Table Of Common Contaminants **Page**

1. Aldrin

Maximum Contaminant Limit = zero

Aldrin is an organochlorine insecticide that was widely used until the 1990s, when it was banned in most countries. It is a colorless solid. Aldrin is a highly effective insecticide for soil-dwelling pests and for the protection of wooden structures against termites and wood borers. Despite being banned, Aldrin remains a persistent pollutant and can remain in soil for years in certain climates.

Aldrin can enter the environment from accidental spills or leaks from storage containers at waste sites. In the past, Aldrin entered the environment when farmers used it to kill crop pests and when exterminators used it to kill termites. Aldrin is still present in the environment from the past. Most commonly, exposure to Aldrin occurs when people ingest food and drinking water contaminated with it. Foods containing Aldrin might include fish or shellfish from contaminated lakes or streams, root crops, dairy products, and meats. Exposure can also occur from physical contact with Aldrin-contaminated air, water and soil.

Aldrin is highly toxic to humans. The target organs affected are typically **the central nervous system** and the **liver**. Severe cases of both accidental and occupational poisoning resulted in fatalities. Studies have also shown that occupational exposure to Aldrin is associated with a significant increase in **liver and biliary cancer.** Other studies have postulated that exposure to Aldrin can increase chances of developing **cancers in the oesophagus, rectum and liver.** The lethal dose of Aldrin is estimated to be approximately 10 mg/kg of body weight per day. Signs of Aldrin exposure include:

- **Headache**
- **Dizziness**
- **Nausea**
- **Malaise**
- **Vomiting**
- **Muscle twitching**
- **Myoclonic Jerks**
- **Convulsions**

**Use of Aldrin is banned or severely restricted in the following countries:

- **United States**
- **European Union**
- **Canada**
- **New Zealand**
- **Japan**
- **Bulgaria,**
- **Ecuador**
- **Finland**
- **Hungary**
- **Israel**
- **Singapore**
- **Switzerland**
- **Turkey**
- **Argentina**
- **Austria**
- **Chile**
- **New Zealand**
- **Philippines**
- **Venezuela**

2. Arsenic (As)

Maximum Contaminant Limit = .01 ppm

Arsenic is a natural component of the earth's crust and is widely distributed throughout the environment in the air, water and land. It is highly toxic in its inorganic form. Exposure to elevated levels of inorganic arsenic can occur by: drinking contaminated water, using contaminated water in food preparation and irrigation of food crops, industrial processes, eating contaminated food and smoking tobacco.

The greatest threat to public health from arsenic originates from **contaminated groundwater**. Inorganic arsenic is naturally present at high levels in the groundwater of a number of countries, including Argentina, Bangladesh, Chile, China, India, Mexico, and the United States. Drinking-water, crops irrigated

with contaminated water, food prepared with contaminated water, and industrial runoff are some of the common sources of exposure.

Inorganic arsenic is **a confirmed carcinogen** and is the most significant chemical contaminant in drinking-water globally. The immediate symptoms of acute arsenic poisoning include:

- **Vomiting**
- **Abdominal Pain**
- **Diarrhea**
- **Numbness**
- **Tingling of the extremities,**
- **Muscle Cramping**

The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humans, and has also stated that arsenic in drinking-water is **carcinogenic to humans**. Long-term exposure to arsenic through drinking-water and food is linked to a multitude of diseases and **cancers**, including:

- **Skin cancer**
- **Bladder Cancer**
- **Lung Cancer**
- **Diabetes**
- **Pulmonary Disease**
- **Cardiovascular Disease**

Pregnancy & Early Childhood Development

Arsenic is also associated with adverse pregnancy outcomes and infant mortality. Arsenic exposure in utero and in early childhood has been linked to increases in mortality in young adults due **to multiple cancers, lung disease**, **heart attacks**, and **kidney failure**.. Numerous studies have demonstrated negative impacts of arsenic exposure on **cognitive development, intelligence**, and **memory**.

3. <u>Asbestos</u>

<u>Maximum Contaminant Limit = 7 MFL (Million Fibers per Liter)</u>

Asbestos is a term for a group of naturally occurring fibrous minerals that have been used in a wide range of cement-based building products including roofing, wall and fence sheeting, water pipes, and flues for heating appliances. Asbestos fibers can manifest in air and water through two primary means: the weathering of natural deposits and the degradation of manufactured asbestos products, like those that were once commonly used in building materials and plumping. <u>The American Cancer Society</u> has classified several types of asbestos as known **carcinogens** in humans.

Although the most common means of asbestos exposure happens through inhalation, it can also occur by consuming asbestos fibers that are present in water. Fibers typically enter a water supply via erosion from natural deposits or piles of waste asbestos, from asbestos-containing cement pipes used to carry drinking water, or from filtering through asbestos-containing filters. Most drinking water supplies in the United States have concentrations of less than 1 million fibers per liter (MFL), even in areas with asbestos deposits or asbestos-cement water supply pipes.

While much scientific literature exists linking asbestos inhalation with increases in **lung cancer** and **mesothelioma**, currently there is no scientific consensus on the health effects of ingesting asbestos in drinking water. A small number of epidemiological studies have found a weak positive association between asbestos fiber ingestion and **gastrointestinal cancer**. Other studies have shown a **higher-than-average rate of death** from certain **cancers** (**Stomach, Intestinal, Esophageal**). Some long-term animal laboratory testing studies have also suggested a **statistically significant increase in the appearance of polyps** associated with asbestos fiber ingestion.

