Water Quality Assessment

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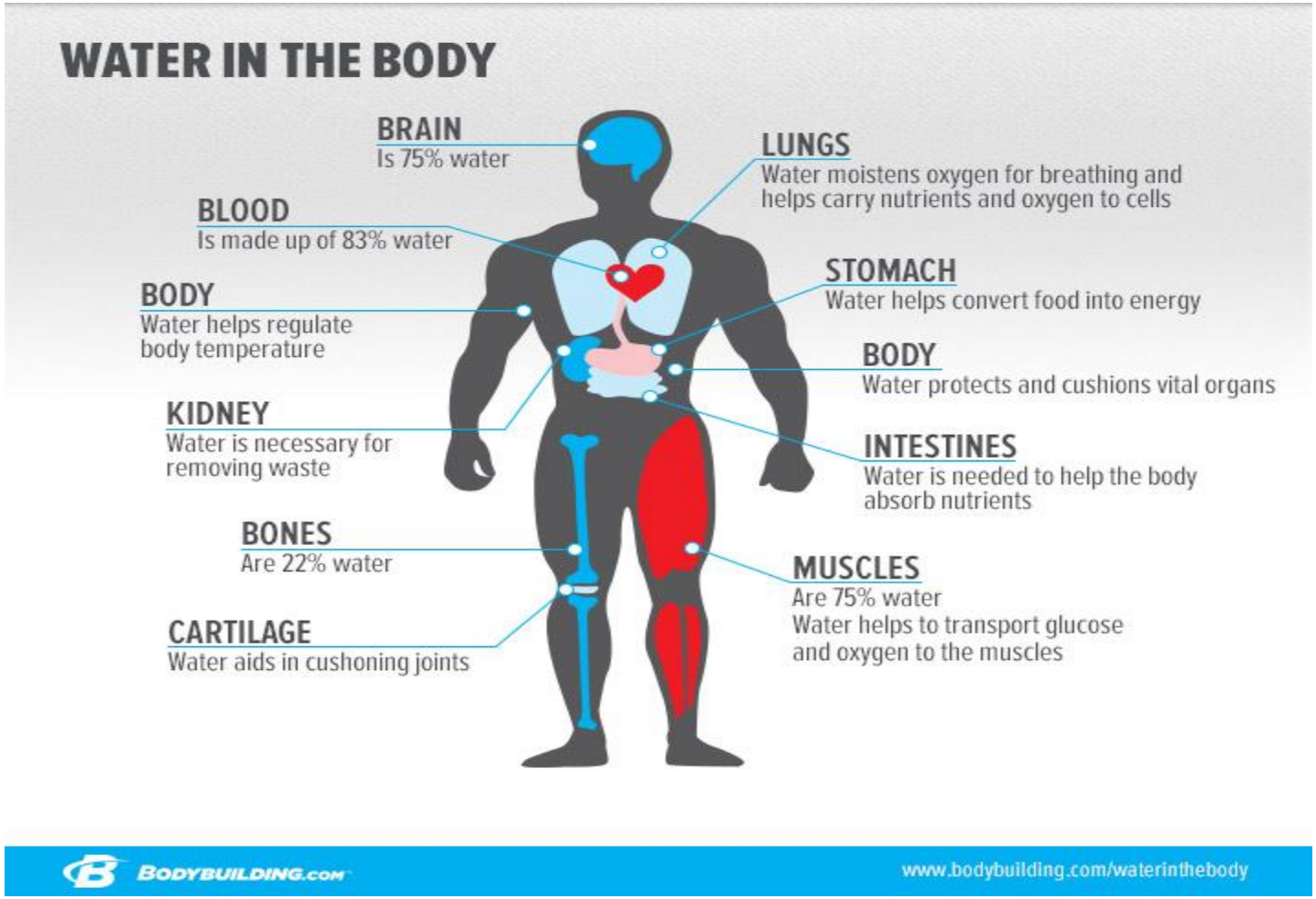
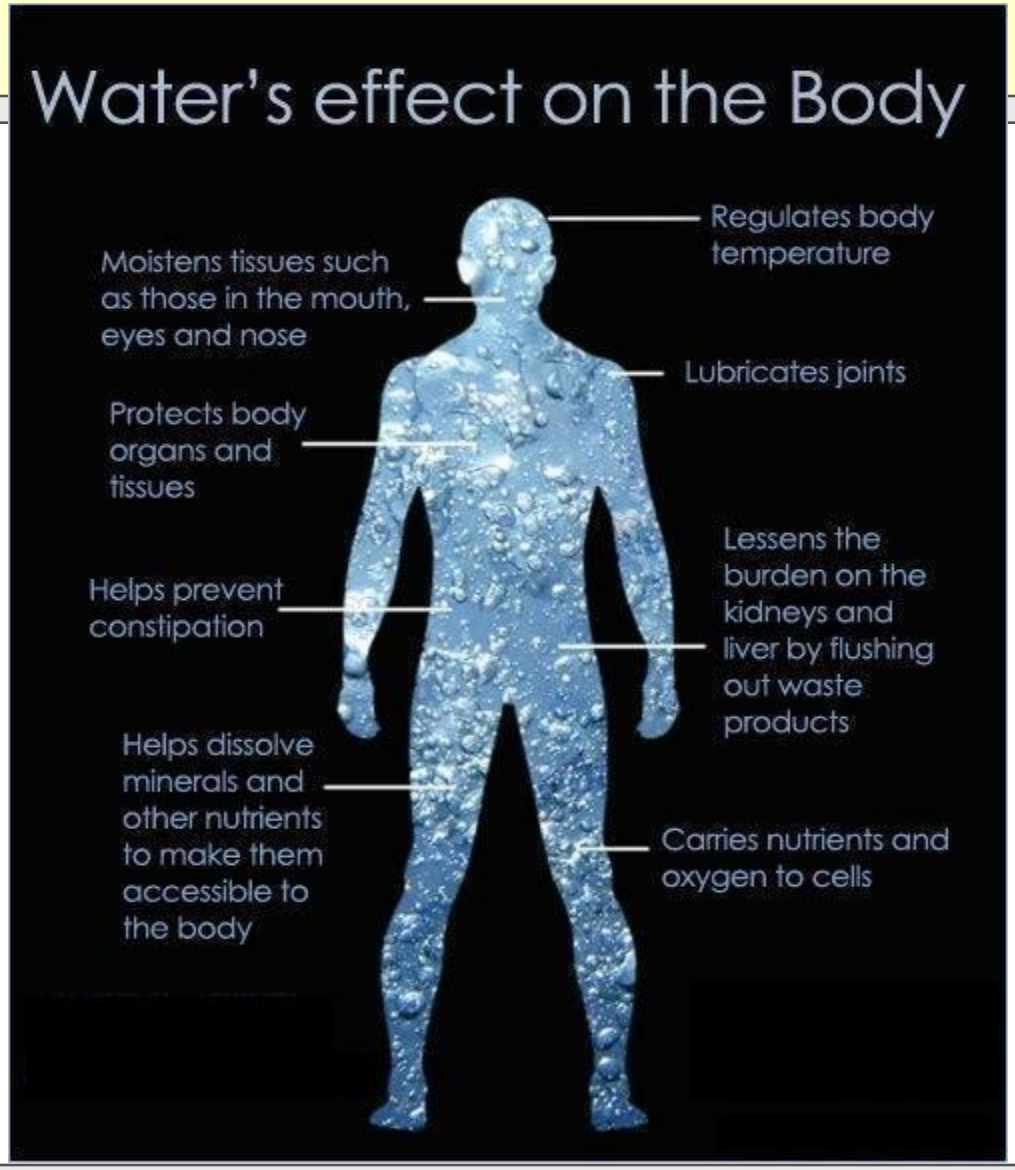
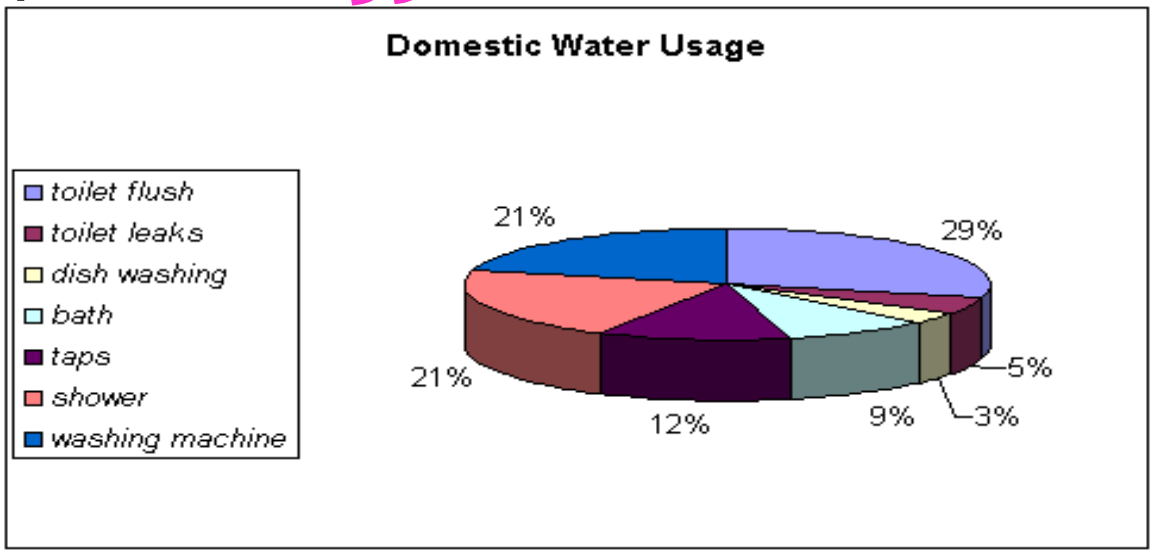

