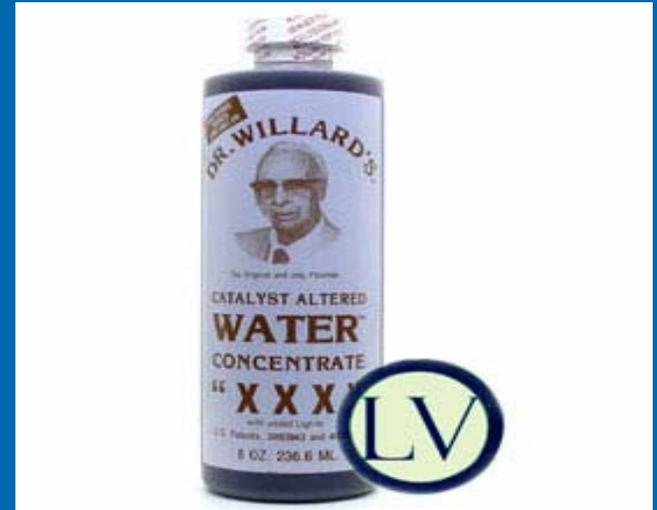


Fluoridated water for babies: Is it a scam?



Homeopathy: Water to Cure Every Disease

More health quackery nonsense—catalyst altered or special memory water.



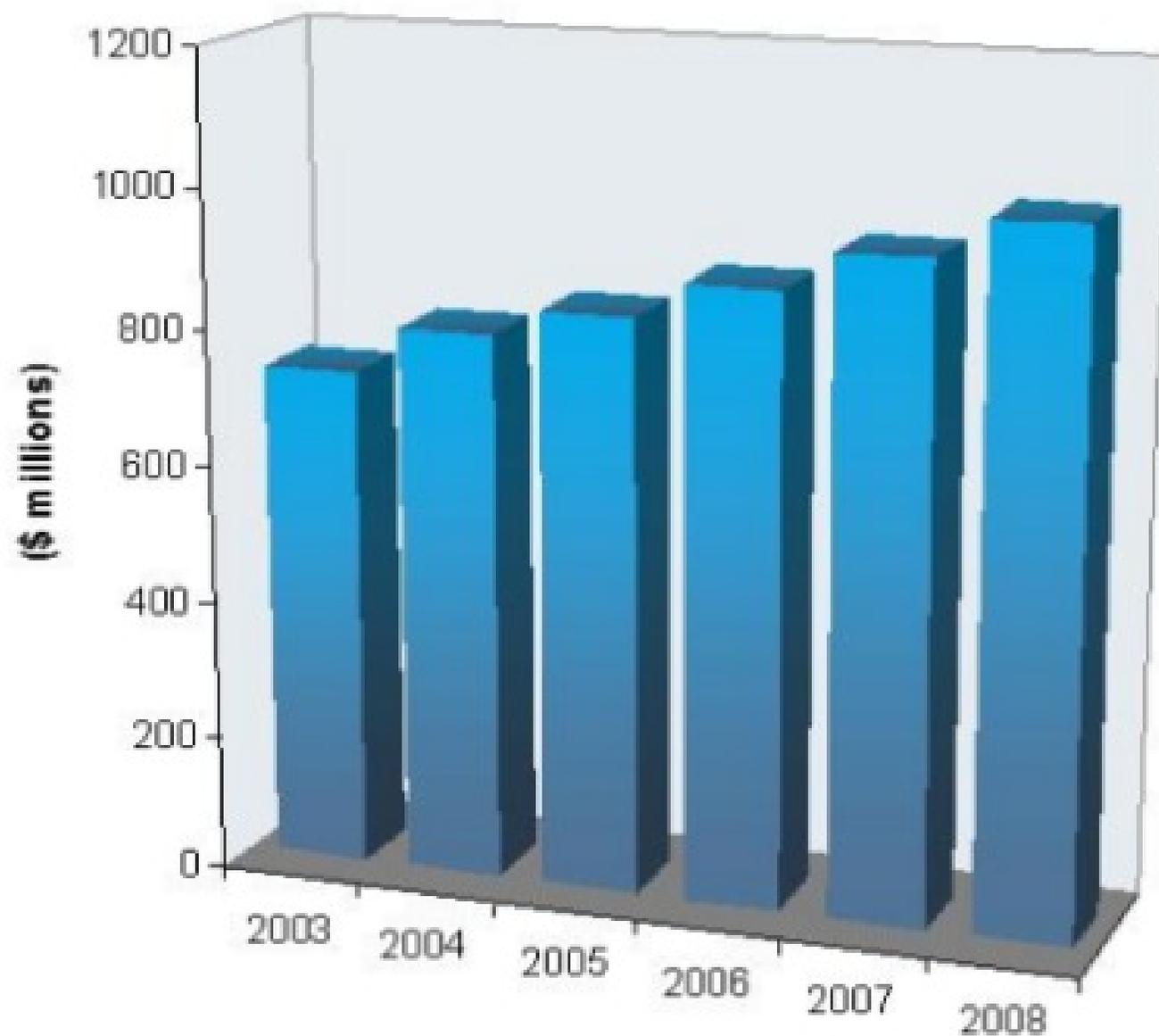
Two Categories of Home Water Treatment Scams

1. Those convincing consumers to purchase treatment devices that do not work
2. Those convincing consumers to purchase treatment devices they do not need

NOTE: There are scams associated with remedying both health and nuisance problems.