4. Calcium (Ca)

Calcium is a chemical element that is essential for living organisms, including humans. It is the most abundant mineral in the body and vital for good health. Calcium occurs naturally in water as it can dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, and fluorite. The presence of calcium in a water source is a primary factor in determining **water hardness**. Calcium laden water can cause mineral deposit build-up in a plumping system leading to reduced efficiency of water pipes, water heaters, and reduced effectiveness of soaps and detergents

For the vast majority of healthy people, when calcium is absorbed in excess of need, the kidney excretes the excess. However, excess calcium intake primarily affects those who are prone to **milk alkali syndrome,** a condition that is caused by the ingestion of large amounts of calcium, and absorbable alkali, with resulting **hypercalcemia.** Symptoms of **milk alkali syndrome** and **hypercalcemia** include:

- **Loss of appetite**
- **Dry Mouth**
- **Dizziness**
- **Headache**
- **Confusion**
- **Diuresis**
- **Psychosis**
- **Kidney Failure**
- **Metabolic Alkalosis***

***Metabolic Alkalosis** is a metabolic condition in which the pH of tissue in the body is elevated beyond the normal range (7.35–7.45). Symptoms of **Metabolic Alkalosis** include

- **Confusion**
- **Hand Tremors**
- **Lightheadedness**
- **Muscle Twitching**
- **Nausea**
- **Vomiting**
- **Extremity Numbness**
- **Prolonged muscle spasms.**

5. Chlorine (Cl)

Chlorine is a common chemical element and member of a group of compounds known as *halogens.* Chlorine is a yellow-green gas at room temperature. It is an extremely reactive element and a strong oxidizing agent. Large amounts of chlorine are produced for use as disinfectants and bleach for both domestic and industrial purposes. Chlorine is widely used to disinfect drinking water and swimming pools and to control bacteria and odors in the food industry

Chlorine is present in most disinfected drinking-water at concentrations of 0.2–1 mg/liter. Studies on the effects of heavily chlorinated water on human populations exposed for varying periods did not show any adverse health effects. Some studies on the effects of progressively increasing chlorine doses on healthy male volunteers showed an absence of adverse, physiologically significant toxicological effects in all of the study groups It has been reported that **asthma** can be triggered by exposure to chlorine. Episodes of **Dermatitis** have also been associated with chlorine exposure to the skin. Symptoms of dermatitis include:

- **Dry, Flaky Skin**
- **Peeling**
- **Persistent Rashes**
- **Skin Redness**
- **Dandruff**

Other studies have shown an **increased risk of bladder cancer** appeared to be associated with the consumption of chlorinated tap water in a population-based, case–control study of adults consuming chlorinated or non-chlorinated water for half of their lifetimes.

**The EPA lists the maximum contaminant level (MCL) for chlorine at 4 mg/L or 4 ppm.

Chlorine Poisoning

Exposure to high levels of chlorine can cause significant **damage to the human circulatory system**. Incidents of **chlorine poisoning** usually occur from ingesting household cleaning products. Symptoms of chlorine poisoning include:

- **Burning of the mouth & throat**
- **Esophageal Swelling**
- **Stomach Pain**
- **Vomiting**
- **Bloody Stool**
- **Blurry Vision**
- **Low Blood Pressure**
- **Vision Loss**
- **Dermal Tissue damage/irritation**

6. Copper (Cu)

Maximum Contaminant Limit = 1.0 ppm

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. It is an essential element for all known living organisms including humans, plants, and animals at low levels of intake. At higher levels of exposure however, it can have toxic effects. It is common in the western hemisphere for plumping systems to contain copper and brass fixtures. Highly corrosive water can leach soluble copper into drinking water at levels beyond acceptable standards.

Consuming water with elevated levels of copper can lead to a **copper toxicity**, as well as a variety of **gastrointestina**l and other health issues including:

- **Nausea**
- **Vomiting**
- **Stomach Cramps**
- **Diarrhea**
- **Jaundice**
- **Muscle Pain**
- **Liver Damage**
- **Heart Failure**
- **Renal Failure (Kidney Disease)**

Other studies on copper consumption have suggested that copper prevents the clearance of toxic proteins in the brain, which could lead to the onset, and rapid progression of **Alzheimer's Disease**.

Furthermore, scientific studies conducted over the past two decades has shown that copper plays an important role in inflammation and the growth of **cancerous tumors.** The copper concentration in serum (blood) and tumor tissue is significantly higher than that of healthy individuals.

7. Iron (Fe)

Maximum Contaminant Limit = .3 ppm

Iron is the second most abundant metal on the planet, accounting for 5% of the Earth's crust. Elemental iron is rarely found in nature, as it readily combines with oxygen- and sulfur-containing compounds to form oxides, hydroxides, carbonates, and sulfides. It is an essential element in human nutrition. The estimated minimum daily requirement for iron ranges from 10 to 50 mg/day depending on age, sex, physiological status, and iron bioavailability.

The average lethal dose of iron is 200–250 mg/kg of body weight, however fatalities have occurred following the ingestion of doses as low as 40 mg/kg of body weight. Excess ingestion of iron can lead to a condition called **Iron Overload**. Iron Overload is generally the result of a genetic disorder known as **Hemochromatosis,** which affects around 1 million people in the United States.

Symptoms related to conditions that arise from iron overload such as:

- **Diabetes**
- **Darkening/Discoloration of the skin**
- **Heart Arrhythmias**
- **Arthritis/Joint Pain**
- **Fatigue**
- **Abdominal pain**
- **Liver disease**
- **Loss of sex drive**
- **Impotence**

8. <u>Lead</u>

<u>Maximum Contaminant Limit = .015 (Action Level)</u>

Lead is the most common of the heavy elements in existence, accounting for .0013% of the Earth's crust. It is a heavy metal that is denser than most common elements. Lead is soft and malleable, and has a relatively low melting point. When freshly cut, lead is silvery with a hint of blue; it tarnishes to a dull gray color when exposed to air.