WATER IN THE BODY
BRAIN
Is 75% water
LUNGS
Water moistens oxygen for breathing and helps carry nutrients and oxygen to cells
BLOOD
Is made up of 83% water
STOMACH
Water helps convert food into energy
BODY
Water helps regulate body temperature
BODY
Water protects and cushions vital organs
KIDNEY
Water is necessary for removing waste
INTESTINES
Water is needed to help the body absorb nutrients
BONES
Are 22% water
MUSCLES
Are 75% water
Water helps to transport glucose and oxygen to the muscles
CARTILAGE
Water aids in cushoning joints
BODYBUILDING.COM
www.bodybuilding.com/waterinthebody

Water's effect on the Body



Water:- a person use each day

- Americans use an average of 168 liters a person each day
- Dutch people-is about 135 litres



the water that is used by industries, businesses and institutions an

American uses an average of 650 gallons each day

Water Sources

- Groundwater
- Surface Water
- Municipal Water Supplies

Water Sources – Ground Water

Advantages:

- Constant Temperature

Disadvantages:

- Dissolved H_2S and CO_2
- Low Dissolved Oxygen
- Supersaturation
- High Iron Concentration

Water Sources – Municipal Water

Designed and treated to safeguard the health of humans, not fish!

Advantages

- Availability
- Reliability

Disadvantage

- Chlorine
- Fluorine
- Cost

Water Quality Parameters

Critical Parameters

- Dissolved Oxygen
- Temperature
- Ammonia/Nitrite/Nitrate
- pH

Important Parameters

- Alkalinity/Hardness
- Salinity
- Carbon Dioxide
- Solids

Water quality parameters

Water Quality Parameters

- Dissolved oxygen
- Suspended sediments (TSS) and turbidity
- Specific conductivity (EC)
- alkalinity
- pH
- Temperature
- Major ions

Dissolved Oxygen

DO – importance and reporting

- Oxygen is produced during photosynthesis and consumed during respiration and decomposition.
- **Generally < 3 mg/L is stressful to aquatic life**

- Units of measurement are:
  - **Concentration: mg/L = ppm**; concentrations range 0.0 to 20 mg/L

  - **% saturation** – used to determine if water is fully saturated with oxygen at a particular temperature

DO probes and meters

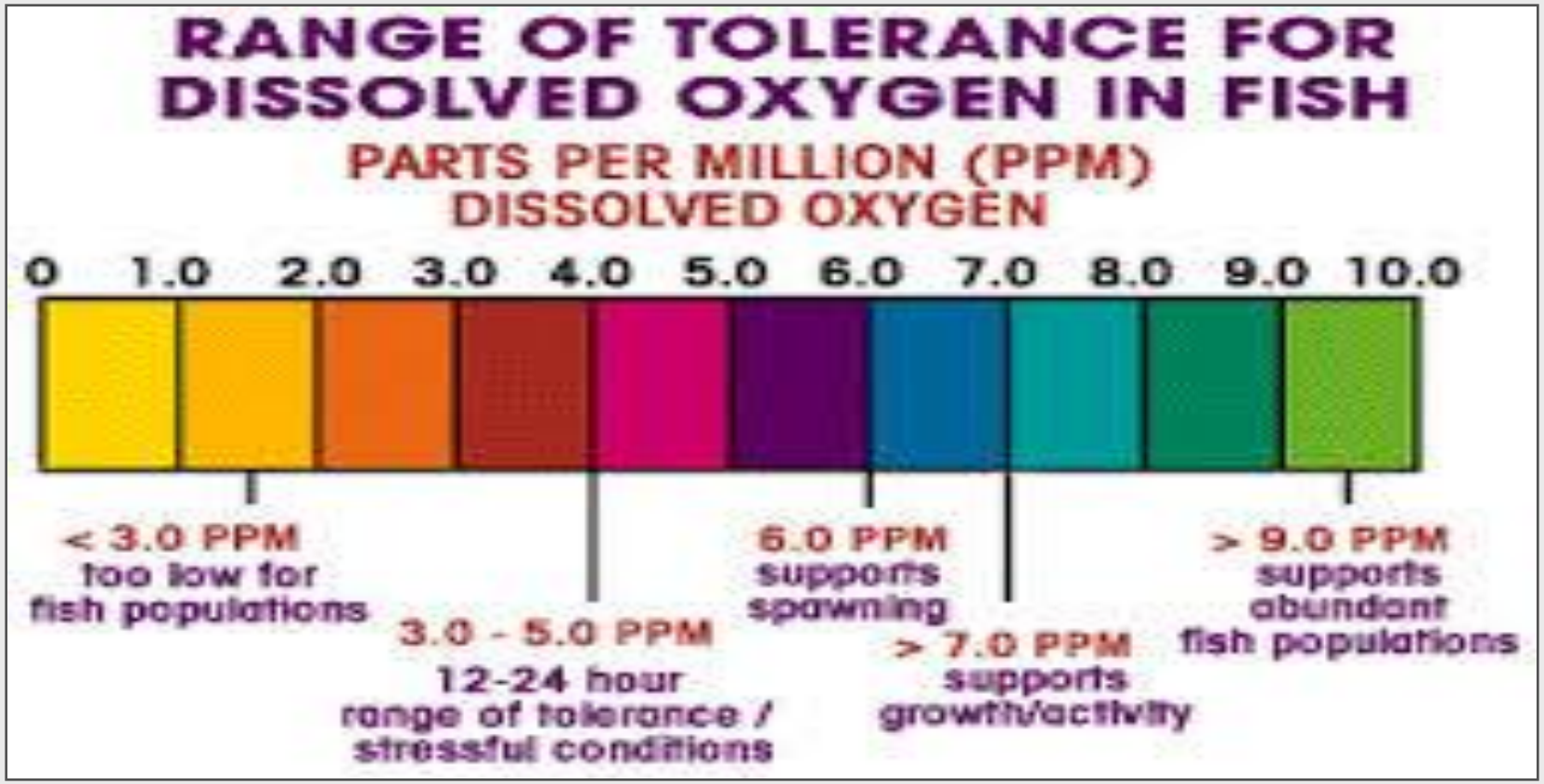
- The WOW units use either Hydrolab or YSI multiprobe data sounds, but there are many others










