AgroLab Inc.
INTERPRETATION OF WATER ANALYSIS
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IRRIGATION WATER QUALITY AND INTERPRETATION

Irrigation water quality is dependent on its chemical composition. The concentration of mineral constituents in the water varies depending on the amount of soluble materials encountered by the water. These soluble constituents are called soluble salts. If soluble salts are high they may be detrimental to plants. The most common soluble salts are the cations, sodium (Na), calcium (Ca), magnesium (Mg) and potassium (K), and the anions, carbonate (CO_3), bicarbonate (HCO_3), chloride (Cl), sulfate (SO_4) and nitrate (NO_3).

The total soluble salt level is determined by the electrical conductivity reading. Since cations are positively charged and anions are negatively charged, they will conduct an electric current. The more ions present the more readily it will conduct an electric current which is calibrated to give soluble salt readings in millimhos per centimeter.

The higher the electrical conductivity reading is the higher the salinity hazard. The salinity hazard interpretation is:

Electrical Conductivity, mmho/cm	**Interpretation**
less than 0.75	No problems - little chance for increased salinity.
0.76 - 1.50	There may be some detrimental affects on crops such as field beans, lettuce, bell pepper, onion and carrots
1.51 - 3.00	Water may have adverse effects on many crops. Salinity will increase without adequate leaching.
3.00 - 7.50	Water can be used for salt tolerant crops on permeable soils. High leaching requirement is necessary.

In addition to the soluble salts, one must analyze the sodium level in the water. The presence of high sodium can reduce permeability of the soil. The sodium hazard of irrigation water is estimated by calculating the sodium adsorption ratio (SAR). In general, the SAR should not be greater than 5; otherwise corrosion, crop damage and animal health problems may develop or exist.

If sodium is the predominant cation in the irrigation water, continual use of the water will adversely affect the physical condition of the soil. Sodium replaces exchangeable calcium and magnesium, which causes dispersion of clay. This dispersion destroys soil aggregates so the soil appears slick when wet and very hard when dry. In addition to reduced permeability other problems are slow seed germination, less soil aeration and more difficult disease and weed control due to surface water ponding and stagnation.

In addition to the salinity and sodium hazards of irrigation water, chloride, bicarbonate and boron are potential hazards.

The interpretation of these constituents are shown below for plants sensitive to the constituent:

Constituent	**Content**	**Interpretation**

Chloride (ppm Cl)	less than 140 140 - 350 greater than 350	No Problem Increasing problem Severe problem
Bicarbonate (ppm HCO_3)	less than 180 180 - 520 greater than 520	No Problem Increasing problem Severe problem
Boron (ppm B)	less than 0.75 0.75 - 2.0 greater than 2.0	No Problem Increasing problem Severe problem

LIVESTOCK WATER QUALITY

A clean, plentiful supply of livestock water is as important to optimum animal performance as is a balanced ration. When a water shortage occurs, it is easy to see the problem. However, the quality of water is much more difficult to visualize and laboratory analysis is usually required. Poor water quality is often caused by excessive salinity or total dissolved solids in the water. Sometimes nitrate contributes to the problem. Occasionally, alkalinity or another factor may be the cause of the problem.

INTERPRETING A WATER ANALYSIS

A guide to the use of saline water for livestock is presented in Table 1. General guidelines for use of water containing nitrate are shown in Table 2. Waters with alkalinities of less than 1000 ppm are satisfactory for most livestock.

Table 1 - A Guide to the Use of Water Containing Salts:

Total Dissolved Solids	Comments
<1000 ppm	Excellent for all livestock classes.
1000 - 2999 ppm	Satisfactory for most livestock, may cause decreased gain or death with poultry.
3000 - 4999 ppm	Satisfactory for some livestock, may cause decreased gain or death with poultry.
5000 - 6999 ppm	Acceptable. Do not use for pregnant or lactating livestock. Unacceptable for poultry.
>7000 ppm	Unacceptable for all livestock use.

Table 2- A Guide to the Use of Water Containing Nitrate:

ppm NO_3-N	Comments
<100	No harm to livestock and poultry.
100 - 300	No harm when used alone on livestock and poultry. Use caution when feeds also contain nitrates.
>300	Nitrate poisoning occurs.

SALINITY

Highly mineralized or salty water can cause physiological disturbances in animals including gastrointestinal disturbances, poor rate of gain, and sometimes death. The dissolved minerals that contribute to high salt content are inorganic salts; calcium, magnesium, sodium, chloride, sulfate and bicarbonate.

Animals are more susceptible to salts when a physical stress, such as pregnancy, lactation, or rapid growth

occurs. Anything causing an increase in water consumption, such as lactation, high temperature, or exertion increases the danger. When livestock are fed a salt limiting ration, special care needs to be taken to supply water low in salt because ration salt will increase total water consumed by the livestock. Poultry is least tolerant to excess salt; cattle and sheep are most tolerant. Salt in water is measured in parts per million (ppm) as total dissolved solids (TDS).