Lead is used in the production of lead acid batteries, solder, alloys, cable sheathing, pigments, rust inhibitors, ammunition, glazes and plastic stabilizers. In the past, there was almost universal use of lead compounds in plumbing fittings and as solder in water distribution systems which was a significant contributing factor to elevated lead levels in drinking water. Lead pipes are also commonly found in older distribution systems and plumbing.

Lead is present in tap water to some extent as a result of its dissolution from natural sources, but primarily comes from household plumbing systems in which pipes, solder, fittings or service connections to homes contain lead. Polyvinyl chloride (PVC) pipes also contain lead compounds that can leach in high concentrations in drinking water. The amount of lead dissolved from the plumbing system depends on several factors, including the presence of chloride and dissolved oxygen, pH, temperature, water softness and standing time of the water. Soft, acidic water is the most absolvent. Soldered connections in recently built homes fitted with copper piping can release enough lead **to cause intoxication in children.**
Lead can also be released from flaking lead pipe and iron sediment from old galvanized plumbing service connections,

Lead is a cumulative general poison for **infants, children up to 6 years of age, fetuses, and pregnant women being the most susceptible** to adverse health effects. Its effects on the central nervous system can be particularly serious. Symptoms of long-term exposure **and acute lead poisoning** include:

- **Dullness,**
- **Restlessness**
- **Irritability**
- **Poor Attention Span**
- **Headaches**
- **Muscle Tremors,**
- **Gastrointestinal Symptoms**
- **Kidney Damage**
- **Hallucinations**
- **Memory Loss**
- **Encephalopathy ***
- **Damage to Central and Peripheral Nervous System**

* *Encephalopathy is a general term describing a disease that affects the function or structure of your brain*

Long-term exposure to lead can result in reproductive defects in both men and women. In men, studies have shown that acute exposure of lead can cause **gonadal dysfunction**, including **depressed sperm counts.** Reproductive dysfunction may also occur in females occupationally exposed to lead.

Pregnant Women

Epidemiological studies have shown that lead exposure for pregnant women leads to an **increased risk of pre-term delivery**. A study of 774 pregnant women who were followed to the completion of their pregnancy saw the relative risk of pre-term delivery was **more than 4 times higher among women with elevated blood lead levels.**

Fetal Development

Fetal lead exposure has an **adverse effect on neurodevelopment**, said effect may be most pronounced during the first trimester and best captured by measuring lead in either maternal plasma or whole blood. Studies have been conducted on children tested at 24 months of age months using the Mental Development Index (MDI), which evaluates memory, language, and sensory abilities, Researchers found that lead exposure during the **first trimester of pregnancy was more strongly linked to later decreases in the MDI scores** than exposure during the latter two trimesters

Children

Lead poisoning can lead to a variety of health problems in kids, including:

- **Decreased bone/muscle growth**
- **Poor Muscle Coordination**
- **Damage to Nervous System**
- **Renal (kidney) failure**
- **Hearing, Speech problems**
- **Developmental delay**
- **Seizures**
- **Unconsciousness**
- **Behavioral Problems/Irritability**
- **Difficulty Concentrating**
- **Headaches**
- **Loss of Appetite**
- **Weight Loss**
- **Sluggishness or Fatigue**
- **Abdominal Pain**
- **Vomiting**
- **Nausea**
- **Constipation**
- **Anemia**
- **Metallic taste in mouth**
- **Muscle and Joint Weakness/Pain**

9. Magnesium (Mg)

Magnesium is a chemical element and abundant mineral in the body that is also present in many foods. It is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Magnesium is a natural component of surface water, and its concentrations can be shaped by various factors, mostly the geological structure of an area, soil, regional flora, weather conditions, and intensity of the water supply (ground and surface water runoffs and outflows). It is one of the most prevalent alkali metals in nature.

Generally, excess intake of magnesium does not pose a health risk in healthy individuals because normal renal function will excrete it in urine. For individuals diagnosed with kidney problems, excess intake of magnesium can lead to elevated levels in the human body, a condition known as **Hypermagnesaemia.** The major cause of **hypermagnesaemia** is renal (kidney) insufficiency associated with a significantly decreased ability to excrete magnesium. Symptoms of **Hypermagnesaemia** include:

- **Weakness, nausea and vomiting**
- **Impaired breathing**
- **Decreased respirations**
- **Low blood pressure**
- **Low blood calcium**
- **Abnormal heart rhythms and asystole.**

- **Decreased or absent deep tendon reflexes.**
- **Low heart rate.**

Drinking water with elevated levels of magnesium may cause **diarrhea** but seldom causes **hypermagnesaemia** in persons with normal kidney function.

10. Manganese (Mn)

Maximum Contaminant Limit = .05 ppm

Manganese is a naturally occurring element commonly found in minerals, rocks, and soil. It is the 12th most abundant element on Earth and thus is widely distributed across the planet's surface. Manganese is naturally present in surface and groundwater sources and in soils that may erode into these waters. Human activities are responsible for much of the manganese contamination in water in some areas, particularly where there is a high-density of motor vehicle traffic and fossil fuel use.

The human body requires a small amount of manganese to maintain proper health. However, adverse health effects can be caused by overexposure. The EPA recommends a concentration of manganese in drinking water not to exceed 0.05 ppm. The common means of exposure happens via inhalation and ingestion of contaminated water. Over-consumption of manganese can cause a **"Parkinson's-like**" neurological disorder known as **Manganism.** Symptoms include:

- **Tremors**
- **Difficult walking**
- **Cognitive Impairment (Memory loss, difficulty concentrating)**
- **Facial Muscle Spasms**
- **Irritability**
- **Hallucinations**

Indirect evidence exists showing that **reproductive outcomes may be affected** in manganese-exposed men. Issues include:

- **Decreased libido**
- **Impotence**
- **Increased Sexual Dysfunction**
- **Reduced Sperm Quality**

Excessive manganese in drinking water poses a particularly high risk to children and infants. Research studies have shown that consuming too much manganese in drinking water can **affect the behavioral and cognitive development** of infants. Toddlers and young children with long-term exposure to manganese in drinking water can **develop problems with memory, attention, and motor skills.**

11. Microbeads & Microplastics

Microbeads are manufactured solid plastic particles of less than one millimeter in their largest dimension. They are most frequently made of polyethylene but can be of other petrochemical plastics such as polypropylene and polystyrene. They are used in exfoliating personal cosmetic care products such as soap, facial scrubs, and toothpastes, and in biomedical and health-science research.