RANGE OF TOLERANCE FOR DISSOLVED OXYGEN IN FISH
PARTS PER MILLION (PPM) DISSOLVED OXYGEN
0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
< 3.0 PPM too low for fish populations
3.0 - 5.0 PPM 12-24 hour range of tolerance / stressful conditions
6.0 PPM supports spawning
> 7.0 PPM supports growth/activity
> 9.0 PPM supports abundant fish populations

Temperature

Off-the-self-components and hardware.

Included with most DO, pH, conductivity meters.

NOT RECOMMENDED!

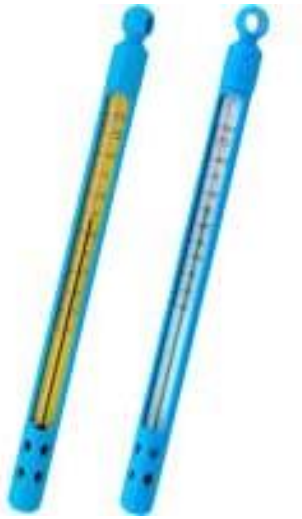
Mercury thermometers

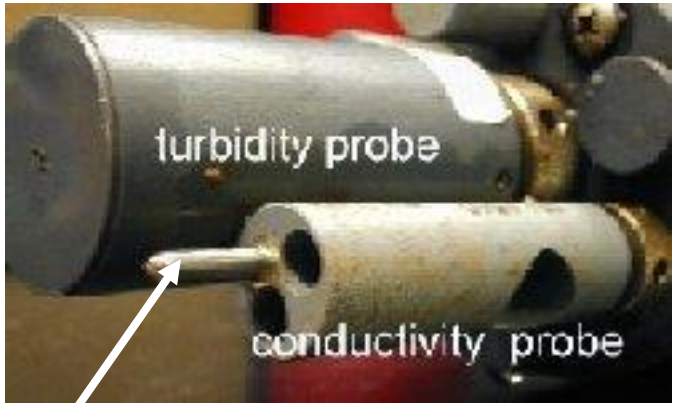
Temperature importance

- **Temperature affects:**
  - the oxygen content of the water (**oxygen levels become lower as temperature increases**)
  - the **rate of photosynthesis by aquatic plants**
  - the **metabolic rates** of aquatic organisms
  - the **sensitivity of organisms** to toxic wastes, parasites, and diseases

Temperature measurement - probes

- Types of probes
  - Liquid-in-glass
  - Thermistor: based on measuring changes in electrical resistance of a semi-conductor with increasing temperature.





thermistor on a YSI sonde

pH

pH value expresses the intensity
of the acidic or basic characteristic of water.