NITRATE

Nitrate is found in most all forages and occasionally in water. Nitrate itself is not toxic, but during digestion bacteria reduce nitrate to nitrite, which then gets into the blood stream. There, the nitrite converts the red pigment hemoglobin, which carries oxygen from lungs to tissue, to methemoglobin, a dark brown pigment which cannot carry oxygen. Nitrate poisoning is usually more of a problem in young, especially newborn animals. Older animals seem able to tolerate higher nitrate levels. High nitrate water levels are often caused by shallow water tables, leaching of nitrate from sandy soils, or under heavy N fertilization.

OTHER FACTORS

Natural waters rarely contain or become contaminated with toxic substances such as boron, iron, copper, magnesium, manganese, and zinc. Analysis needs to be made for these when excess levels are suspected.

REFERENCE TEST LEVELS:

Contaminant, mineral or ion	Levels considered average	Maximum Acceptable Level	Comments
Bacteria Total Bacteria (TPC) CFU/ml Total Coliforms Fecal Coliforms	 0 CFU/ml 0 CFU/ml 0CFU/ml	 1000 CFU/ml 50 CFU/ml 0 CFU/ml	Total Bacteria is used as an indicator of system cleanliness, high numbers do not necessarily mean the bacteria present is harmful but it does mean that the system is capable of harboring pathogenic organisms. High bacteria levels can impact taste of water resulting in reduced consumption by birds Shock the well then implement sanitation program such as gas chlorine, bleach, hydrogen peroxide or other sanitizers. Maintain a residual Presence of any fecal coliform means water is unfit for consumption by poultry or humans
pH	6.0-7.8	5-8	pH below 5 can be harmful to drinker equipment- causing corrosion to metal components with long term exposure pH above 8- impacts effectiveness of most water sanitizers and if high pH is also associated with high alkalinity, may result in reduced water consumption in poultry due to "bitter" taste. If pH is lower than 5 soda ash or caustic soda injection will raise pH. If pH is high acid injection will be required.
Total Hardness	60-180 mg/l	110 mg/l	Hardness can also be determined by adding the Calcium and Magnesium content, Hardness causes scale which can reduce pipe volume and cause drinkers to be hard to trigger or leak Softeners can remove compensated hardness up to a practical limit of 100 gpg or 1710 ppm /mg/l If the hardness is above 30 gpg or the sodium to hardness ratio is greater than 33% then the sodium level will be high after softening and reverse osmosis may be required .Phosphate injection will sequester the hardness.
Natural Elements			
Calcium	60 mg/l		No upper limit for calcium, birds very tolerant of calcium but if values above 110 mg/l may require water softener, polyphosphates or acidifier to prevent

(Ca)			scale build-up p
Magnesium (Mg)	14 mg/l	125 mg/l	Higher levels of Mg may cause flushing due to laxative effect particularly if high sulfate present. Water softener can be used for removal
Iron (Fe)	.2 mg/l	.3 mg/l	Birds tolerant of iron metallic taste but high iron causes leaking drinkers and promotes the growth of E coli and pseudomonas and has been linked to botulism, Treatment includes oxidation with chlorine, chlorine dioxide or ozone and then filtration. Other oxidation and filtration technologies are available and effective such a green sand filtration or resin bed exchange technology
Manganese (Mn)	.01 mg/l	.05 mg/l	Can result in black grainy residue on filters and in drinkers, Treatment includes oxidation with chlorine, chlorine dioxide or ozone then filtration, green sand filtration and softeners will remove Mn. Mn oxidation is more effective in pH range of >8.
Chloride (Cl)	50 mg/l	150 mg/l	When combined with high sodium levels, creates salty water that can act as a laxative causing flushing and feed passage, also, salty water can promote the growth of enteroccoci organisms that can lead to enteric issues Treatment- Reverse Osmosis, anion exchange resin, lower dietary salt level, blend with non-saline water, Keep water clean and use daily sanitizers such as hydrogen peroxide or iodine to prevent microbial growth
Sodium (Na)	50 mg/l	150 mg/l	When combined with high chloride levels, creates salty water that can act as a laxative causing flushing, also, salty water can promote the growth of enteroccoci organisms that can lead to enteric issues Treatment- Reverse Osmosis, lower dietary salt level, blend with non-saline water, Keep water clean and use daily sanitizers such as hydrogen peroxide or iodine to prevent microbial growth
Sulfates (SO4)	15-40 mg/l	200 mg/l	Sulfates can cause flushing in birds. If rotten egg odor present, then bacteria producing hydrogen sulfide are present and system will require shock chlorination plus establishment of good daily water sanitation program, sulfates can be removed by reverse osmosis or anion resin. If H2S is present (the rotten egg smell) than aerating water into a holding tank, treatment with sanitizers then filtration. H2S can airlock water lines.
Nitrates	1-5 mg/l	25 mg/l	High nitrate levels can result in poor growth and feed conversions. Presence of nitrates may indicate fecal contamination so also test for bacteria Can be removed with Reverse Osmosis or anion exchange resin.
Lead	0 mg/1	.014 mg/l	Long term exposure can cause weak bones and fertility problems in breeders and turkeys. Reverse osmosis ,softener or activated carbon will greatly reduce the lead
Copper	.002 mg/l	0.6 mg/l	
Zinc		1.5 mg/l	