

## I. Water Treatment

### A. U.S.A.

- < In the U.S.A. approximately \_\_\_\_\_ gallons of water is withdrawn from surface and groundwater supplies daily.
- < About 7% of this amount (32 bgd) is used for p\_\_\_\_\_ water supplies.
- < Approximately 50,000 c\_\_\_\_\_ water systems supply 80 to 90% of the U.S. population.
- < On average, Americans use \_\_\_\_\_ gal/person/day. (This includes industrial uses and system losses).
- < About \_\_\_\_\_ people do not have running water in their homes.
- < The split between surface water and well water is about \_\_\_\_\_.
- < In rural areas 95% of the population uses g\_\_\_\_\_.
- < 20% of all public water supply wells and 29% of wells in urban areas have detectable levels of at least one v\_\_\_\_\_ o\_\_\_\_\_ c\_\_\_\_\_.<sup>1</sup>
- < At least 13 organic chemicals that are confirmed animal or human c\_\_\_\_\_ have been detected in drinking water wells.<sup>1</sup>
- < Toxic organics were found in some wells in almost every state east of the Mississippi, t\_\_\_\_\_ (TCE) was the most prevalent.<sup>1</sup>
- < 1000 public drinking water systems that serve 12 million people in the U.S. exceed n\_\_\_\_\_ levels at least some of the time. 8.7 million of these people are in California.<sup>2</sup>

### B. Worldwide

- < Approximately \_\_\_\_\_ of the world's population does not have access to safe drinking water supplies.
- < In developing countries, \_\_\_\_\_ people die daily from waterborne illnesses, and half the children die before the age of five due to lack of safe drinking water, despite the fact that dehydration from diarrhea is easily treated.

1. In *Major Environmental Issues Facing the 21st Century*, by Theodore & Theodore. Prentice Hall, 1996.

2. In a report by the Environmental Working Group (1997).

## Water Treatment (continued)

### II. Hardness and Trace Metals<sup>1</sup>

- C life expectancy for white males over 45 years of age has not changed much since 1900 (mainly due to little progress in the control of c \_\_\_\_\_ disease)
- C in 1959 researchers noticed a large discrepancy between rates of cardiovascular heart disease depending on g \_\_\_\_\_ location
- C significant negative correlations were found between m \_\_\_\_\_ from cardiovascular heart disease and magnesium, calcium, bicarbonate, sulfate, fluoride, dissolved solids, specific conductance, and pH
- C most significant negative correlation was for h \_\_\_\_\_
- C mortality from cardiovascular heart disease in hard water areas has been shown to be h \_\_\_\_\_ that in soft water areas
- C t \_\_\_\_\_ metals may be an important factor
- C c \_\_\_\_\_ of water may be an important factor
- C studies in Texas have shown a relationship between the levels of l \_\_\_\_\_ in groundwater and incidence of schizophrenia, psychosis, neurosis, personality problems, and homicidal tendencies

#### U. S. Geological Survey Classification of Hardness

Classification	Hardness, mg/L as CaCO <sub>3</sub>
Soft	0 - 55
Slightly Hard	55 - 100
Moderately Hard	100 - 200
Very Hard	> 200

<sup>1</sup> Hoadley, A. (1978) "Public Health Aspects of Water Supplies," In *Water Treatment Plant Design*, R. L. Sanks (Ed.) Ann Arbor, Stoneham, Mass. 17.

### Four Water Quality Characteristics

1. **P** \_\_\_\_\_ characteristics relate to quality of water for domestic use: e.g., color, turbidity, temperature, and taste and odor.
2. **C** \_\_\_\_\_ characteristics are often evidenced by observed reactions: e.g., hardness of water.
3. **B** \_\_\_\_\_ characteristics are important for public health reasons: e.g., pathogens.
4. **R** \_\_\_\_\_ factors must be considered where there is possibility of contact with radioactive substances: e.g., radon in groundwater.

## I. Physical Characteristics.

- A. **Turbidity.** Presence of s\_\_\_\_\_ m\_\_\_\_\_ in water. Measured by refraction of light (Nephelometric Turbidity Units, NTU). Not necessarily a health concern, but may be an indication of contamination.
- B. **Color.** Dissolved organic material from decaying vegetation may cause color in water. Color is a concern from the standpoint of aesthetics and it often indicates the presence of h\_\_\_\_\_ substances which are precursors of t\_\_\_\_\_ h\_\_\_\_\_ m\_\_\_\_\_, THMs, formed during chlorination.
- C. **Taste and Odor.** Taste and odor in water is caused by o\_\_\_\_\_ c\_\_\_\_\_, i\_\_\_\_\_ s\_\_\_\_\_, or d\_\_\_\_\_ g\_\_\_\_\_. Objectionable tastes and odors should be removed from drinking water.
- D. **Temperature.** Consistently cool drinking water is most desirable (\_\_\_\_\_ - \_\_\_\_\_ /C).

## II. Chemical Characteristics.

### A. Inorganic Substances.

1. **Chloride.** All waters contain some chloride due to leaching of m\_\_\_\_\_ s\_\_\_\_\_  
d\_\_\_\_\_, infiltration of sea water, or industrial and agricultural influence.  
Concentrations in excess of \_\_\_\_\_ mg/L may cause noticeable taste.
2. **Copper.** Found in some natural waters, particularly around ore deposits and mines. Small quantities are not considered a problem, but may cause a undesirable t\_\_\_\_\_ in water.
3. **Fluorides.** Some waters contain natural fluorides. Good in preventing t\_\_\_\_\_  
d\_\_\_\_\_ when concentration is between 0.7 and 1.2 mg/L. Higher concentrations can lead to f\_\_\_\_\_, a discoloration and pitting of teeth in children.
4. **Iron.** Usually present in small amounts, especially in groundwater. High levels of iron are objectionable because they leave a b\_\_\_\_\_ c\_\_\_\_\_ on laundry and impart taste and odor to the water.
5. **Lead.** Dangerous even in small quantities. Cumulative p\_\_\_\_\_. Poorly absorbed by adults (5 - 7%) but highly absorbed by children (up to 40%). Stored in the b\_\_\_\_\_ and slowly released into the bloodstream. Lead poison can cause brain and nerve damage, kidney damage, anemia, and porphyrinuria (excretion of hemoglobin precursors in urine). Problem in drinking water due to lead solder, lead pipes, and lead cores in drinking water fountains.