Chart 1:

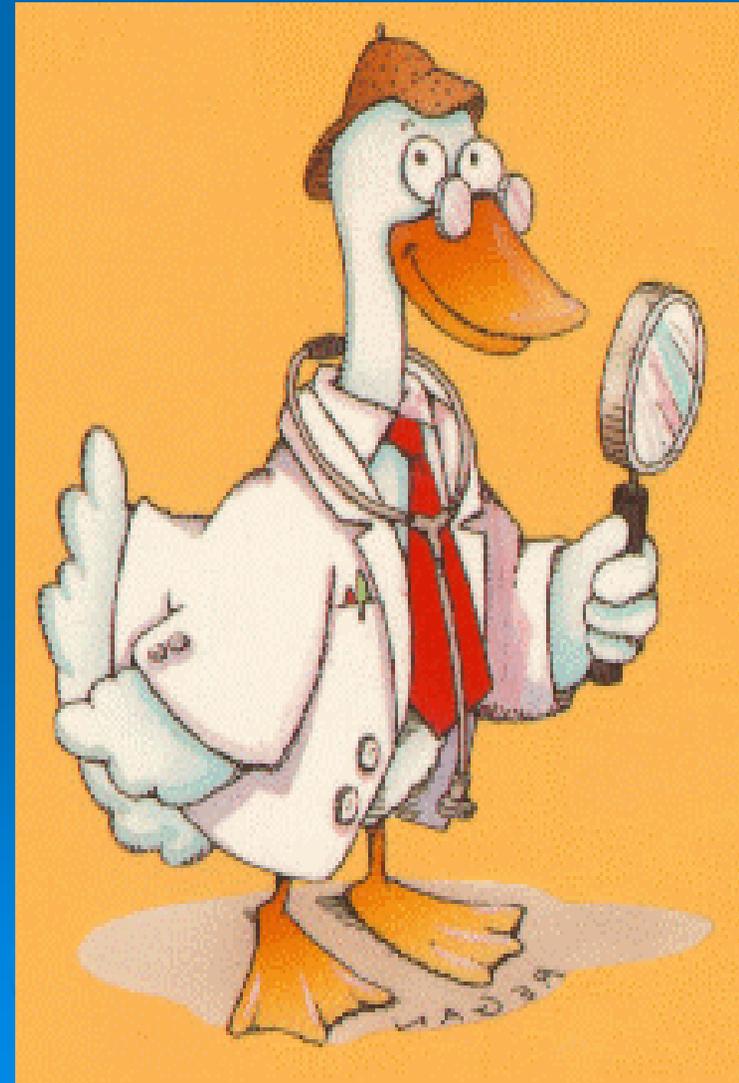
Residential Water Treatment Equipment Market: Revenue Forecast (US), 2003-2008



Source: Frost & Sullivan

Home Treatment Health Quackery Devices

- **Devices that produce oxygenated, super-oxygenated or antioxidant water**
- **Devices that produce special structure-altered or special clustered water**
- **Devices that produce alkaline or ionic forms of water**
- **Devices that produce water with some special form of energy or other magical properties**



Oxy-Plus Water Treatment Devices



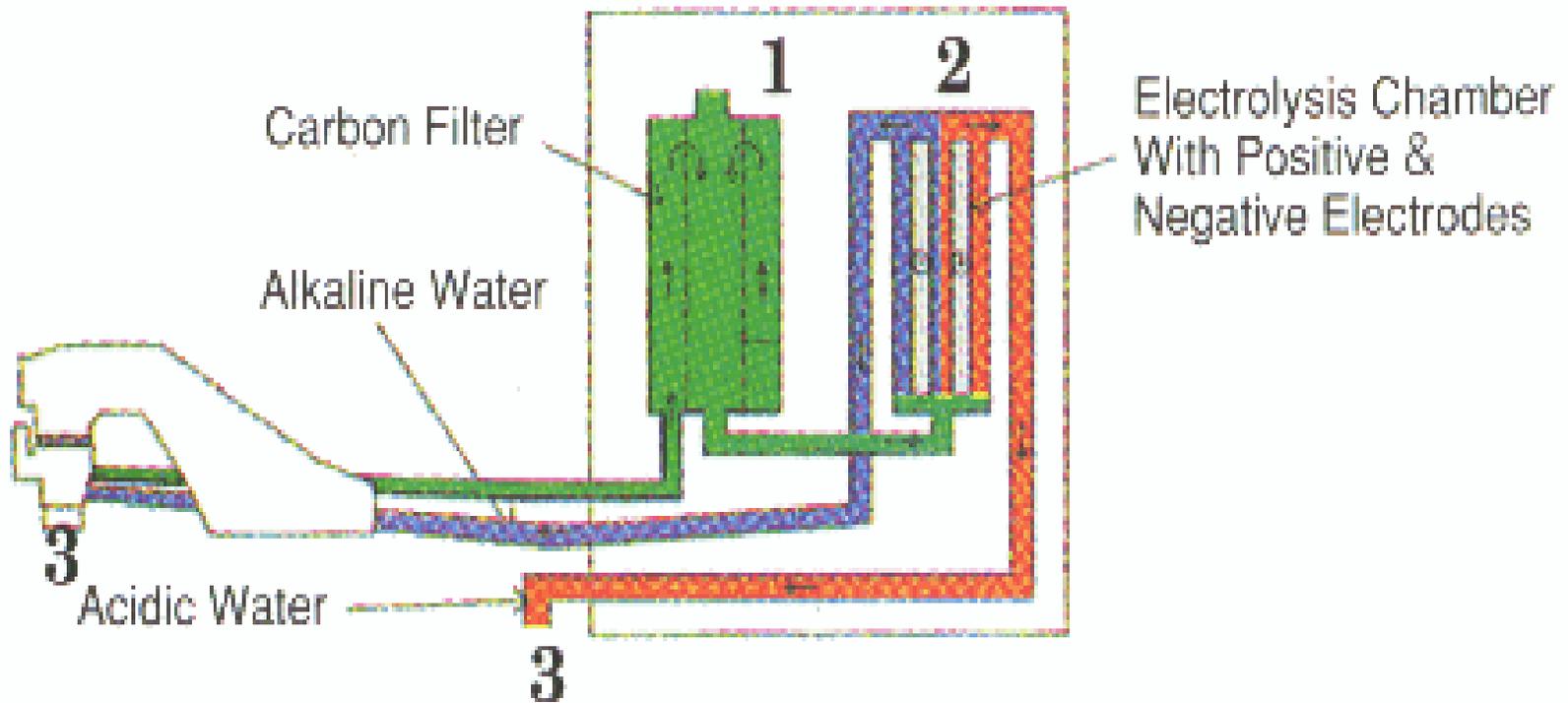
Devices for producing water with micro-clusters