Plastic particle pollution occurs when microbeads are washed down a drain and pass unfiltered through water treatment facilities and make their way into rivers and canals. Once in a water system,

microbeads can exacerbate the problems caused by other pollutants like pesticides and polycyclic hydrocarbons by absorption and concentration.

The proliferation of microbead plastics in the Earth's water systems is a relatively new phenomenon. So far, no long-term scientific studies on microplastic toxicity in humans have been performed. Animal studies however, have show that microparticles can infiltrate an affected creature's bloodstream, lymphatic system, and perhaps their liver, while simultaneously accumulating in the gut with potentially harmful consequences for their organs, intestines, and hormone regulation.

Some recent facts and stories on microbead plastics include:

- A study conducted by scientists at the State University of New York in Fredonia analyzed 259 bottles of water from 19 locations in nine countries across 11 different brands. Results showed **an average of 325 plastic particles for every liter of water sold.**

- Microbeads have been found to pollute the Great Lakes in high concentrations, particularly Lake Erie. A study from the State University of New York, found anywhere **from 1,500 to 1.1 million microbeads per square mile** on the surface of the Great Lakes.

- A recent study conducted by the United European Gastroenterology organization took stool samples from eight subjects from eight different countries (Austria, Italy, Finland, Japan, the Netherlands, Poland, Russia, and the UK). **Every participant's sample tested positive** for the presence of microplastics.

- A total of 24 German beer brands was analysed for the contents of microplastic fibres, fragments and granular material**. In all cases contamination was found**.

- In China, a study on Sea Salt and Table Salt products found **abundant levels of microplastic contamination**

- A test conducted on 20 brands of honey originating from Switzerland **found that all samples contained three different forms of microplastic** , including: clothing fibres, fragments of sheet plastic and granular material coming from cosmetics and toothpaste

- A report prepared by the International Maritime Organization, the UN agency responsible for preventing marine pollution has shown **a significant presence of microbead plastics in supermarket fish and shellfish**. A researcher involved in the study stated, *"It has infiltrated every level of the food chain in marine environments and likely fresh water, and so now we're seeing it come back to us on our dinner plates,"*

- In December 2015, then-President Barack Obama signed the **Microbead-Free Waters Act** prohibiting the manufacture and introduction into interstate commerce of rinse-off cosmetics containing intentionally-added plastic microbeads.

- Since 2015 in addition to the U.S, the following countries have banned, or begun the legislative process to ban, products containing microbeads: **Canada, France, India, Italy, Ireland, Netherlands, New Zealand, Sweden, South Africa, Taiwan, and the United Kingdom**

12. MTBE

MTBE (*methyl tertiary-butyl ether*) is a flammable, colorless liquid that dissolves easily in water. It is part of a group of chemicals known as *fuel oxygenates*. Oxygenates do not occur naturally in gasoline; but are added to increase gasoline's oxygen content. MTBE and other oxygenates make gasoline burn better, which lowers harmful carbon monoxide and other emissions from vehicles, reducing air pollution.

MTBE's widespread use as a gasoline additive provides a number of opportunities for release into the nation's ground and surface waters. According to the Alliance for Proper Gasoline Handling, each year approximately 9 million gallons of gasoline are released to the environment in the United States from leaks and spills. Leakage from gasoline storage and distribution systems is a major source of both aboveground and underground contamination. Underground storage tanks (USTs) and other gasoline storage and distribution facilities are also responsible for releasing large volumes of gasoline into the environment

From a drinking-water perspective, one of the most important aspects of MTBE is its objectionable taste and odour. MTBE is resistant to chemical and microbial decomposition in water. In surface water, MTBE will usually be removed very rapidly due to its high volatility. In groundwater, it is more persistent than in surface water because its volatilization to air will be reduced or eliminated. MTBE does not adsorb into soil particles to a great degree and is considered mobile.

The majority of the human health-related research conducted to date on MTBE has focused on effects associated with the inhalation of the chemical. There have been no studies of human health effects following oral exposure to MTBE. However, numerous studies have shown a human response to inhalation MTBE in air, particularly in areas where MTBE has been added to gasoline. Following the introduction of petrol containing 15% by volume of MTBE to Alaska there were numerous consumer complaints of **headaches**, **eye irritation** and **coughs** reported.

The EPA's Office of Water has concluded that available data is not adequate to estimate potential health risks of MTBE at low exposure levels in drinking water, but the data supports the conclusion that MTBE is **a potential human carcinogen at high doses**.

13. Nitrates-Nitrogen

Maximum Contaminant Level = 10 ppm

Nitrates are inorganic compounds that occur under a variety of conditions in the environment, both naturally and synthetically. They are the most common form of groundwater contaminant in rural areas. Excess nitrate levels in water, while not posing a direct threat to older adults, can be especially harmful to infants and young children. **Methemoglobinemia**, or "blue baby" disease, can occur when nitrates interact with iron-based hemoglobin in the blood and form **methemoglobin**, which can have a drastic affect on the capacity of red blood cells to carry oxygen in the body. Short-term exposure to drinking water with a nitrate level at or just above the health standard of 10 ppm nitrate-N can cause potential health problems for infants. Babies tend to consume large quantities of water relative to their body weight, especially if water is used to mix powdered or concentrated formulas or juices.