Seawater: 8.0- 8.5

Freshwater: 6.5 – 9.0

pH

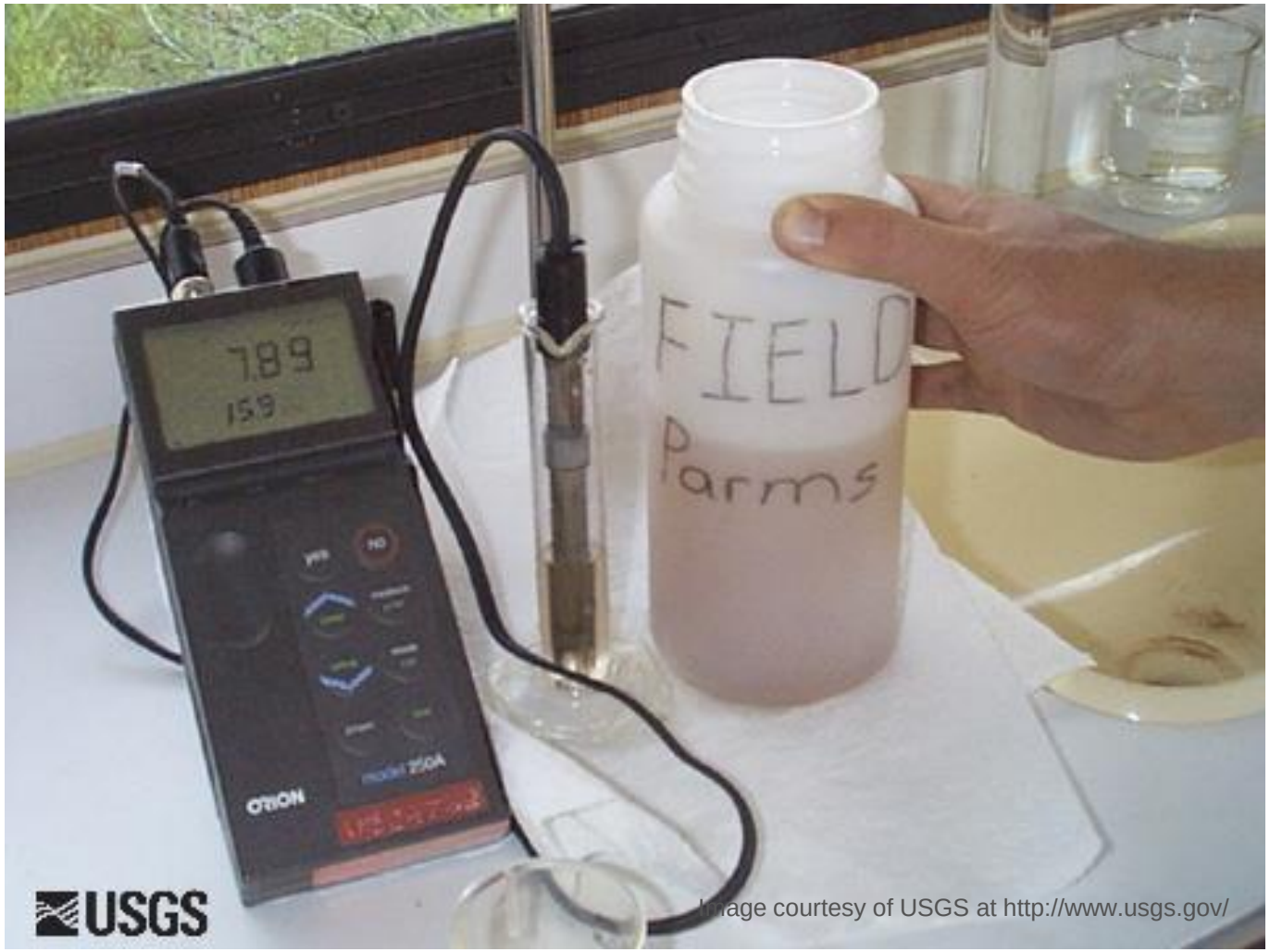
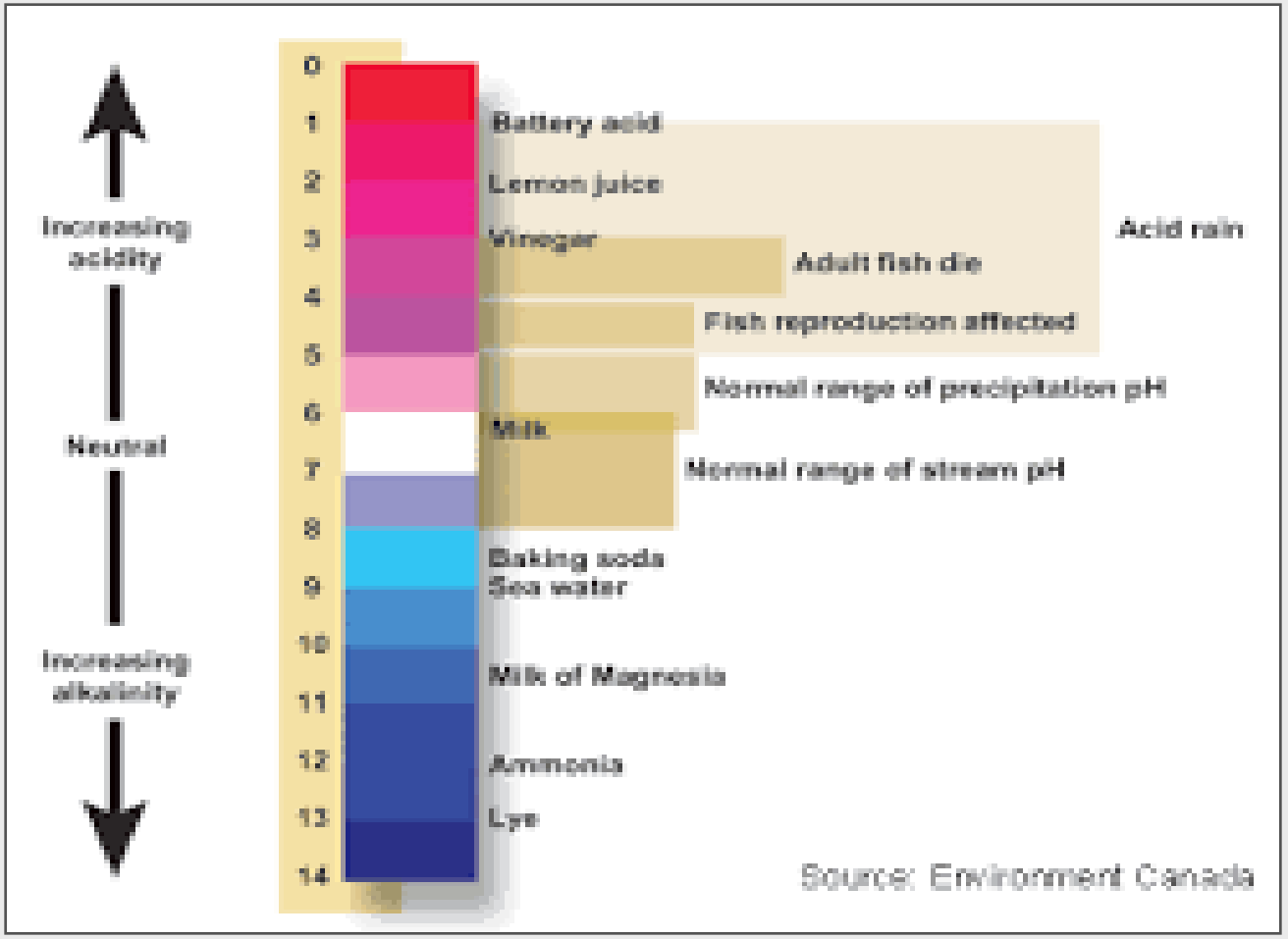
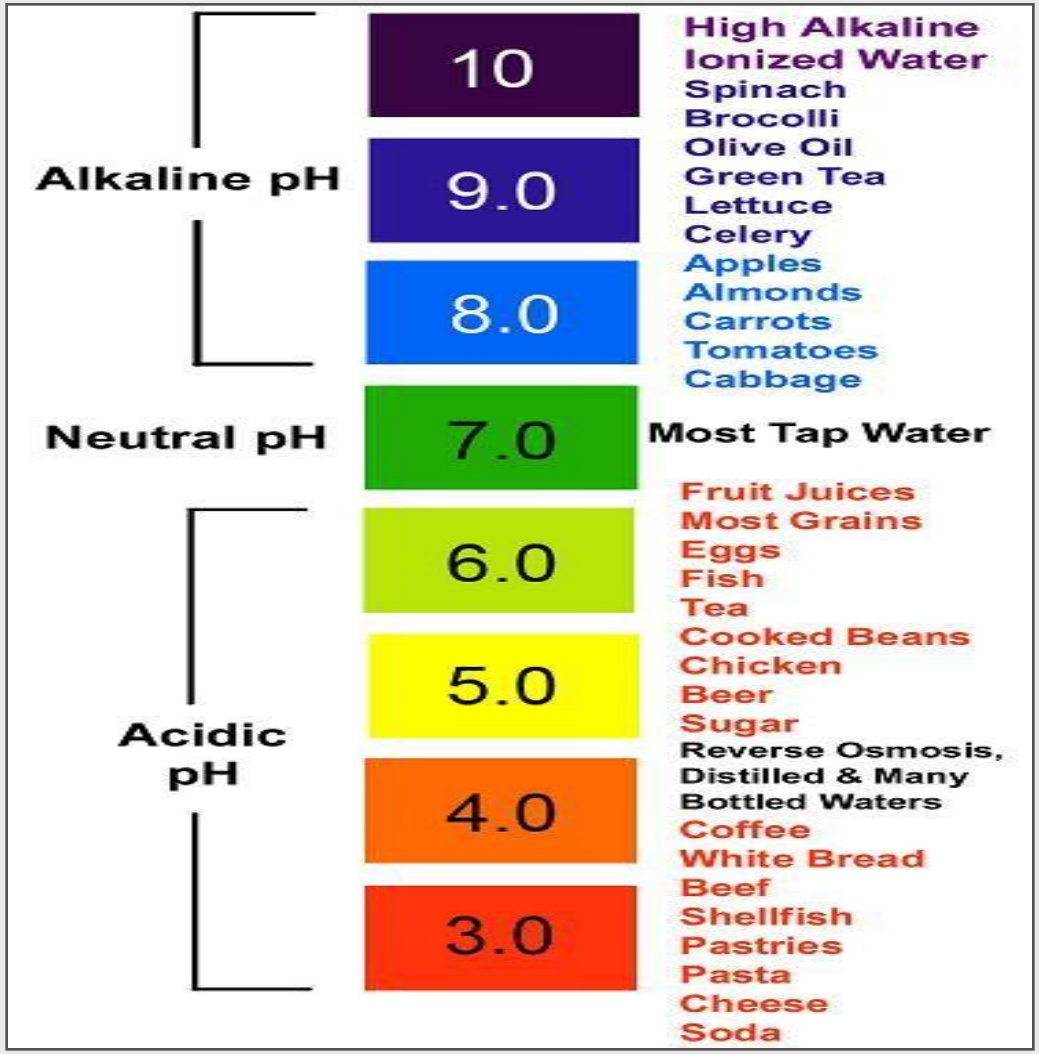