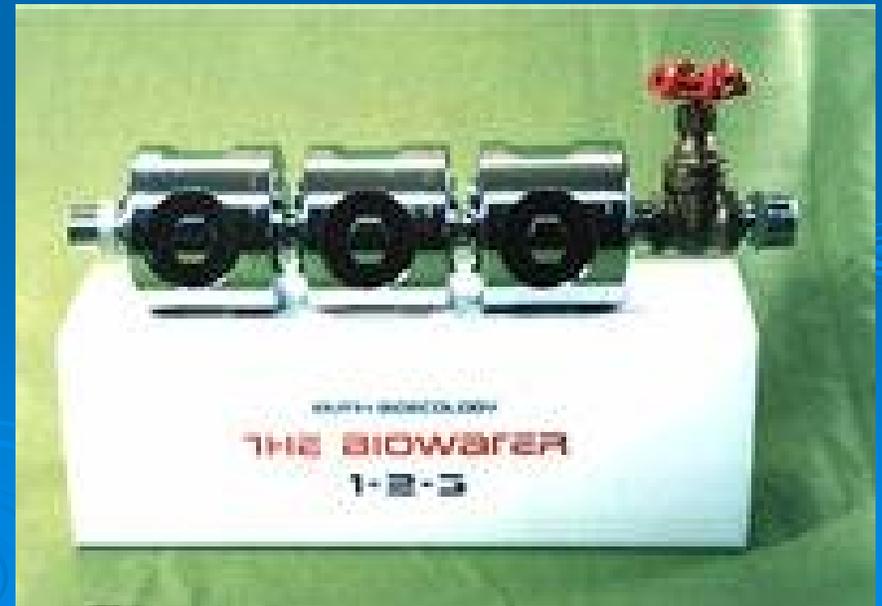
Ion Bunk H_2O dot con "ionized" and alkaline water: snake oil on tap



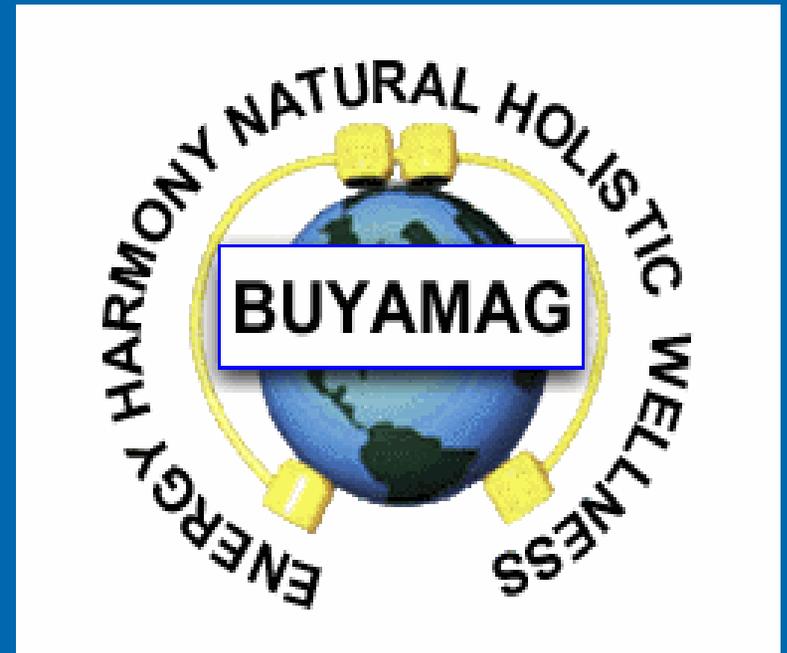
Ionizer for the Faucet



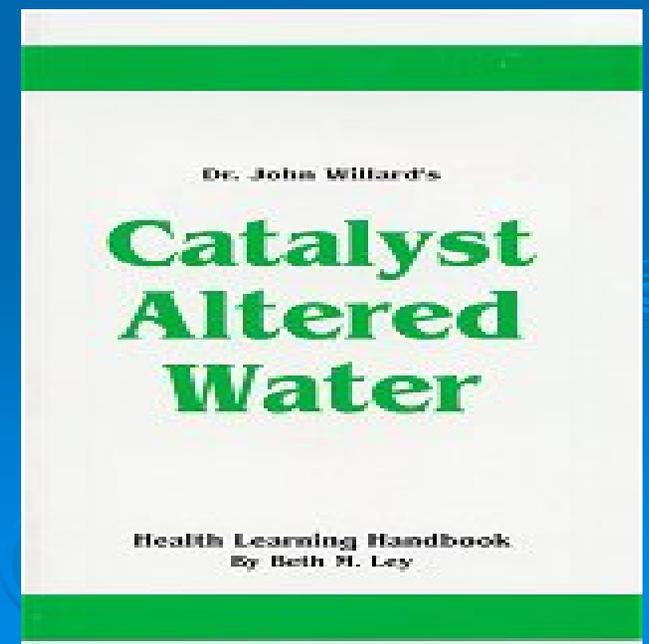
There are several opinions as to just what bio-water is. The main thing is that it is a scam.