Nitrate in groundwater originates primarily from:

- **Fertilizers**
- **Septic systems**
- **Manure storage or spreading operations.**

Nitrogen in fertilizer that is not taken up by plants, volatilized, or carried away by surface runoff leaches to the groundwater in the form of nitrate. Nitrogen from manure similarly can leach from fields, barnyards, or storage locations. Septic systems may also elevate groundwater nitrate concentrations because they remove only half of the nitrogen in wastewater, leaving the remaining half to percolate in to groundwater.

14. **pH** (EPA Recommended Range = 6.5-8.5)

"pH" is a term used in chemistry to measure the alkalinity or acidity of an aqueous solution on a scale of 1-14. Pure distilled water that registers a neutral pH of "7" is neither acidic nor alkaline.

a.) Acidic Water (Less than pH 7)

Water with an acidic pH level will leach metal from a plumbing system and cause significant corrosion. As a result, acidic water tends to be high in **iron**, **manganese**, **lead, copper**, and **zinc**.

The high concentratn of **lead** in drinking water is a primary concern of high pH. It places adults at risk for health problems such a:

Cancer
Stroke
Kidney Disease
Cognitive and Memory problems
High Blood Pressure.

Children are at a **greater risk** because their rapidly growing bodies absorb the contaminant more quickly.

Copper, **Iron**, **Zinc** and **Manganese** are also classified as secondary drinking water contaminants. These contaminants are likely to cause hard water and staining problems at home. But if found in elevated levels, they could cause a variety of health issues including:

- **Nausea**
- **Vomiting**
- **Diarrhea**
- **Stomach cramps**
- **Kidney Disease**
- **Liver Disease**
- **Nervous system problems.**

b.) Acidic Water and Reverse Osmosis

Water purified through a process of reverse osmosis (RO) tends to become acidic, as minerals like calcium and magnesium get filtered out through the system's semi-permeable membrane. Consuming acidic water can lead to a disorder in the body known as **Acidosis**, which occurs when the human body is unable to naturally regulate pH levels because body fluids are overly acidic. This condition forces the body to borrow minerals—including calcium, sodium, potassium and magnesium—from the gastrointestinal tract, other vital organs and bones to buffer (neutralize) the acid and safely remove it from the body.

Issues relating to acidosis include:

- Cardiovascular damage
- Gastrointestinal Distress – Severe Diarrhea
- Weight gain, obesity, and diabetes
- Bladder and kidney conditions – Diuresis
- Immune deficiency
- Osteoporosis; weak, brittle bones, hip fractures and bone spurs
- Joint pain, aching muscles and lactic acid buildup
- Low energy and chronic fatigue

c.) Alkaline/Basic Water (Greater than pH 7)

While drinking alkaline water is generally considered safe, high levels of consumption can lead to negative side effects including the lowering of natural stomach acidity, which helps kill bacteria and expel other undesirable pathogens from entering your bloodstream. An excess of alkalinity in the body can also cause certain skin and gastrointestinal issues. Agitating the body's normal pH can lead to a condition known as **metabolic alkalosis**, which may produce the following symptoms:

- **Hypocalcemia (Calcium Deficiency)**
- **Nausea**
- **Vomiting**
- **Hand tremors**
- **Muscle twitching**
- **Tingling in the extremities or face**
- **Confusion**

15. Phosphorus (P)

Phosphorus is a chemical element and the second most prevalent mineral in the human body. It is an essential nutrient for critical biological reactions that maintain the healthy homeostasis of cells in the body. Under natural conditions phosphorus is typically scarce in water. As phosphorus is a popular fertilizer for food crops, excessive amounts have entered the environment from runoff polluting streams, rivers, lakes, bays, and coastal waters for the past several decades, resulting in serious environmental and human health issues.

Elevated levels of phosphorus in the water can cause algae to grow faster than ecosystems can handle. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms and they can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish. Some algal blooms, like the red tide which frequently occurs off the Floridian coast, are harmful to humans because they produce elevated toxins and bacterial growth that can make people sick if they come into contact with polluted air or water, consume tainted fish, or drink contaminated water.

Intake of excessive levels of phosphorus can be toxic, with risks being especially high for individuals with kidney problems. Symptoms of **phosphorus toxicity** can include **diarrhea** as well as **hardening of the organs and soft tissue**

16. Potassium (K)

Potassium is one of the seven essential macro-minerals. As a macro mineral, Potassium is an essential element in humans and is seldom found in drinking water at levels that could be a concern for healthy individuals. It occurs widely in the environment, including all natural waters. It can also occur in drinking water as a consequence of the use of potassium permanganate as an oxidant in water treatment. The primary source of potassium for the general population is the diet, as potassium is found in all foods, particularly vegetables and fruits.

Potassium permanganate may be used in the drinking-water treatment process. Resulting levels of potassium in drinking water are relatively low compared with levels resulting from the use of water softeners using potassium chloride. Where potassium permanganate is used in water treatment, recommended concentrations of added potassium can be up to a maximum of 10 mg/l. Although concentrations of potassium normally found in drinking water are generally low and do not pose health concerns, the high solubility of potassium chloride and its use in treatment devices such as water softeners can lead to significantly increased exposure. Increased consumption can lead to a condition known as **Potassium Toxicity.** Case studies on resulting effects of toxicity have reported:

- **Chest Tightness/Difficulty Breathing**
- **Nausea**
- **Vomiting**
- **Diarrhea**
- **Hyperkalaemia**
- **Heart Failure**

Adverse health effects due to excess potassium consumption from drinking water pose a significant risk to certain **high-risk** segments of the general population. High-risk groups susceptible to potassium toxicity include individuals with:

- **Kidney Dysfunction**
- **Heart Disease**
- **Coronary Artery Disease**
- **Hypertension**
- **Hyperkalaemia****
- **Elderly and infants**

****Hyperkalaemia** is a condition that occurs when there are elevated levels of potassium in the blood. Excess potassium in the blood can have serious effects on an individual's normal cardiac functioning. Symptoms of **Hyperkalaemia** include:

- **Heart Arrhythmia (abnormal heart rhythm) – potentially fatal**
- **Slowed Heart Rate**
- **Weakness**

17. Radon (Rn)

Radon is a naturally occurring radioactive gas and human carcinogen found in groundwater and indoor air across the world. Most Radon gas comes into existence through the natural decay process of uranium in the ground. Radon gas is odorless, colorless, and tasteless. It is usually found in igneous rock and soil. In some cases, well water may also be a source of radon.

According to the US Environmental Protection Agency and the Surgeon General's Office, radon exposure causes between 14,000 and 20,000 cancer deaths per year. Radon is the second leading cause of lung cancer. In the US alone, Radon-induced **lung cancer** costs over $2 billion dollars per year in both direct and indirect health care costs.

The primary risk of Radon exposure occurs through inhalation in the house. A common source for Radon can be found in ground water tapped by wells, which supply about half the drinking water in the United States. Ground water moves through rock containing natural uranium that releases radon into the water. The gas is then released into a household as water-containing radon is exposed to the air via taps, shower-heads, and faucets. According to a 1999 study by the National Academy of Sciences, "the majority (90%) of the risk from radon in water is from inhaling the radon released from the water in household uses such as laundering and showering.

Pulmonary symptoms relating to radon exposure include:

- **Persistent cough**
- **Hoarseness**
- **Wheezing**
- **Shortness of breath**
- **Coughing up blood**
- **Chest pain**
- **Frequent infections like bronchitis and pneumonia**
- **Loss of appetite**
- **Weight loss**
- **Fatigue**

Some scientific studies have shown that consuming water-containing radon can lead to elevated levels of radiation in the stomach, which can contribute to the onset of **stomach cancer.**

18. Sodium (Na)

Sodium is a common element in the environment and occurs widely in soils, plants, water, and foods. It is the sixth most abundant element on Earth, making up about 2.6% of the Earth's crust. Sodium is typically present at low-levels in water supplies, however elevated amounts can be found in groundwater wells due to natural and man-made sources.

Sodium ion is ubiquitous in water, owing to the high solubility of its salts and the abundance of sodium-containing mineral deposits. Sodium chloride can also be found in many rivers and inland lakes and seas, in concentrations varying from 20 mg/L in the Mississippi River to 120,000 mg/L in the Great Salt Lake. Groundwater typically contains higher concentrations of minerals and salts than surface waters, especially in areas with an abundance of sodium mineral deposits or in areas with sea or estuarine water intrusions.

In general, sodium salts in water are not acutely toxic because of the efficiency with which mature adult kidneys excrete sodium. However, excessive salt intake is known **to aggravate chronic congestive heart failure**. Furthermore, acute effects of over-consumption of sodium can include:

- **Nausea**
- **Vomiting**
- **Nosebleeds**
- **Convulsions**
- **Muscular Twitching/Rigidity**
- **Cerebral Edema**
- **Pulmonary Edema**

Studies have also shown that consumption of water containing elevated levels of sodium can lead to **higher diastolic blood pressure levels.**

The relationship between elevated sodium intake and **hypertension** has been the subject of considerable scientific controversy. Although short-term studies have suggested that such a relationship does exist, on the basis of existing data, no firm conclusions can be drawn concerning the possible association between sodium in drinking water and the occurrence of hypertension.

19. Sulfate (SO4)

Maximum Contaminant Limit = 250 ppm

Sulfates are a combination of sulfur and oxygen and are a part of naturally occurring minerals in some soil and rock formations that contain groundwater. Sulfates appear in numerous minerals, including barite ($BaSO_4$), epsomite ($MgSO_4 \cdot 7H_2O$) and gypsum ($CaSO_4 \cdot 2H_2O$). These dissolved minerals contribute to the mineral content of many drinking waters.

Sulfates products are used in the production of fertilizers, chemicals, dyes, glass, paper, soaps, textiles, fungicides, insecticides, astringents and emetics. They are also used in the mining, wood pulp, metal and plating industries, in sewage treatment and in leather processing. Aluminum sulfate (alum) is used as a sedimentation agent in the treatment of drinking water. Copper sulfate has been used for the control of algae in raw and public water supplies.

The presence of sulfate in drinking water can result in a noticeable taste; the lowest taste threshold concentration for sulfate is approximately 250 ppm. Sulfate in water may also contribute to the **corrosion of distribution systems**. Exposure to high-levels of sulfate in drinking water can cause **gastrointestinal discomfort** and **diarrhea** that can lead to **dehydration** and is of special concern for infants and the elderly.

20. Total Coliform

Total Coliform represents a large collection of bacteria that are commonly found in the environment (soil and vegetation). Their presence in a water supply could indicate the presence of environmental contamination. If Total Coliform is found in a sample supply, further testing for bacterial subgroups such as fecal coliform and E.Coli are necessary. Symptoms of consuming water containing coliform bacteria may include gastrointestinal illnesses such as **severe diarrhea**, **nausea**, and possibly **jaundice** as well as associated **headaches and fatigue**. Within the category of Total Coliform, are the two subgroups: Fecal Coliform and E.Coli.