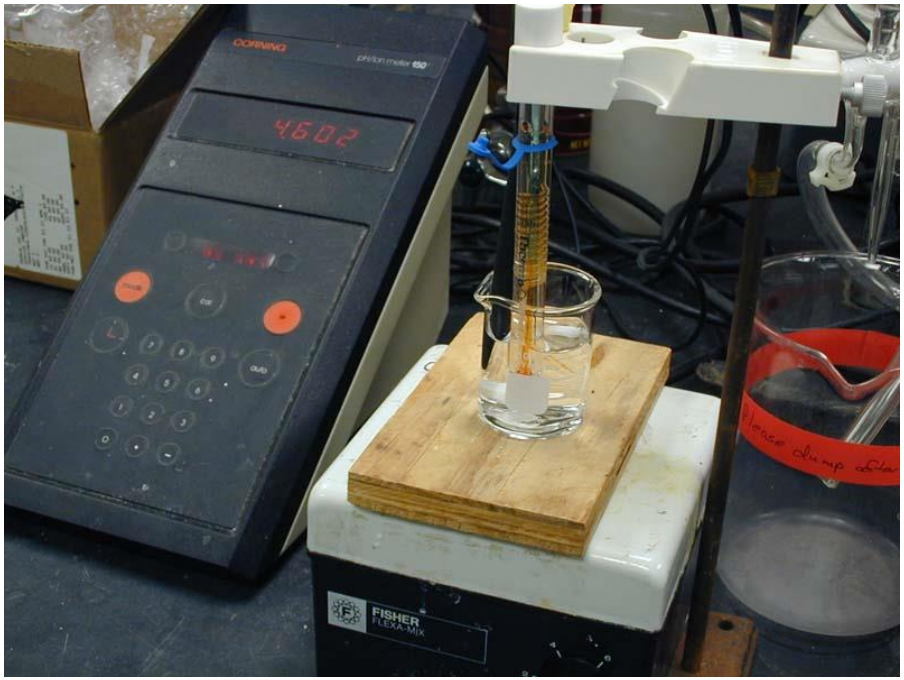
Image courtesy of USGS at http://www.usgs.gov/


Increasing acidity
Neutral
Increasing alkalinity
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Battery acid
Lemon juice
Vinegar
Adult fish die
Fish reproduction affected
Normal range of precipitation pH
Milk
Normal range of stream pH
Baking soda
Sea water
Milk of Magnesia
Ammonia
Lye
Acid rain
Source: Environment Canada


Alkaline pH
Neutral pH
Acidic pH
10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
High Alkaline Ionized Water
Spinach
Brocolli
Olive Oil
Green Tea
Lettuce
Celery
Apples
Almonds
Carrots
Tomatoes
Cabbage
Most Tap Water
Fruit Juices
Most Grains
Eggs
Fish
Tea
Cooked Beans
Chicken
Beer
Sugar
Reverse Osmosis, Distilled & Many Bottled Waters
Coffee
White Bread
Beef
Shellfish
Pastries
Pasta
Cheese
Soda

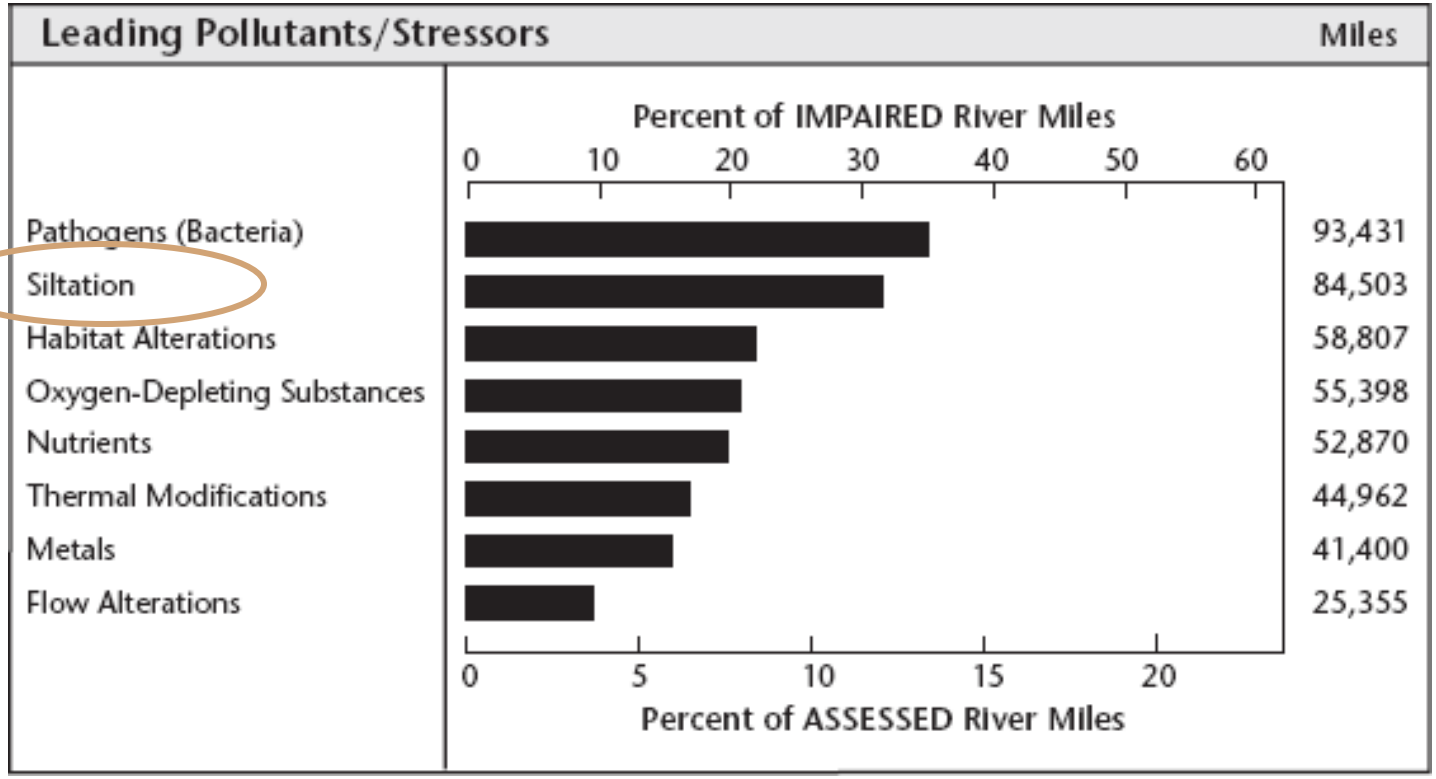
pH – probes

- a bench or hand-held meter and probe can be used in a fresh subsample if you don't have a field meter with a pH probe.