The magic of magnetism



Catalyst altered water



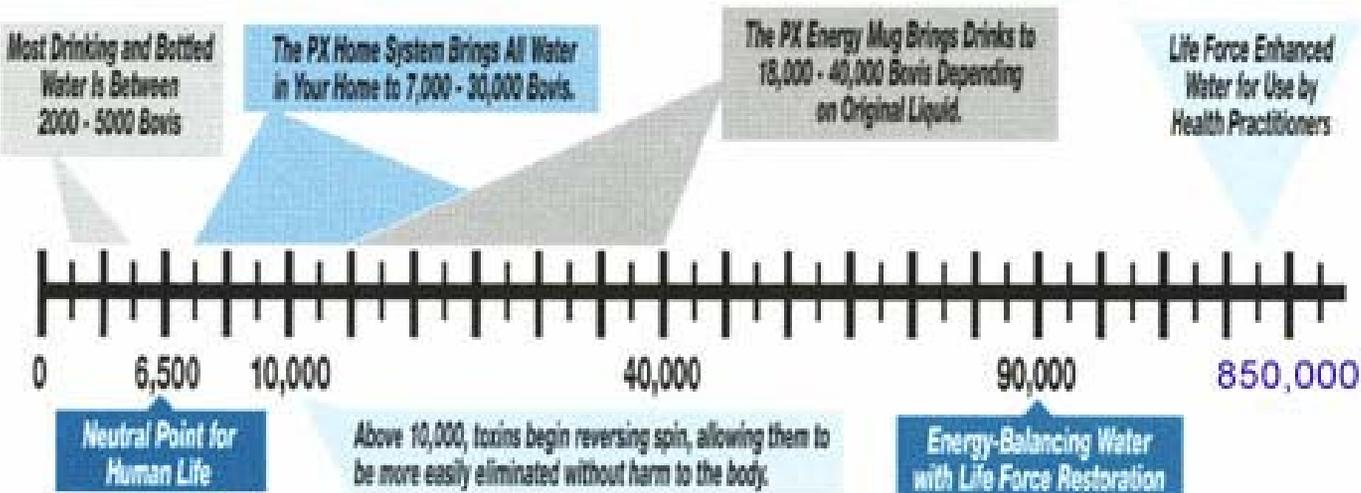
Magnetic Nonsense



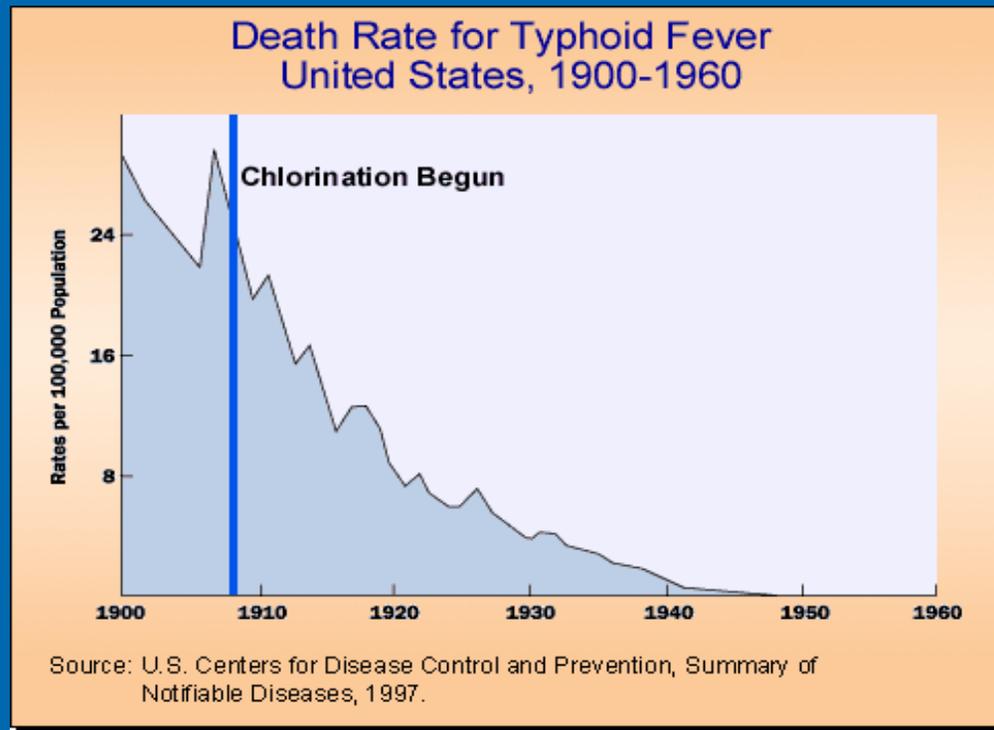
Specially Energized Water



The PX ENERGY MUG and the LIFE FORCE or BOVIS SCALE



Scare Tactics: A way to sell home water filtration systems.

