Categories of Water Use:

human drinking water
recreation
livestock drinking water
irrigation
protection of aquatic life

Monitoring Water Quality

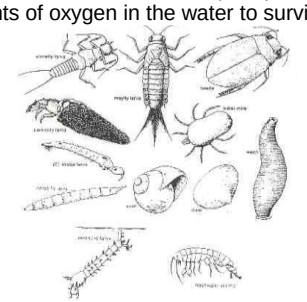
Clarity may be one indicator, but clear water does not indicate what chemicals are present. Water Quality is determined using biological and chemical indicators according to what the water is going to be used for.

Microbiological Indicators

Microscopic organisms (bacteria) can cause serious health problems if they are present in sufficient numbers. Samples are taken to identify their presence to avoid contamination of the water supply.

Biological Indicators

Species of aquatic organisms (invertebrates – animals without a backbone) require certain amounts of oxygen in the water to survive.



Aquatic Environments - The place where aquatic organisms live varies, depending on the pH level and the amount of dissolved oxygen present … likely no fish in water that has a pH below 5.0... worms and midge larva thrive in polluted water, as they require only small amounts of dissolved oxygen for survival

Chemicals Affect Aquatic Organisms

Chemical indicators of water quality: dissolved oxygen, acidity, heavy metals, nitrogen, phosphorus, pesticides, salts – such as sodium chloride and magnesium sulfate.

Dissolved Oxygen

Abiotic factors - water temperature, rate of flow (turbulence), obstacles in the water, wind, amount of photosynthesis by water plants,
Biotic factors - number of organisms using oxygen
Most organisms need 5 milligrams per Litre (5 ppm) of dissolved oxygen to survive. The diversity of species often gives us a relative idea of the amount of dissolved oxygen present. A large number of different species means a high level (likely 8 ppm or more) of dissolved oxygen, whereas a few species indicates a low level (below 5 ppm) of dissolved oxygen.

Measuring Chemicals in ppm

The concentrations of chemical indicators is usually measured in parts per million. One part per million means that one unit of an element or chemical can be found in one million units of solution …

parts per million (ppm),

$$ppm = \frac{\text{grams of solute}}{\text{grams of solution}} \times 10^6$$

or in milligrams per Litre (mg/L).

$$ppm = \frac{\text{mg of solute}}{\text{L solution}}$$

pH Testing

Acidity is measured on the pH scale with 7.0 being neutral and anything below 7 is acidic.

Phosphorus and Nitrogen

Phosphates and Nitrates often enter the water supply by sewage and runoff – They increase the growth of algae and weeds in the water. This then increases the food supply for bacteria, which decompose the plants, as they die. The presence of more and more bacteria uses up the available supply of dissolved oxygen and many of the aquatic organisms die as a result.

Acid Rain & Acid Shock

Sulfur and nitrogen oxides emitted from industries (such as smelters) combine with water vapor in the air to produce sulfuric and nitric acid that fall to the ground as acid rain
... causing chemical changes in the soil
…reducing soil fertility
... retarding tree growth
... killing organisms in lakes & streams
... corroding exposed metal surfaces
... breaking down stone and limestone
... leaching toxic chemicals from the soil
A decrease of one unit indicates the acidity has been **multiplied by a factor of 10**. Periods of extreme acidity (like in the spring when the acid snow melts and the acidic water enters the waterways) are called **acid shock**.
Pesticides - When pesticide chemicals remain in the environment, a toxin is created. Several pesticides mixed together can have a cumulative effect and become very toxic. A toxic substance is poisonous. Dioxins are chemicals found in certain pesticides and industrial wastes can cause severe illness and possibly birth defects.

Measuring Toxicity

Toxins or poisons are substances that produce serious health problems, or death when introduced into an organism. Scientists measure toxins in **LD50** amounts. LD stands for **'Lethal Dose"** and 50 represents 50% of the subject group that will die if they are given the specified dose, all at once.
Noise Pollution: can cause hearing loss and other damage to living organisms. Thermal Pollution: can eliminate species unable to tolerate the increase in temperature
Heavy Metals - have a density of 5g/cm^3 or more. Examples: mercury, copper, lead, zinc, cadmium and nickel. These metals occur naturally and are also processed into a wide variety of products. Heavy metals can be toxic to a wide range of organisms, so concentrations are constantly monitored. Heavy metals can enter the water supply by the action of acid rain and improper solid waste disposal. Heavy metals are especially toxic to children causing abnormal development, brain damage or even death.

Suspended Solids

- turbidity
- unpleasant appearance
- blocks sunlight
- decreases oxygen production

Testing: Use the filtration method to separate the sample into **residue** and **filtrate**

Mobile Air Monitoring Laboratory - Air quality can be measured in two ways: by measuring the levels of pollutants in the air and by estimating the amount of emissions from pollution sources.

Sulfur Dioxide ($SO_{2(g)}$) is a major air pollutant produced through industrial processes (forming smog and acid rain). It can affect your respiratory system and irritate your eyes. **Scrubbers** are used to reduce sulfur dioxide emissions by up to 99%. They use limestone to convert it to a useful product – gypsum.

Nitrogen Oxides

$NO_{x(g)}$ are mixtures of NO and NO_2 and are major contributors to smog and acid rain as well. Vehicle emissions and the burning of fossil fuels are the main contributors of Nitrogen Oxides.

Carbon Monoxide

CO is called the **'silent killer'** because it is a colorless, odorless gas. It is caused by the burning of fossil fuels and not enough oxygen to produce carbon dioxide (CO_2). Motor vehicles are the main producers of CO, but other sources include the burning of wood (forest fires produce large quantities) in fireplaces and stoves, natural gas, industrial processes, airplanes and cigarettes. If inhaled, CO reduces the amount of oxygen in the blood and can cause headaches, sleepiness, chest pains, brain damage and death. **Catalytic converters** are used to convert CO into CO_2

Ground-Level Ozone

Ozone ($O_{3(g)}$) is an odorless, colorless gas that has 3 oxygen atoms. It protects us from harmful ultraviolet rays from space, but at ground-level it can be harmful, because it can affect the respiratory system, deteriorates plastics and can have serious effects on crops. Ground-level ozone forms from reactions between oxygen, nitrogen oxides and compounds that are volatile organic compounds (VOC's), in the presence of sunlight and heat. Fuel combustion is the major source.

Monitoring The Atmosphere

Chemicals in the air can cause mild to serious effects in local areas, but chemicals in the atmosphere can have serious global effects. Ozone depletion and climate change are the primary concerns internationally.