- ***Fecal Coliform*** is a group of the Total Coliforms that are considered to be present specifically in the gut and feces of warm-blooded animals. Because the origins of Fecal Coliforms are more specific than the origins of the more general Total Coliform group of bacteria, Fecal Coliform is considered a more accurate indication of animal or human waste in a water supply. Symptoms and diseases associated with Fecal Coliform pathogens can range from:

- ***Upset Stomach***
- ***Diarrhea***
- ***Typhoid Fever***
- ***Hepatitis***
- ***Gastroenteritis***
- ***Dysentery***

- ***Escherichia Coli (E.Coli)*** is the major species in the Fecal Coliform group. Of the five general groups of bacteria that comprise the Total Coliforms, only E. Coli is generally not found growing and reproducing in the environment. Consequently, E. Coli is considered to be the species of coliform bacteria that is the best indicator of fecal pollution and the possible presence of pathogens. Particular strains of the bacteria can cause abdominal cramps, vomiting, and bloody diarrhea. E.Coli is also the leading cause of acute kidney failure in children. Other life-threatening symptoms include:
  - ***Adult kidney failure***
  - ***Fever***
  - ***Bleeding***
  - ***Confusion***
  - ***Seizures***

Defects in a water system that could contribute to the presence of ***Total Coliform*** bacteria include:

- **Missing or defective well cap** - seals around wires, pipes, and where the cap meets the casing may be cracked, letting in contaminants

- **Contaminant seepage through the well casing** - cracks or holes in the well casing allow water that has not been filtered through the soil to enter the well. This seepage is common in the wells made of concrete, clay tile, or brick

- **Contaminant seeping along the outside of the well casing** - many older wells were not sealed with grout when they were constructed

- **Well flooding** - a common problem for wellheads located below the ground in frost pits that frequently flood during wet weather.

Sources of ***E.Coli*** and ***Fecal Coliform*** in water can be attributed to:

- **Sewage & Wastewater seepage/runoff**
- **Wild animal waste**
- **Runoff from Livestock Production operations.**

21. Total Dissolved Solids (TDS)

Maximum Contaminant Level = 500 ppm

Total Dissolved Solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a filter with two micron pores. Total dissolved solids are normally discussed only for freshwater systems. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is not generally considered a primary pollutant (it is not deemed to be associated with health effects) it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants.

Primary Sources for TDS in receiving waters are agricultural and residential runoff, clay rich mountain waters, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium and chloride. These constituents are commonly found in nutrient and general storm water runoff, as well as runoff from de-icing salts used in snowy climates. The chemicals may be cations, anions, and molecules. More exotic and harmful elements of TDS are pesticides arising from surface

runoff. Certain naturally occurring total dissolved solids arise from the weather and dissolution of rocks and soils.

22. Total Hardness

Hard water refers to water that contains a high dissolved mineral content. Generally, hard water is formed when water percolates through deposits of limestone and chalk, which are largely made of calcium and magnesium carbonates. Hard drinking water may have moderate health benefits, but can pose critical problems in industrial and commercial settings, where water hardness is monitored to avoid costly breakdowns in boilers, cooling towers, and other equipment that handles water. In domestic settings, hard water is often indicated by a lack of foam formation when soap is agitated in water, and by the formation of lime scale in water heaters and residential plumping systems.

Depending upon interactions with other factors, such as pH and alkalinity, hard water can cause increased soap consumption and scale deposition in the water distribution system, as well as in heated water applications where insoluble metal carbonates are formed, coating surfaces and reducing the efficiency of heat exchangers. Excessively hard water can also have corrosion tendencies.Small water supplies using groundwater often encounter significant levels of hardness, but some larger surface water supplies also have the same issue. Calcium concentrations up to and exceeding 100 mg/l are common in natural sources of water, particularly groundwater. Magnesium is present in natural groundwater usually at lower concentrations (from negligible to about 50 mg/l and rarely above 100 mg/l), thus calcium-based hardness usually predominates.

a.) Calcium

Calcium is a mineral that is an essential part of bones and teeth. The heart, nerves, and blood-clotting systems also need calcium to work. For the vast majority of healthy people, when calcium is absorbed in excess of need, the kidney excretes the excess. Concern for excess calcium intake is directed primarily to those who are prone to **milk alkali syndrome,** a condition that is caused by the ingestion of large amounts of calcium and absorbable alkali, with resulting **hypercalcemia.** Symptoms of **milk alkali syndrome** and **hypercalcemia** include:

- **Loss of appetite**
- **Dry Mouth**
- **Dizziness**
- **Headache**
- **Confusion**
- **Psychosis**
- **Kidney Failure**
- **Metabolic Alkalosis**

b.) Magnesium

Magnesium is a mineral that is important for normal bone structure in the body. For individuals diagnosed with kidney problems, excess intake of magnesium can lead to elevated levels in the human body, a condition known as **Hypermagnesaemia.** The major cause of **hypermagnesaemia** is renal (kidney) insufficiency associated with a significantly decreased ability to excrete magnesium. Symptoms of **Hypermagnesaemia** include:

- **Weakness, nausea and vomiting**
- **Impaired breathing**
- **Decreased respirations**
- **Low blood pressure**
- **Low blood calcium**
- **Abnormal heart rhythms and asystole**
- **Decreased or absent deep tendon reflexes**
- **Low heart rate**

Drinking water with elevated levels of magnesium may cause **diarrhea** but seldom causes hypermagnesaemia in persons with normal kidney function.

23. <u>Turbidity</u>

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. It is an optical characteristic of water and is an expression of the amount of light that is scattered by particles in water when a light is shined through a sample. The higher the intensity of scattered light, the higher the turbidity. Substances that can cause water to be turbid include: clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, and plankton and other microscopic organisms.

Excessive turbidity in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide cover for the existence of pathogens in water. If not removed, turbidity can promote growth of pathogens in a distribution system, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis throughout the United States and elsewhere. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa.