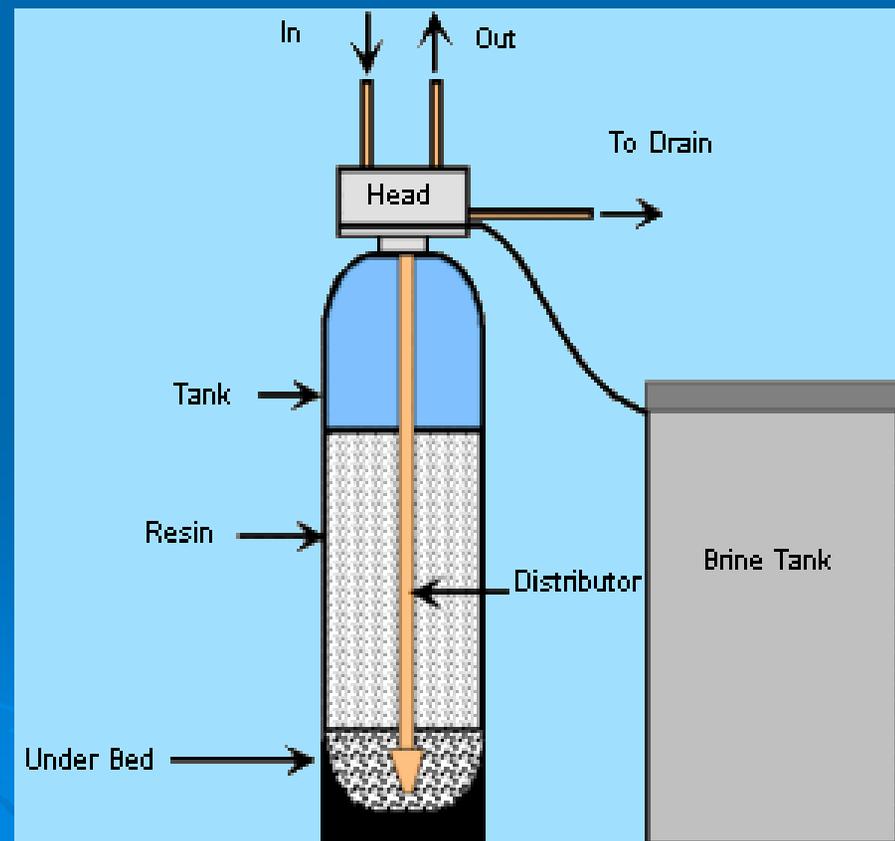
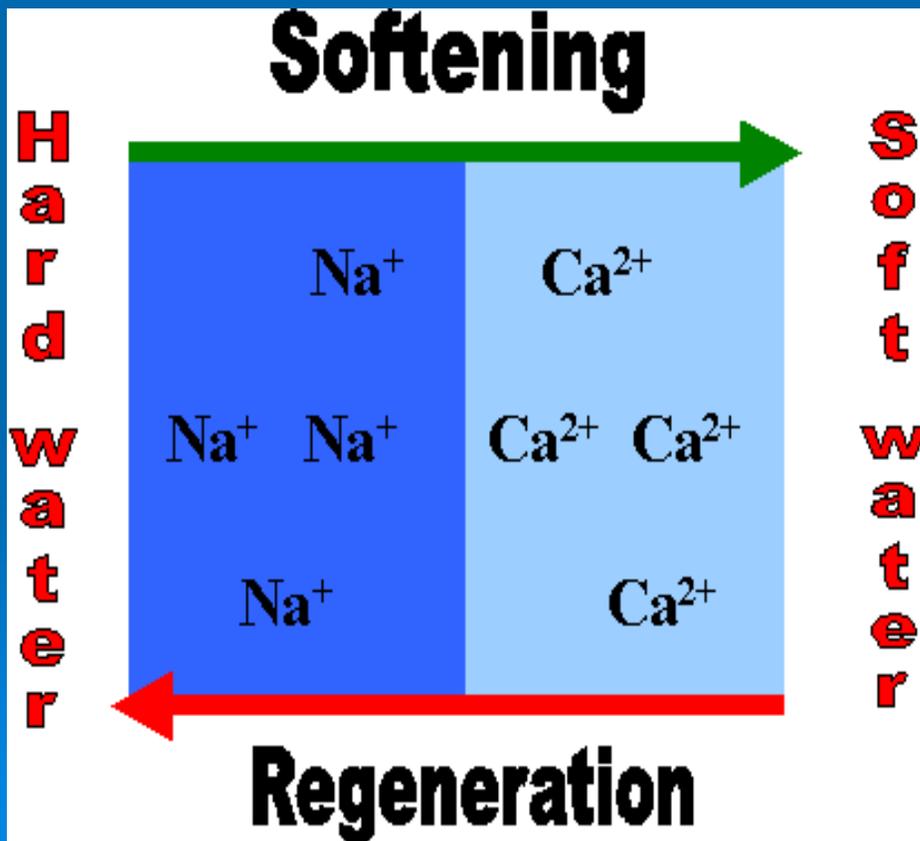


Be Wary of Water Testing Scams

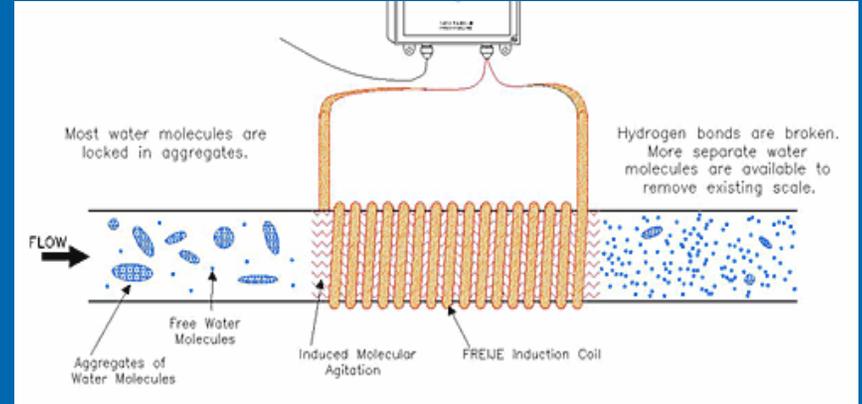
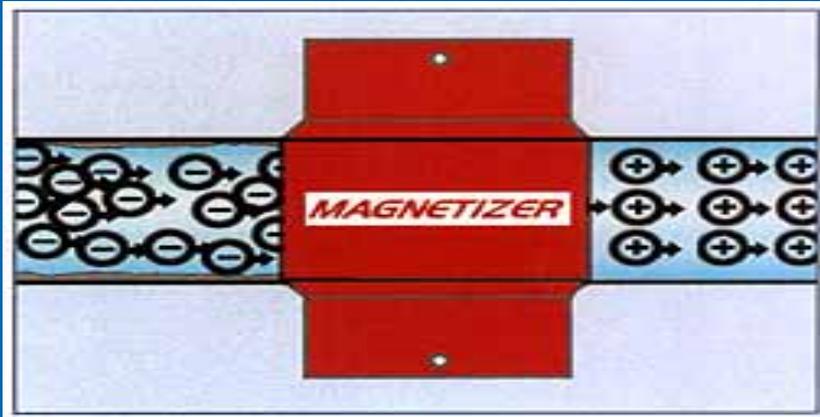
1. On-site demonstration tricks
2. Misinterpretation of lab test results
3. Fake lab test results



Softening requires removal or reduction of divalent cations in solution. Water conditioning is not water softening.