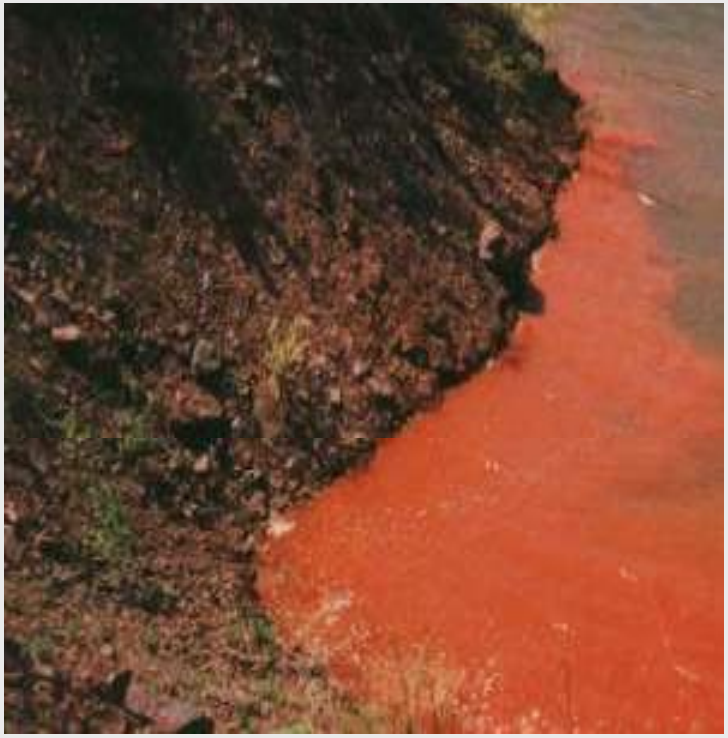
Sedimentation/siltation

- **Excessive sedimentation in streams and rivers is considered to be a major cause of surface water pollution in the U.S. by the USEPA**



Measuring turbidity

- Turbidity measures the scattering effect suspended particles have on light
  - inorganics like clay and silt
  - organic material, both fine and colored
  - plankton and other microscopic organisms
  - Transparency or turbidity tubes



Even small amounts of wave action can erode exposed lakeshore sediments, in this case a minepit lake from northeastern Minnesota. Guess the mineral mined here.

Turbidity

- Field turbidity measurements are made with
  - Turbidimeters (bench meter for discrete samples)
  - Submersible turbidity sensors (Note - USGS currently considers this a *qualitative* method)

Hydrolab turbidity probe

Turbidity – units and reporting

- Nephelometric Turbidity Units (NTU) standards are formazin or other certified material

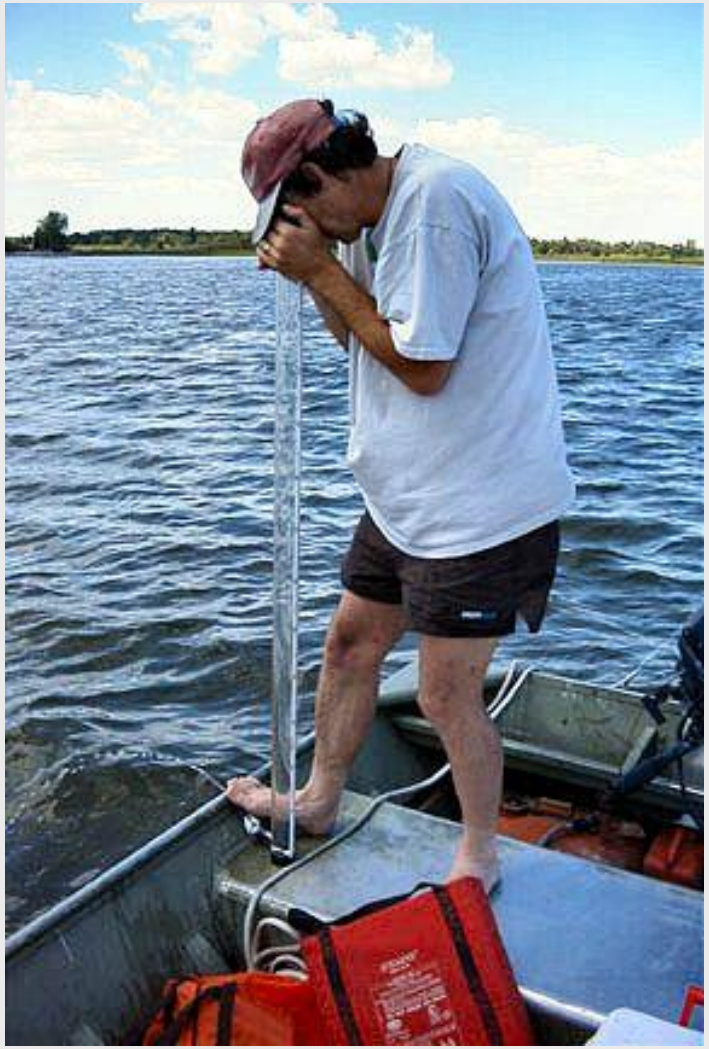
- JTU's are from an "older" technology in which a candle flame was viewed through a tube of water

1 NTU = 1 JTU (Jackson Turbidity Unit)

Water clarity – transparency tubes

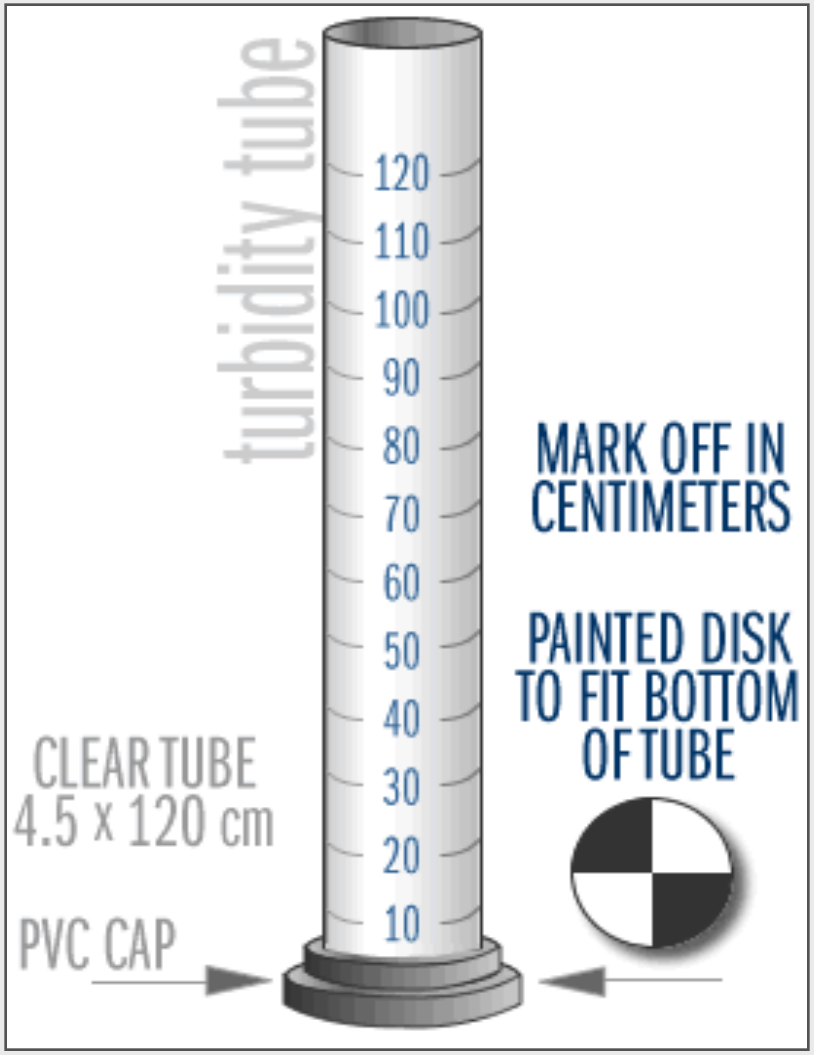
Water clarity – transparency tubes

- Used in streams, ponds, wetlands, and some coastal zones
- Analogous to secchi depth in lakes: a measure of the dissolved and particulate material in the water



