Black Earth Creek & Limnology Minifacts & Analysis

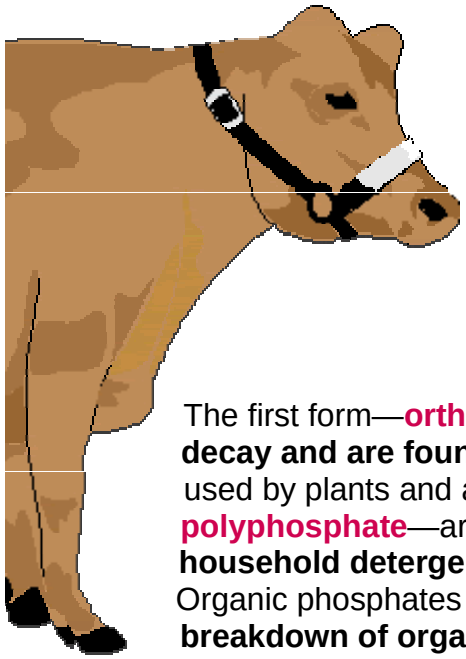
Sheet 2

Phosphorus Amounts

Information on Phosphorus Amounts & Water Quality

Introduction

Phosphorus is one of the key elements **necessary for growth of plants** and animals. **Phosphates PO_4**--- are formed from this element. Phosphorus (P) is an essential nutrient for all life forms. Phosphorus plays a role in deoxyribonucleic acid (DNA), ribonucleic acid (RNA), adenosine diphosphate (ADP), and adenosine triphosphate (ATP). Phosphorus is required for these necessary components of life to occur. Phosphorus is the eleventh most abundant mineral in the earth's crust and does not exist in a gaseous state.



Phosphates can be produced and may occur in water in two Forms. Phosphorus in freshwater and marine systems exists in either a **particulate phase** or a **dissolved phase**. Particulate matter includes living and dead plankton, precipitates of phosphorus, phosphorus adsorbed to particulates, and amorphous phosphorus. The dissolved phase includes inorganic phosphorus, organic phosphorus excreted by organisms, and macromolecular colloidal phosphorus.

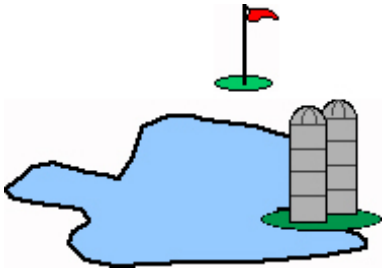
The first form—**orthophosphate**—are produced by natural processes such as **decay and are found in sewage**. This very useful form of phosphorus is the one used by plants and animals for growth. The second form of phosphate—**polyphosphate**—are used for treating boiler waters and are found in **many household detergents and soaps**. In water, they change into the ortho form. Organic phosphates are important in nature. Their occurrence may result from the **breakdown of organic pesticides** which contain phosphates. They may exist in solution, as particles, loose fragments or in the bodies of aquatic organisms.

Environmental Impact:

Lakes and reservoir sediments serve as phosphorus sinks. Phosphorus-containing particles settle to the substrate and are rapidly covered by sediment. Continuous accumulation of sediment will leave some phosphorus too deep within the substrate to be reintroduced to the water.

Rainfall can cause varying amounts of phosphates to wash from farm soils into nearby waterways. Phosphate will stimulate the growth of phytoplankton and aquatic plants which provide food for fish. This may cause an increase in the fish population and improve the overall water quality. However, if an excess of phosphate enters the waterway, algae and aquatic plants will grow wildly, choke up the waterway and use up large amounts of oxygen. This condition is known as eutrophication or over-fertilization of receiving waters. This rapid growth of aquatic vegetation eventually dies and as it decays it uses up oxygen. This process in turn causes the death of aquatic life because of the lowering of dissolved oxygen levels.

Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate. Phosphate itself does not have notable adverse health effects. However, phosphate levels greater than 1.0 may interfere with coagulation in water treatment plants. As a result, organic particles that harbor microorganisms may not be completely removed before distribution.



What Does our Data Tell You?