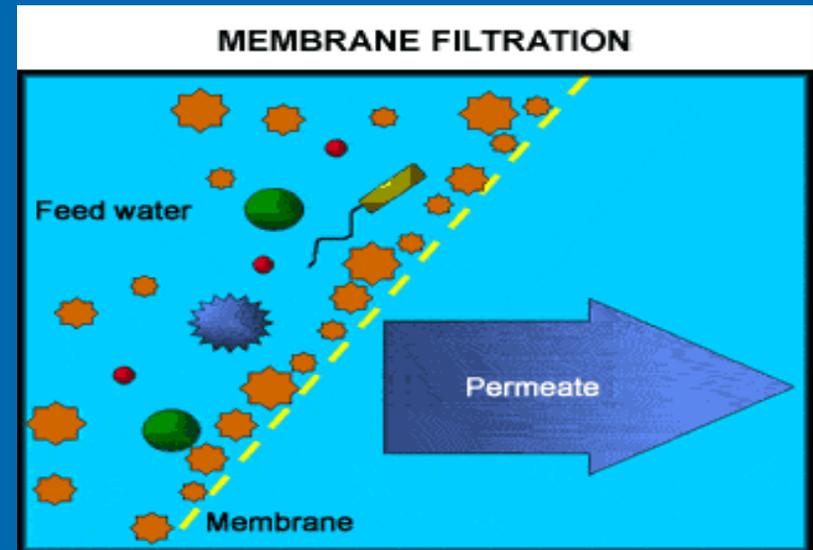


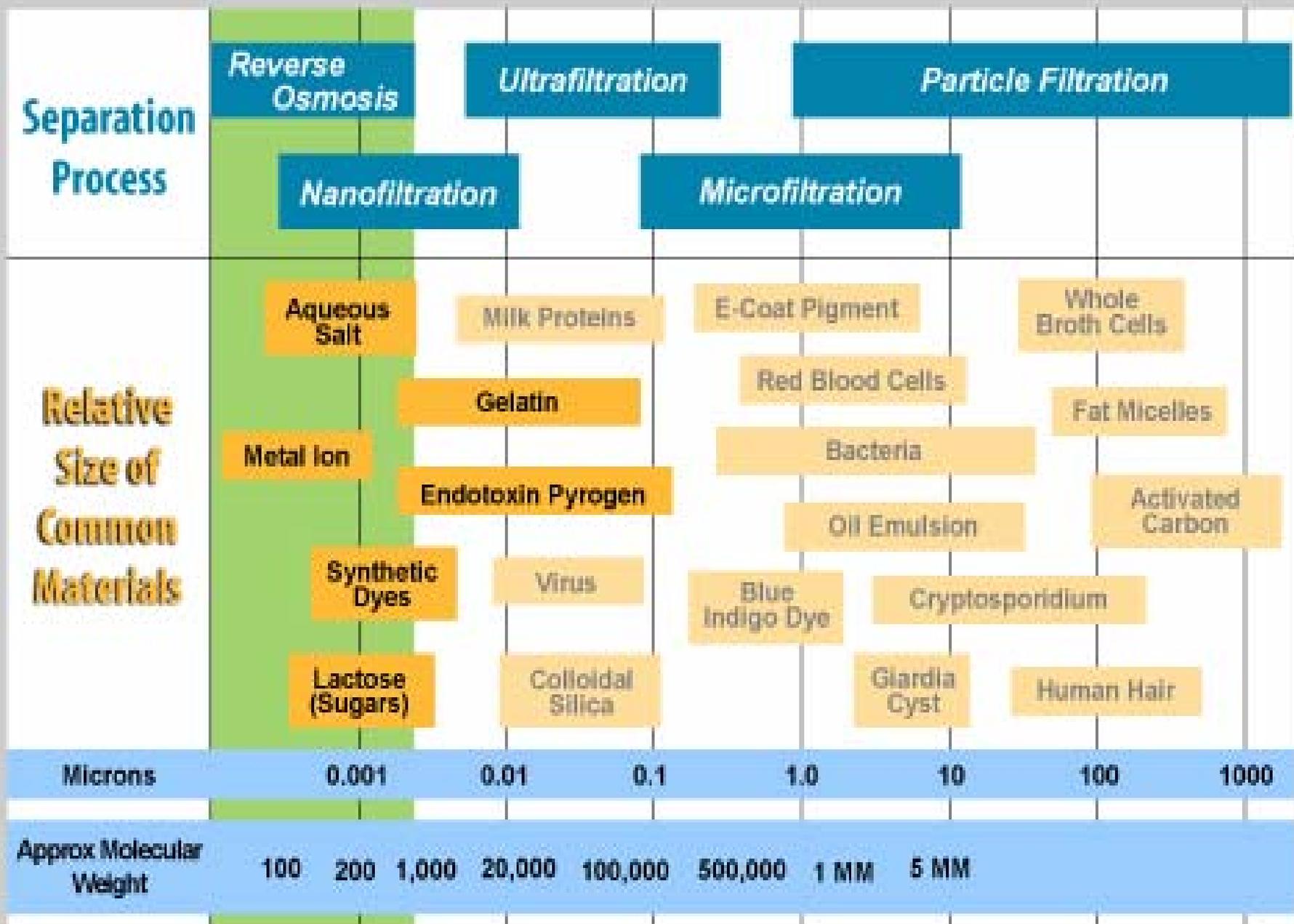
Water conditioners are not water softeners, just magnetic magic.



Many home water treatment devices work fine but are often not needed and require regular maintenance.

Filtration through some media or multi-media and more recently, through porous membranes with or without added pressure, is the technique most used now in removing contaminants from water.