The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. The U.S. Environmental Protection Agency associates turbidity with several classifications of pathogens, including*:* **Cryptosporidium, Giardia Lamblia, Legionella, and Enterovirus**

a.) ***Cryptosporidium***

Cryptosporidium is a single-celled protozoan parasite commonly found in lakes and rivers, especially when the water is contaminated with sewage and animal waste. *Cryptosporidium* can cause gastrointestinal illness; symptoms may include:

- **Abdominal Cramps**
- **Diarrhea**
- **Vomiting**

b.) Giardia Lamblia

Giardia Lamblia is a single-celled protozoan parasite that lives in the intestine of infected humans or animals. It is found on surfaces or in soil, food, or water that has been contaminated with the feces from infected humans or animals. Symptoms of Giardia Lamblia exposure include:

- **Abdominal Cramps**
- **Nausea**
- **Diarrhea**
- **Headaches**

c.) ***Legionella***

Legionella bacteria are found naturally in the environment, usually in water. The bacteria grow best in warm water, like the kind found in hot tubs, cooling towers, hot water tanks, large plumbing systems, or parts of the air-conditioning systems of large buildings. Legionella bacteria in water are a health risk if the bacteria are aerosolized (e.g., in an air conditioning system or a shower) and then inhaled. Inhalation can result in a type of pneumonia known as **Legionnaires disease**. Symptoms of Legionaries disease include:

- **Coughing**
- **Diarrhea**
- **Fever Chills**
- **Muscle Aches**
- **Shortness of breath**

- **Headache**

d.) ***Enterovirus***

Enteroviruses are small viruses that live in the intestines of infected humans or animals. This group includes:

- **Polioviruses**
- **Coxsackieviruses**
- **Echoviruses**

In addition to the three different polioviruses, there are **62 non-polio enteroviruses** that can cause disease in humans: **23 Coxsackie A viruses, 6 Coxsackie B viruses, 28 echoviruses, and 5 other enteroviruses.** Illness from viruses ranges from gastroenteritis caused by viruses such as **rotavirus** and **norovirus**, to **meningitis** caused by echovirus to **myocarditis** caused by Coxsackie B.

EPA Treatment Technique Recommendation:

" For systems that use conventional or direct filtration, at no time can turbidity exceed 1 Nephelometric Turbidity Unit (1 NTU), and samples for turbidity must be less than or equal to 0.3 NTUs in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTUs."

24. Uranium

Uranium is a naturally occurring radioactive metal that occurs in low concentrations in nature. It is present in the ocean and certain types of soils and rocks, especially granite. Naturally occurring uranium in groundwater is a result of the dissolution of uranium bearing minerals that have been in contact with groundwater for long periods of time. Elevated concentrations of natural uranium in well water are more likely to be found in drilled wells that obtain their water from the cracks and fractures of bedrock, rather than dug wells or surface water supplies. Uranium can also be found in the environment as a result of human activities such as mill tailings, emissions from the nuclear industry, and the combustion of coal and other fuels.

The primary chemically induced effect of uranium on humans is **kidney inflammation**, a condition known **Nephritis.** Symptoms of **Nephritis** include:

- **Pelvic Pain**
- **Pain/Burning sensation while urinating**
- **Increased Frequency of Urination**
- **Cloudy urine**
- **Blood or pus in the urine**
- **Pain in the kidney area or abdomen**
- **Extremity Swelling**
- **Vomiting**
- **Fever**
- **High blood pressure**

EPA has set the maximum containment level (MCL) for uranium in drinking water as 0.03 ppm

25. Zinc (Zn)

Maximum Contaminant Limit = 5 ppm

Zinc is an essential trace element that exists in nature. In its elemental form, it appears as a bluish-white metal, and it can be found in nearly all types of igneous rock. Zinc makes up about 0.0075% of Earth's crust, making it the 24th most abundant element on Earth.

Although zinc occurs naturally, most zinc finds its way into the environment because of human activities. Mining, smelting metals (like zinc, lead and cadmium) and steel production, as well as burning coal and certain wastes can release zinc into the soil and surrounding environment. When high levels of zinc are present in soils, such as at a hazardous waste site, it can seep into the groundwater.

Industries also can release dust containing higher levels of zinc into the air we breathe. Eventually, the zinc dust will settle out onto the soil and surface waters. In natural surface waters, the concentration of zinc is usually below .01 ppm, and in groundwaters, .01-.04 ppm. In tapwater, the zinc concentration can be much higher as a result of the low pH corrosive water, caused by reverse osmosis treatment, leaching zinc from galvanized piping and fittings.

Acute Zinc Toxicity arises from the ingestion of excessive amounts of zinc salts, either accidentally through drinking water, or deliberately as an emetic or dietary supplement. Other incidents of zinc poisoning have occurred from drinking beverages from galvanized containers. Symptoms of Acute Zinc Toxicity include:

- **Fever**
- **Diarrhea**
- **Nausea**
- **Vomiting**
- **Abdominal Cramps**
- **Intestinal Bleeding**

Studies have shown that chronic ingestion of zinc can lead to a **zinc-toxicity induced copper deficiency** in the human body. Symptoms for this disorder include:

- **Fatigue and Weakness**
- **Compromised Immune System**
- **Weak, Brittle Bones (Osteoporosis)**
- **Problems with Neurological Function and Capacity**
- **Difficulty walking**
- **Heightened sensitivity to temperature change**
- **Premature Grey Hair**
- **Vision Loss**

Other research has postulated links between long term zinc consumption and **Gastritis,** a condition in which there is severe inflammation and/or erosion of the stomach lining. Symptoms of **Gastritis** include:

- **Nausea/Recurrent Upset Stomach**
- **Abdominal bloating**
- **Abdominal pain**
- **Vomiting of blood**
- **Indigestion**
- **Black, tarry stools.**

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