Water clarity – transparency tubes

- Useful for shallow water or fast moving streams bodies where a secchi would still be visible on the bottom
- It is a good measure of turbidity and suspended sediment (TSS)
- Used in many volunteer stream monitoring programs



AlkalinityAlkalinity

- a measure of the **pH-buffering capacity or the acid-neutralizing capacity of water.**
- In chemical terms, alkalinity is defined as
- **the total amount of titratable bases in water expressed as mg/L equivalent calcium carbonate ($CaCO_3$).**

Alkalinity

Alkalinity (50 -150 mg/l as $CaCO_3$)

Formula	Common Name	Equivalent Weight
NaOH	sodium hydroxide	40
Na_2CO_3	sodium carbonate	53
$NaHCO_3$	sodium bicarbonate	83
$CaCO_3$	Calcium Carbonate	50
CaO	slaked lime	28
$Ca(OH)_2$	hydrated lime	37

- Alkalinity

2320 – Titration Method

Titration with 0.02 N Sulfuric Acid with methyl orange indicator end point (4.5 pH)

1 ml titrant equals 10 mg/L $CaCO_3$.

Salinity

Usually reported as parts per thousand, ppt.

Osmoregulation

Rule of Thumb

To reduce stress and reduce energy required for osmoregulation, freshwater aquaculture systems are maintained at 2-3 ppt salinity.

Specific electrical conductivity = EC25

EC25 - importance

- **Cheap, easy way to characterize the total dissolved salt concentration of a water sample**

- **For tracing water masses and defining mixing zones**
  - Groundwater plumes
  - Stream flowing into another stream or into a lake or reservoir

Solids – settleable, suspended, dissolved

Rule of Thumb

Solids produced by fish :
0.3 to 0.4 kg TSS for every
1 kg of feed fed

Three categories:

- settleable
- suspended
- fine or dissolved solids

- upper limit: 25 mg TSS/L
- normal operation (species dependen
  - 10 mg/L for cold water species
  - 20 – 30 mg/L for warm water species

EC25 – units and reporting

Principle of measurement

- A small voltage is applied between 2 parallel metal rod shaped electrodes, usually 1 cm apart
- **Measured current flow** is **proportional** to the **dissolved ion content of the water**
- If the sensor is **temperature compensated to 25ºC**, EC is called *"specific"* **EC (EC25)**

EC25 - units

- What in the **world** are microSiemens per centimeter **(µS/cm)**

- Units for EC and EC25 are mS/cm or µS/cm @25°C. The WOW site reports it as EC @25°C (in µS/cm).

- Usually report to 2 or 3 significant figures (to ± ~ 1-5 µS/cm)

EC25

- EC25 values in **streams** reflect primarily a combination of watershed sources of salts and the hydrology of the system
  - *wastewater* from sewage treatment plants and industrial discharge
  - *wastewater* from on-site wastewater treatment and dispersal systems (septic systems and drain fields)
  - *urban runoff*
  - *agricultural runoff*
  - *acid mine drainage*
  - *atmospheric inputs*

Hardness

Classified as:

soft (0-75 mg/L

moderately hard (75 – 150 mg/L)

hard (150-300 mg/L)

very hard (> 300 mg/L)

Recommended range: 20 to 300 mg/L $CaCO_3$

Salinity

Measurement of a physical property:

- **Conductivity**
- **Density - hydrometer**
- **Refractive index**

Ammonia, Nitrite and Nitrate

Ammonia: colorimetric Nesslerization
ion specific electrodes

Nitrite: colorimetric

Nitrate: reducing to nitrite with cadmium
catalyst, measure nitrite.
ion specific electrode

Nitrates, Nitrites, and Ammonia

- **Nitrogen** is an **essential nutrient**
- required by all plants and animals for the **formation of amino acids**
- In **molecular form**, nitrogen **cannot be used** by **most aquatic plants**
- therefore it must be **converted to** another form
- such form is **ammonia (NH_3)**

common procedure for measuring nitrate

- **first measure** the **amount of nitrite in a sample**
- **reduce** any nitrate **to nitrite**
- Lastly**, measure the combined nitrite** (the initial nitrite plus the reduced nitrate) concentration

- Ammonia may be taken up by plants or
- oxidized by bacteria into nitrate (NO_3^-) or nitrite (NO_2)
- **nitrate** usually **the most important**
- very **difficult to directly measure**

Common sources of excessive nitrogen

- **Sewage**
- **agricultural runoff**
- Elevated stream water nitrogen levels
- **indicate** the **presence of one or both** of these forms **of pollution**

Taste sense

- able to detect concentrations of a **few tenths** to **several hundreds** of **ppm**
- Taste can indicate that **contaminants** are **present**
- cannot identify **specific contaminants**

Color

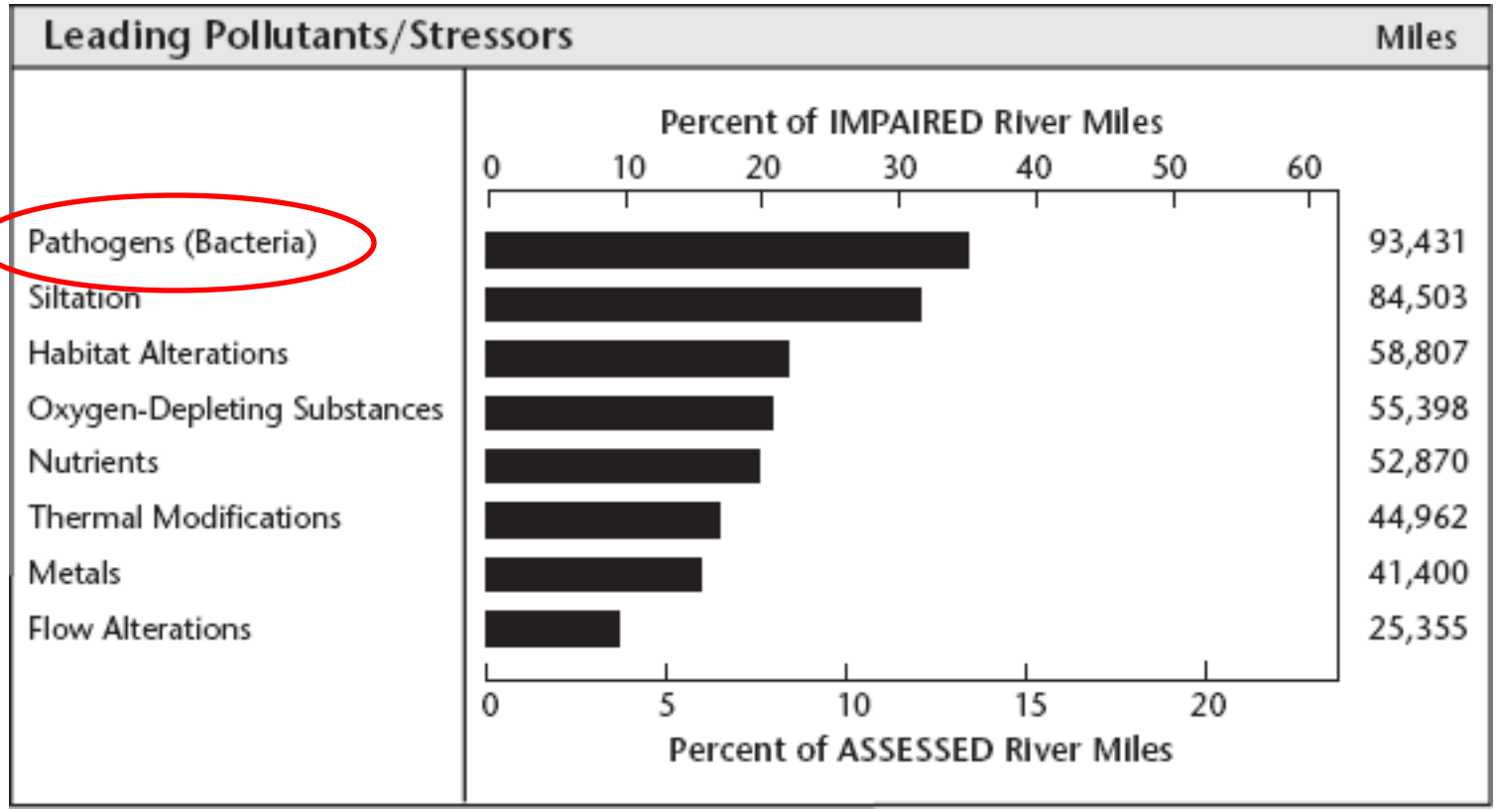
- suggest that **organic impurities** are **present**
- can even be caused by metal ions
- measured by **comparison** of different samples **visually** or with a **spectrometer**
- an unusual color
- usually does **not** mean a **health concern**