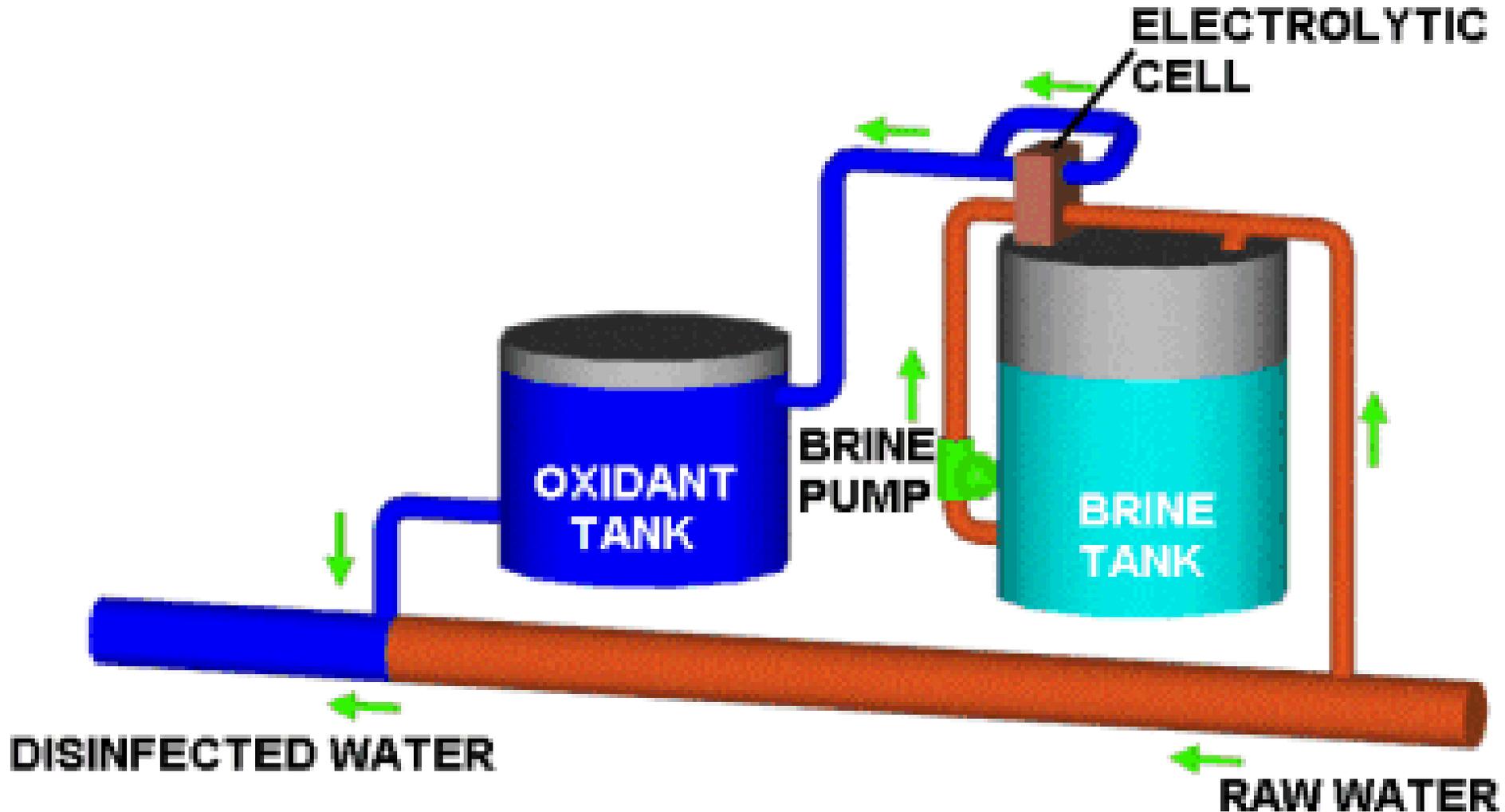




Note: 1 micron (micrometer) = 4 x 10⁻⁵ inches = 1 x 10⁴ Angstrom units

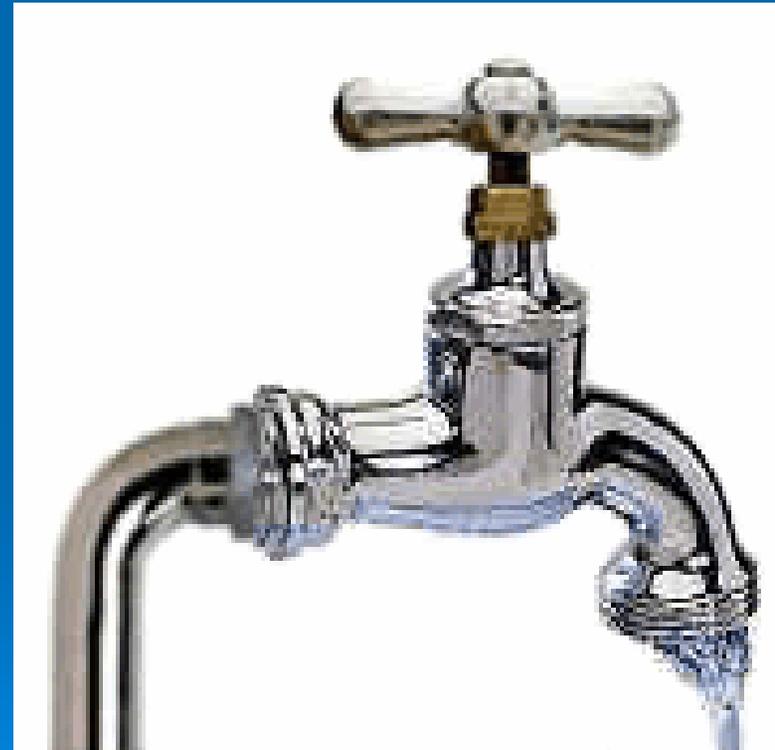
© 2004 - Koch Membrane Systems

**New techniques are not necessarily
scams.**



Supply-Related Water Scams

- Water locating scams
- Rain making scams
- Well drilling scams
- Water privatization scams



Does dowsing to find ground water really work?



DOWSING for BEGINNERS



The Art of Discovering:

Water • Treasure • Gold • Oil • Artifacts

Richard Webster

FREE DOWSING
1991
1992

Can rain dancing and rockets fired into clouds produce rain?