Designated Use		Limit
Freshwater		
Federal criteria used:		
Streams/rivers:		.1 ppm
Streams entering lakes:		.05 ppm
Lakes/reservoirs:		.025 ppm
State criteria used:		
Reservoirs		
(WI) Streams which do not empty into reservoirs for drinking:		no more than **0.1 ppm**
(WI) Streams discharging into reservoirs for drinking:		no more than **0.05 ppm**
(WI) For reservoirs where drinking water is obtained:		no more than **0.025 ppm**
(MN)	Total P:	.015 ppm
(VT)	Total P:	.014 mg / L
Impoundments (EPA Regoin 4):		
Water Supply	Total P:	.015 mg / L
Aquatic Life	Total P:	.025 mg / L
Lakes	Total P:	.05 mg / L
Mountain Lakes	Total P:	.02 mg / L

Aquatic Life Support	**Maximum Diversity**
Phosphorus	0.01 * (and nitrogen < 0.1 ppm)
Moderate Diversity	0.1 * (and nitrogen < 1.0 ppm)

Environmental Effects:

The growth of larger aquatic plants and phytoplankton is stimulated principally by nutrients such as phosphorus and nitrogen. Nutrient-stimulated primary production is of most concern in lakes and estuaries, because primary production in flowing water is thought to be controlled by physical factors, such as light penetration, timing of flow, and type of substrate available, instead of by nutrients.

- **Freshwater system impacts:** Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used, plant growth will cease, no matter how much nitrogen is available. The natural background levels of total phosphorus are generally less than 0.03 mg/L. The natural levels of phosphate usually range from 0.005 to 0.05 mg/L.

- Many bodies of freshwater are currently experiencing increases of phosphorus and nitrogen from outside sources. The increasing concentration of available phosphorus allows plants to assimilate more nitrogen before the phosphorus is depleted. Thus, if sufficient phosphorus is available, elevated concentrations of nitrates will lead to algal blooms. Although levels of 0.08 to 0.10 ppm phosphate may trigger periodic blooms, long-term eutrophication will usually be prevented if total phosphorus levels are below 0.5 ppm and 0.05 ppm, respectively.

- **Freshwater systems:** Nutrient-induced production of aquatic plants in freshwater has several detrimental consequences:

    1. Algal mats, decaying algal clumps, odors and discoloration of the water will interfere with recreational and aesthetic water uses.
    2. Extensive growth of rooted aquatic macrophytes will interfere with navigation, aeration, and channel capacity.
    3. Dead macrophytes and phytoplankton settle to the bottom of a water body, stimulating microbial breakdown processes that require oxygen. Eventually, oxygen will be depleted.
    4. Aquatic life uses may be hampered when the entire water body experiences daily fluctuations in dissolved oxygen levels as a result of plant respiration at night. Extreme oxygen depletion can lead to death of desirable fish species.
    5. Siliceous diatoms and filamentous algae may clog water treatment plant filters and result in reduced time between backwashing (process of reversing water flow through the water filter in order to remove debris).
    6. Toxic algae (occurrence of "red tide") have been associated with eutrophication in coastal regions and may result in paralytic shellfish poisoning (Mueller et al., 1987).
    7. Algal blooms shade submersed aquatic vegetation, reducing or eliminating photosynthesis and productivity (Dennison et al., 1993; Batiuk et al., 1992).

Sources of Phosphorus:

1. **Nonpoint sources:**

   - **Natural:** Phosphate deposits and phosphate-rich rocks release phosphorus during weathering, erosion, and leaching. Phosphorus may be released from lake and reservoir bottom sediments during seasonal overturns.

2. **Point sources:**

   - Sewage treatment plants provide most of the available phosphorus to surface water bodies. A normal adult excretes 1.3 - 1.5 g of phosphorus per day. Additional phosphorus originates from the use of industrial products, such as toothpaste, detergents, pharmaceuticals, and food-treating compounds. Primary treatment removes only 10% of the phosphorus in the waste stream; secondary treatment removes only 30%. The remainder is discharged to the water body. Tertiary treatment is required to remove additional phosphorus from the water. The amount of additional phosphorus that can be removed varies with the success of the treatment technologies used. Available technologies include biological removal and chemical precipitation.