6. **Manganese.** Imparts a b\_\_\_\_\_ color to water and laundry, flavors coffee and tea.
7. **Nitrate.** Causes methemoglobinemia (b\_\_\_\_\_ b\_\_\_\_\_) in infants given formula containing high concentrations of nitrate and breast fed babies whose mothers drink high levels of nitrate. The babies blood absorbs nitrate instead of oxygen resulting in oxygen depletion. Nitrates are found in water contaminated from wastewaters or fertilizers.
8. **Sodium.** Concern for people with heart, kidney, or circulatory ailments. Most home w\_\_\_\_\_ s\_\_\_\_\_ use sodium, replacing the calcium and magnesium ions with sodium ions.
9. **Sulfate.** Waters containing high sulfate concentrations from contact with natural deposits of magnesium or sodium sulfate may act as a l\_\_\_\_\_.
10. **Zinc.** Zinc in water supplies (usually near zinc ore mines) will give an undesirable t\_\_\_\_\_.

#### Maximum Contaminant Levels for Inorganic Compounds

Contaminant	Existing MCL (mg/L)	Proposed MCL (mg/L)
Arsenic	0.05	
Asbestos		7 million fibers/L
Barium	1.0	5.0
Cadmium	0.010	0.005
Chromium	0.05	0.1
Lead	0.05	
Mercury	0.002	0.002
Nitrate (as N)	10.0	10.0
Nitrite (as N)		1.0
Selenium	0.01	0.05
Silver	0.05	delete

#### B. Organic Substances.

1. **Volatile Organic Compounds.** Compounds which are characterized by high v\_\_\_\_\_ are classified as volatile organic compounds (VOCs). VOCs may have particular adverse health effects. They are a result of industrial, commercial, and agricultural activity. Many are s\_\_\_\_\_ or additives (e.g., paint thinners).

2. **Synthetic Organic Compounds.** Organic chemicals of an a \_\_\_\_\_ origin are termed synthetic organic compounds (SOCs). Like VOCs, SOC's may have particular adverse health effects and are a result of industrial, commercial, and agricultural activity. Many SOC's are h \_\_\_\_\_, p \_\_\_\_\_, or I \_\_\_\_\_.
  
3. **Disinfection Byproducts.** During disinfection of drinking water, chemical oxidants kill disease causing organisms (p \_\_\_\_\_), but can also create toxic organic compounds. These are termed disinfection byproducts (DBPs). The most common source of DBPs is c \_\_\_\_\_ or b \_\_\_\_\_ of water containing organic matter. This often results in trihalomethanes (THMs), the most common of which are:
  1. Chloroform ( $\text{CHCl}_3$ )
  2. Bromoform ( $\text{CHBr}_3$ )
  3. Bromodichloromethane ( $\text{CHBrCl}_2$ )
  4. Dibromochloromethane ( $\text{CHBr}_2\text{Cl}$ )

### III. Legislation

#### A. SDWA of 1974

- C The S \_\_\_\_\_ D \_\_\_\_\_ W \_\_\_\_\_ A \_\_\_\_\_ (SDWA) was signed into law by President Gerald Ford in 1974.
- C It established minimum national standards for drinking water to protect public health.
- C The act established p \_\_\_\_\_ standards which specified maximum contaminant levels (MCLs) for individual contaminants suspected of having an adverse affect on public health.
- C The act also established s \_\_\_\_\_ standards relating to tastes, odors, and appearance of drinking water.
- C SDWA set a timeline for the promulgation of standards with a review every three years.

#### B. SDWA Amendments of 1986

- C By the 1980s, a number of contaminants had yet to be regulated, and on June 19, 1986 President Reagan signed into law the 1986 Amendments to the SDWA.
- C Major aspects of the 1986 Amendments to the SDWA included:
  - C C \_\_\_\_\_ revisions to drinking water regulations in a timely fashion.
  - C Definition of a t \_\_\_\_\_ t \_\_\_\_\_ for each contaminant regulated.
  - C Requirement of a treatment technique where it is not feasible to ascertain the level of a r \_\_\_\_\_ c \_\_\_\_\_.
  - C F \_\_\_\_\_ r \_\_\_\_\_ for surface waters (Surface Water Treatment Rule, SWTR).
  - C D \_\_\_\_\_ of all water supplies.
  - C Prohibition on the use of l \_\_\_\_\_ products on conveyance systems.

C Requirement for the protection of g\_\_\_\_\_ sources.

C The SDWA directed EPA to set up several classes of compounds for which regulations are to be developed and to establish a timeline for development of the regulations.

**C. SDWA Amendments of 1996**

C On November 29, 1996, the Senate passed a bill to reauthorize the SDWA. This bill contained several amendments to the regulations which would lessen some of the regulatory burden on water utilities, especially small systems. This bill passed both houses in August 1997 and locked EPA into setting DBP and enhanced SWTR regulations by the end of 1998 (a deadline they did not meet) and a filter backwash recycle (FBR) rule by August 2000. EPA's current plan is to publish the proposed Stage 2 DBP Rule and Long-Term Enhanced Surface Water Treatment Rule by November 2000 and publish final regulations by May 2002.