

Water Quality and Soils

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**Fresh Water**  
Fresh surface water, groundwater, soil water  
0.8% total earth water



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**What's in the Water?**

- ❖ Dissolved organic and inorganic compounds
- ❖ Particulate organics and inorganics
- ❖ Gases – oxygen and carbon dioxide
- ❖ Anthropogenic inputs, effects



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## Water Pollution

"any biological, chemical, or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses."

44% of lakes,  
37% of rivers unsafe for recreation due to toxic water pollutants  
32% of estuaries.

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Where does it come from?

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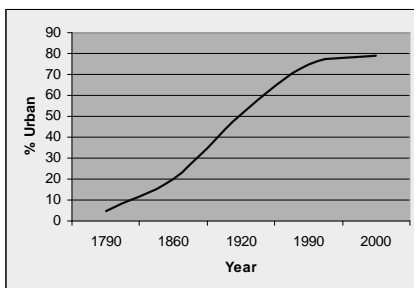
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## Population Dynamics



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## Two Basic Avenues of Water Pollution

### **Non-point source pollution**

Diffuse sources  
Difficult to trace, regulate

### **Point source pollution**

Specific entry point  
Industrial discharges  
Sewage treatment plants  
Landfills

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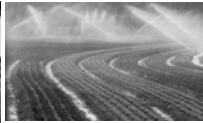
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## Non-point Source Pollution

Lawns, Gardens	Fertilizers (N and P)
Golf Courses	Pesticides (organics)
Agriculture	Animal Wastes (organics, biological)
Urban Runoff	Oil, gas, rubber (organics)



Golf Courses



Agriculture



Urban

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## Point Source Pollution

Factories/Industry  
Wastewater Treatment  
Landfills  
Underground Storage Tanks  
Mines



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## Pollution Types

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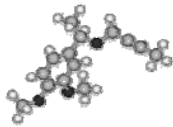
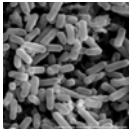
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### Basic Types of Pollution

- 1) biological, such as bacteria or viruses
- 2) physical, such as sediment, radioactive material, and heat.
- 3) chemical, including heavy metals, nutrients, pesticides, and wastes



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### Biological

Bacteria	Typhoid Cholera Dysentery
Viruses	Hepatitis Polio
Protozoa	Schistosomiasis Amoebic dysentery
Parasites	Giardiasis

[http://www.gainesville.com/apps/pbcs.dll/article?AID=/20061009/L\\_OCAL/210090332&SearchID=73259331569108](http://www.gainesville.com/apps/pbcs.dll/article?AID=/20061009/L_OCAL/210090332&SearchID=73259331569108)

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**Physical Pollutants**

**Heat**

electric power plants – O<sub>2</sub>, thermal shock  
½ of water withdrawn



**Sediment**



erosion, deforestation, agriculture  
chokes and fills lakes, reservoirs  
reduced photosynthesis

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**Chemical Pollutants**

**Chemical Pollutants**

**Nutrients**

Nitrogen



Phosphorus



animal wastes, agricultural runoff, and sewage

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**Chemical Pollutants**

**Heavy metals and non-metals**

**Mercury (Hg) (coal)**

**Lead (Pb) (paint, pipes, solder)**

**Arsenic (As) (wood preservative)**

Many can exist as charged species that can interact with soils

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**Metal      Common Health Effects**

	behavioral problems high blood pressure, anemia kidney damage
<b>Lead</b>	memory and learning difficulties miscarriage, decreased sperm production reduced IQ
	blindness and deafness brain damage digestive problems kidney damage
<b>Mercury</b>	lack of coordination cognitive degeneration
	breathing problems death if exposed to high levels decreased intelligence
<b>Arsenic</b>	known human carcinogen: lung and skin cancer nausea, diarrhea, vomiting peripheral nervous system problems

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**Mercury, Arsenic, and Lead**

**Mercury found in hair samples from 10 of 10  
Washingtonians**

**Arsenic found in urine samples from 4 of 10  
Washingtonians**

**Lead found in blood sample from 1 of 10  
Washingtonians**

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Wonderland

Mercury Nitrate in felting process to make hats.

Symptoms included tremors, emotional instability, insomnia, dementia and hallucinations

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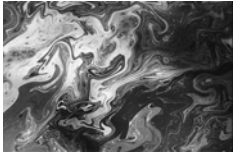
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**Chemical Pollutants**

**Oil**

three to six million metric tons/yr

Exxon Valdez - 300,000 birds and 2,500 otters were killed

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**Radioactive Waste**

iodine, radon, uranium, cesium, and thorium

- nuclear power plants
- processing of uranium
- nuclear weapons production
- natural sources

genetic mutations, miscarriages, birth defects

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**Synthetic Organic Chemicals**

Pesticides	DDT
Industrial Processing	PCBs
Solvents/Cleaning	TCE /PCE
Flame Retardants	PBDE

Half-life	Absorption
Days to years	Sediments/soil carbon

<http://www.npr.org/templates/story/story.php?storyId=6100179>

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Turn 8 pages

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**Synthetic organic Chemicals**

**Point and Non Point Source Pollution**

Petroleum (oil, gasoline) PCBs – electrical insulators Dioxins – by product Pesticides Organic Solvents	
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**Heavy Metals**