National and state certification programs now prevent most well drilling scams.





Alabama

State Water Program

*A Partnership of USDA CSREES
& Land Grant Colleges and Universities*



www.aces.edu/waterquality

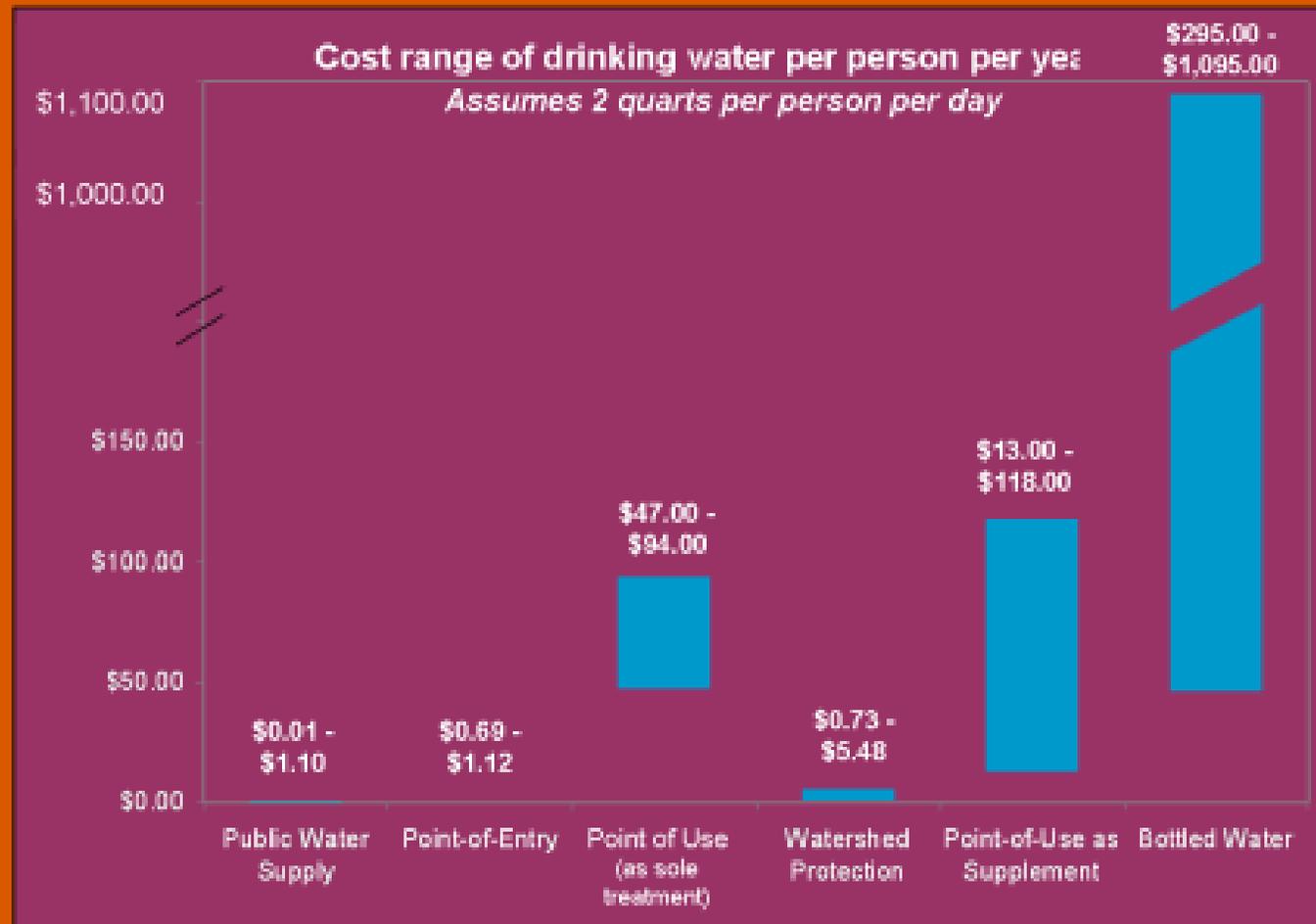
Glossary of over 8000 words and phrases related to water and water quality.

Over 200 articles, over 5000 questions and answers, and over 2000 web links by nine primary topics and 105 subtopics.

Over 50 links on scams and Internet fraud related to drinking water (subject code = 138).

All databases are searchable on the web site by key word (s).

How do the costs of various water protection and supply options compare?



Sources: Burby, R. J., Kaiser, E. J., Miller, T. L., Moreau, D. H. (1983) *Drinking Water Supplies: Protection Through Watershed Management*. Ann Arbor: Ann Arbor Science Publishers; Consumer's Union (1999) "Fit to drink: Devices That Help Keep Water in Good Taste and You in Good Health." *Consumer Reports*, October 1999: 53-55; Consumer's Union (2000) "It's only water, right?" *Consumer Reports*, August 2000: 17-21; Consumer's Union (2000) "Water filters tap into safety and aesthetic concerns." *Consumer Reports*, August 2000: 50-51; Keck, J. C. (2000) *Public Water Supply Protection: An Evaluation of Treatment Plant and Watershed Management Approaches*. Unpublished Ph. D. Dissertation, Department of Civil and Environmental Engineering, The University of Iowa, Iowa City, IA; US CBO (1995) *The Safe Drinking Water Act: A Case Study of an Unfunded Federal Mandate*. Washington, D. C.: Congressional Budget Office; US EPA (1998) *Cost Evaluation of Small System Compliance Options: Point-of-Use and Point-of-Entry Treatment Units*. Online: <http://www.asdwa.org/docs/pd/POU%20POE%20Report%201998.pdf>. Accessed June 8, 2002; US EPA (2002) "How Much Does it Cost to Treat and Deliver My Drinking Water?" EPA Office of Ground Water and Drinking Water. Online: <http://www.epa.gov/OGWDW/wat/wheredoes.html>. Accessed July 11, 2002; personal observation.