Nitrogen

Nitrogen **(N_2)** is the most common gas in our atmosphere (70%) and is converted into different forms because living things cannot use it in its gaseous form. Nitrogen is an essential nutrient for plants and animals, since it is a building block for proteins and amino acids. Forms that are common in the environment include **nitrate (NO_3)**, **nitrite (NO_2)**, and **ammonia (NH_3).** We usually measure nitrate when we are testing water quality because it is the most stable form of nitrogen in aquatic systems. Nitrate is found naturally in unpolluted streams and ponds due to the ongoing process of growth and decay, and from inputs from the terrestrial watersheds.

Generally, unpolluted water has a nitrate-nitrogen concentration of less than one milligram per liter (mg/l of NO_3–N). Pollutants such as sewage, fertilizer, or manure contain high levels of nitrate. Although plants need nitrate to grow, when there is excess nitrate in the soil, it accumulates in groundwater or other water bodies. Nitrate can enter streams and ponds from fertilized fields or lawns, from septic system discharge, or from manure runoff. According to the Environmental Protection Agency, nitrate levels in public water supplies must be less than 10 mg/l of NO_3–N (maximum contaminant level), and 1 mg/L for nitrite-nitrogen for regulated public water systems. Some wildlife, however, can tolerate concentrations of up to 100mg/L NO_3–N. Nitrate is also present in the atmosphere from the combustion of fossil fuels by cars and power plants. Nitrate dissolved in rain water falls to the earth's surface where it enters streams directly or in enters surface runoff. Nitrate-nitrogen concentrations in light rainfall range from 3.0 to 4.0 mg/l, while those in heavy rainfall are more dilute: 0.4 to 1.0 mg/l.

Nitrate is a plant nutrient, but if high levels of nitrate enter a water supply, the algae and other water plants grow rapidly, as long as other essential nutrients like phosphorous are present, and nothing else (like light) is limiting. Water can become thick with algae as a result of the increase in growth. When algae die and sink to the bottom of the water body, the bacteria that decompose these tiny plants use up the available oxygen. The oxygen levels get so low that many types of fish and insects can no longer survive in the water. This process is called eutrophication and can happen in freshwater and coastal ecosystems (to read more about this process, check out the information in "Ponds and Eutrophication").

Nitrate in public water supplies threaten human health if levels exceed 10 mg/l of nitrate-nitrogen (NO_3 – N) or 45 ppm nitrate (NO_3). Infants are especially at risk from a disease called "methemoglobinemia", or blue baby syndrome, which occurs when nitrate keep a baby's blood from carrying enough oxygen. When getting your water tested for nitrogen, be sure to find out what form of nitrogen was tested. Some labs report nitrate, while others report nitrate-nitrogen (the amount of nitrogen in the nitrate form). To compare the two types of reporting systems, see the end of this reading.

The Hudson river has moderately high levels of nitrate. In the freshwater part of the river, concentrations are usually about 2.2 mg/L of NO_3 or 0.5 mg/L of $NO_3 – N$. Ammonia concentrations are much lower, except in New York harbor where high levels of all forms of nitrogen are found due largely to sewage inputs. Like many rivers, the Hudson has a lot of suspended silt (high levels of turbidity), which limits the amount of sunlight that penetrates the water. Consequently, the Hudson does not have problems with eutrophication because there is not enough sunlight to increase the algal growth. However, if the Hudson were to become less turbid, there are lots of excess nutrients (both N and P) to support enormous amounts of algal growth. The NO_3 that the Hudson River discharges into the coastal ocean does contribute to eutrophication in the coastal region.

<u>What does this mean?</u>

Clean water generally has less than 1 mg/L nitrate-nitrogen. High readings indicate pollution from fertilizer, sewage, or industrial waste. Sewage treatment plant effluent often has discharge with nitrate levels of 30 mg/L $NO_3 – N$. For other classes of water (fishing, swimming water) the New York government states "none that will result in growths of algae, weeds, and slime that will impair uses".

<u>Conversions:</u>

Convert nitrate-nitrogen to nitrate:

x mg/L nitrate nitrogen ($NO_3 – N$) * 4.43= y mg/L nitrate (NO_3)

Convert nitrate to nitrate-nitrogen:
x mg/L nitrate (NO_3) * 0.226 = y mg/L nitrate nitrogen ($NO_3 – N$)

Convert µmol/L to mg/L
Many scientists use µmol/L instead of mg/L. In order to convert, you first need to get from µmol to mol. We'll use 35 µmol/L NO_3, since this is the mean value in the Hudson River.

35 µmol/L NO_3 * 1 mol/1,000,000 µmol = 0.000035 mol/L

To go from moles to grams, you need to know the molar mass of the substance that you are converting, which in this case, is nitrate. You simply add together the atomic weights of the compound: 14 + (3*16) = 62. (14 is the molecular weight of nitrogen, and 16 is that of oxygen, multiplied three times.) Now, multiply your moles by the molar mass, which is expressed in grams/mol.

0.000035 mol/L * 62 g/mol = 0.00217 g/L

Finally, convert to mg:

0.00217 g/L * 1000 mg/g = 2.17 mg/L NO_3

Therefore, 35 µmol/L NO_3 is the same as 2.17 mg/L NO_3.