Lead (electronics)	
Cadmium (batteries)	
Chromium (metallurgy)	
Arsenic (wood)	

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**Groundwater Vulnerability**

One gallon of gasoline can  
contaminate 1 million gallons  
of drinking water

1 ppm



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**Dioxins**

July    November



Viktor Yushchenko  
Ukrainian President

6,000 times the usual concentration in his body

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Organic Chemicals and Water Solubility

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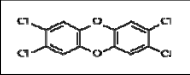
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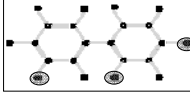
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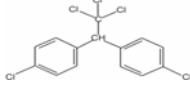
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Dioxin  0.2 µg/L

PCB  10-31 µg/L  
(50% Cl)

DDT  insoluble

Principally carbon, hydrogen

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Ionic Compounds

$\text{NaCl} \longrightarrow \text{Na}^+ + \text{Cl}^-$

Sodium Chloride 350 g/L (3/4 lb.)

Potassium Chloride 280 g/L

Why?

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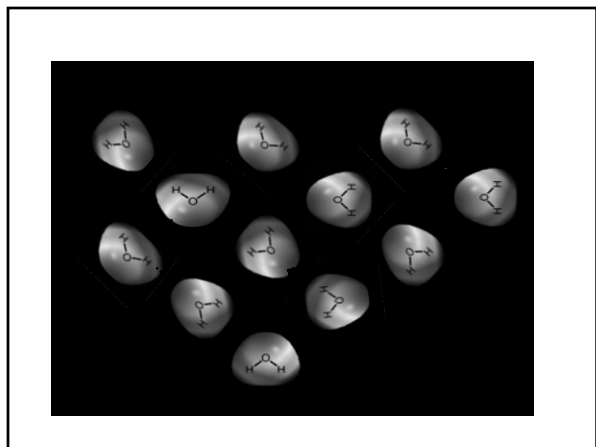
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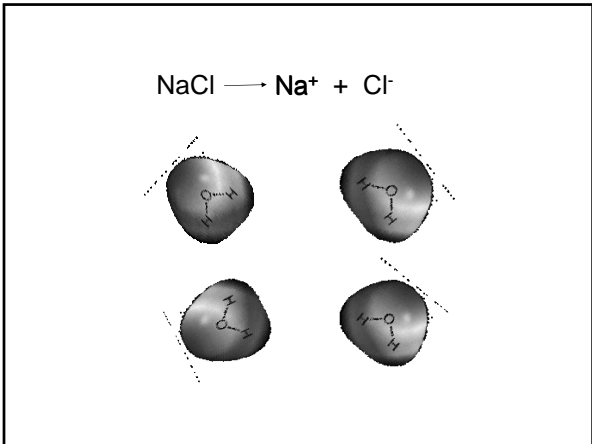
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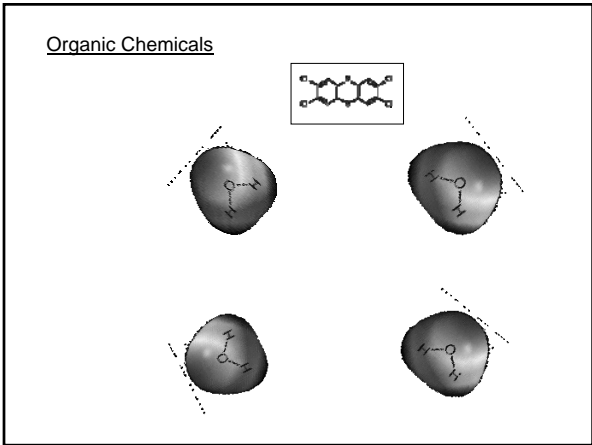
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**PCBs**

Water Solubility

Aroclor 1221 (21% Chlorination) 500-1500 ppb  
 Aroclor 1230 (30% Chlorination) 85-92 ppb  
 Aroclor 1240 (40% Chlorination) 40-170 ppb  
 Aroclor 1254 (54% Chlorination) 10-31 ppb  
 Aroclor 1260 (60% Chlorination) <1 ppb

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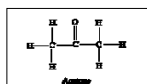
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## Improving Solubility

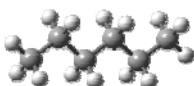
Organic Solvents



Soap/detergents



Structural similarity between the chemical and the solvent.



Hexane

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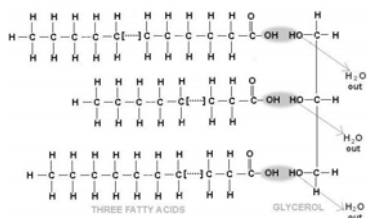
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## Lipids and Solubility



Structural similarity between the chemical and the solvent.

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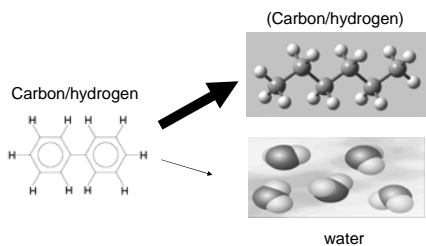
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## Solubility

A chemical's solubility in lipids or organic solvents is inversely proportional to its solubility in water.



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Consequences

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