Other Water Quality Parameters

- Nutrients – nitrogen and phosphorus
- Fecal coliforms
- Biochemical oxygen demand (BOD)
- Metals
- Toxic contaminants

Fecal coliforms

- **Pathogens are number one**



Water sampling - microbes

- **Sterile technique:**
  - Containers must be sterilized by autoclaving or with gas used to kill microbes
  - Take care not to contaminate the container
  - Water samplers should be swabbed with 70 % alcohol

Bacteria – *E. coli* and fecal coliforms

- Fecal bacteria are used as indicators of possible sewage contamination
- These bacteria indicate the possible presence of disease-causing bacteria, viruses, and protozoans that also live in human and animal digestive systems
- ***E. coli*** is currently replacing the fecal coliform assay in most beach monitoring programs

Water sample collection – grab samples

Grab samples for fecal coliforms are taken with sterile containers

Water sample collection

- **General considerations:**
  - Sample in the main current
  - Avoid disturbing bottom sediments
  - Collect the water sample on your upstream side

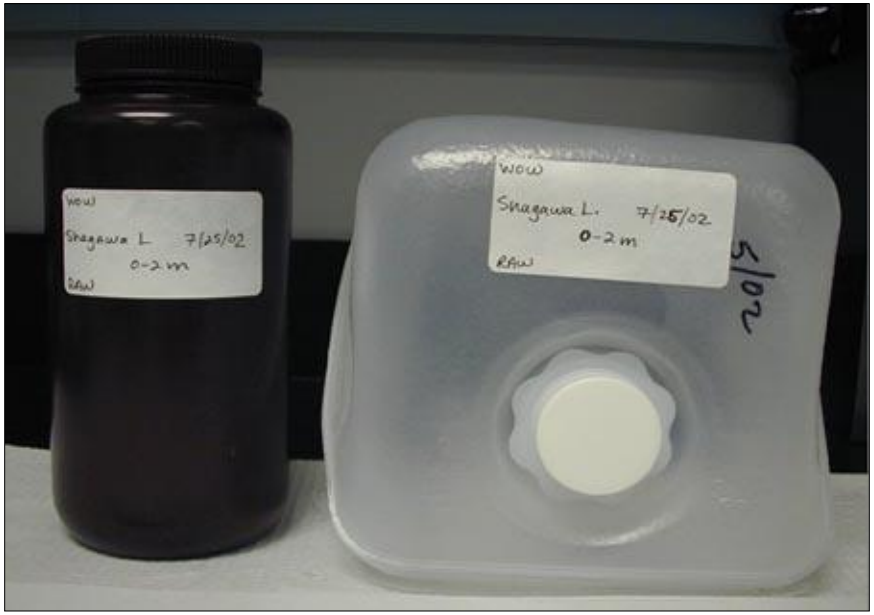
- A detailed discussion on how to manually collect stream and river water can be found in the USGS Field Manual Chapter 4: Collection of Water Samples

Suggested sample volumes

Analyte	Volume needed
chlorophyll	**>500 mLs**
TSS	**Often > 1 L**
total phosphorus **total nitrogen** **anions**	**200 to 500 mLs**
Dissolved nutrients	**~ 100mLs**
Total and dissolved carbon	**~60 mLs**
Metals	**~60 mLs**
color, DOC	**~60 mLs**

Stream sampling– sample labeling

- An unlabeled sample may as well just be dumped down the drain.



- Use good labels not masking tape, etc. Poor labels often fall off when frozen samples are thawed.
- Use permanent markers NOT ball point pens, pencils in a pinch

Water sampling - automated

- Automated stream sampling stations provide continuous monitoring of a variety of parameters
- These units are capable of both collecting water samples and measure various water quality parameters

Automated sampling – Duluth Streams

- **These stream monitoring units are not "state of the art" but provide near real-time data for delivery into the data visualization tools**

water to have a reddish color

- might be affected by **iron**
- a commonly occurring constituent of drinking water
- Iron tends to add a rusty, **reddish brown** (or sometimes **Yellow** color to water
- leaves particles of the same color

- If the color is more like **black**
- it could be a **combination** of **iron** and **manganese**
- Both of these metals can cause
- staining of plumbing fixtures or laundry
- **no**t known to cause **health problems**

Odor

- **smelling** can usually detect even **low levels of contaminants**
- In most countries detecting contaminants through odor is bound to strict regulations
- as it can be a **danger to ones health**
- when dangerous contaminants are present in a sample

water to have an earthy odor

- A frequent cause of musty, earthy odors
- naturally occurring **organic compounds** derived from the **decay of plant material** in lakes and reservoirs
- The odors can be **objectionable**
- generally are **not harmful to health**
- odors can be caused by other constituents as well

water to have a rotten-egg odor

- Hydrogen sulfide (H_2S) is sometimes present in well water
- A few tenths of a milligram of hydrogen sulfide per liter can cause drinking water to have a rotten-egg odor
- While unpleasant, it is **not harmful to health**

sulfur content in well water

- High concentrations of sulfate (SO_4^{--}) may be associated with **diarrhea**
- EPA currently has a secondary drinking-water standard of **250 milligrams per liter** (mg/L) sulfate
- Some waters with elevated sulfate also tend to have low pH (as in acid mine drainage)

tap water often smell like chlorine

- chlorine being the most widely used one
- a very effective **disinfectant**
- If the water has a chlorine smell
- it may actually indicate that **not enough chlorine is being added to the system**
- **By increasing the amount of chlorine** used at the treatment plant, different forms of chlorine are created in the water, which **diminish chlorine odors**


WATER QUALITY REPORT CARD
Overall Grade:


THANK YOU