Drop by

If I had a nickel for every time I witness water sample tests piled upon tests on shelves with information that is simply ignored or misunderstood, well I would probably be writing a novel on a beach instead of an article piece on an airplane.

The truth is that water quality is one of the most misunderstood parts of any golf course management program. So many get lost in the numbers and forget the simple science behind what is important. Most importantly, we forget to carry through on the practical applications that address our water issues... something I have been privileged to do around the globe with many fine superintendents and property managers.

While considering any of this, please note that I have seen some very 'bad' water situations in the golf industry in particular. For one property in the San Diego, Calif., area, the water was so bad that toxic residues would ring the irrigation pond like a halo. But because the superintendent thinks through his challenges there and knows what the limitations and effects of his water will do, he put a program in place that allows him to manage excellent playing conditions while limiting the impact of the bad water on his property. Look for a future article on the practical solutions to bad water...this article is focusing on what to look for in a water quality test to know what your challenges may be.

First off, here are some truths about water quality:

- Water quality has a direct impact on soil and plant health quality on a daily basis
- The quality of the soil takes on the quality of the water over time
- Water quality can determine if an IPM program, including pesticide applications are

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effective or not right out of the tank and with regard to residual effect on the turf and soil

• The relationship of elements and components in a water sample is much more important than the individual elements themselves. For example: A salt is a salt is a salt…the measurement of electro conductivity (EC) which measures salt conductivity in water is oblivious to what salt is causing the reaction. Therefore, EC alone cannot be used to determine water quality although it often is the case that it is.

• Water quality is dynamic, meaning that it changes often throughout the year. Therefore there is no standard water testing protocol. If your water is fairly consistent, annual or even biennial or triennial tests are fine. If you use wells or have water pumped in and that quality changes during various times of the season, you should test whenever a significant change takes place so you can make informed decisions on what practical changes to make to your program.

To develop or implement any cultural practice or management program on the course, we need to understand what the water quality test is telling us. Water quality is defined as the ability of a water source to meet its beneficial uses. In this case, the beneficial use is to supplement rain for the quality growth and performance of the golf course turfgrass and ornamental landscape. The following are the most important things to look for on a water test and what they mean:

TOTAL SALT CONTENT (TDS). This is a measurement of all dissolved salts but does not tell us which salts. This is also known as a measurement of salinity but this does not necessarily mean sodium (Na^+). TDS is roughly 640 times the EC of the water measured in mmhos/cm or dS/m. TDS is typically reported in parts per million (ppm). A TDS level below 480 indicates there is likely not a problem with salts in the water. Between 480 and 1950, potential salt problems exist and this will vary with turf tolerances. Above 1950 we generally see salt related problems and it is imperative that good drainage is in place to be able to move the water through the soil profile to prevent salt buildups in the soil.

ELECTRO-CONDUCTIVITY (EC). This is a measurement of the conductivity of salt reactions in water. As salts dissolve, ions disassociate from each other and carry a charge. That charge gives off energy measured as EC. For example, table salt, sodium chloride (NaCl) dissolves to a Na^+ ion and a Cl^- ion. These ions give off energy measured as EC. All salts dissolve and give of charges. EC is reported in mmhos/cm or its equivalent dS/m. Therefore 1 mmhos/cm = 1 dS/m.

While EC alone cannot tell us what salts are present, it is another indicator of a potential salt problem as it is another measurement of salinity. Remember that turfgrasses, even of the same variety vary in their tolerances of salt, but if salt indicators show that salts are present, again, it is important to insure that we have the ability to move them through the soil profile and away from active roots so that there is no negative impact on turf growth and performance.

General tolerance levels include:

- **<0.25 dS/m** = Low Salinity Hazard
- **0.25 – 0.75** = Tolerable with moderate leaching and permeability in place
- **0.75 – 2.25** = Not tolerable on soils with restricted drainage or with salt sensitive plants
- **>2.25 dS/m** = generally not an acceptable irrigation water source

If you have an 'unacceptable' source of water but are forced to use it, it is imperative that bad salts are replaced with good salts at the irrigation pumping source and through amendments on the course. In addition, quality drainage characteristics must be in place throughout the irrigated property to prevent salt buildup in the soil.

HARDNESS AND ALKALINITY. These are oftentimes considered the same thing, but specifically they are not. Hardness refers to the level of Calcium carbonate and Magnesium carbonate in the water. However, other metals add to the hardness of the water.

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Sometimes you can taste iron in well water for instance. This iron (Fe^{3+}) increases the hardness level of the water, but typically Calcium and Magnesium are the main drivers. Alkalinity refers to the ability of a water source to neutralize acids. As you can see, hardness and alkalinity go hand in hand. Just as if we have an acid water source we need compounds like Calcium and Magnesium carbonates to neutralize the acid, if we have high levels of Calcium and Magnesium (Hardness), we need to break those down (dissolve them) by using an acid. Remember that it is not the Ca and Mg that do the neutralizing of acid. It is the Carbonate (CO_3^{2-}) as it associates with H^+ ions…the ions that are causing the acid reaction. On the flip side, using acids in the presence of carbonates allows a disassociation of the carbonate compounds to take place. This happens most easily at the pumping source…particularly with using acids. To an extent, we can also address some related hardness issues using appropriate amendments on the course from routine applications of soluble products.

General hardness tolerance levels, reported as parts per million (ppm):

- **0 – 125:** Satisfactory
- **126 – 245:** Possible problem with calcium and magnesium buildup
- **>245:** Likely problem with calcium and magnesium buildup

CARBONATES (CO_3^{2-}) AND BICARBONATES (HCO_3^-) THESE LEVELS ARE THE FIRST INDICATORS OF MULTIPLE SALT ISSUES. As carbonates and bicarbonates rise, the sodium absorption ratio (SAR) and exchangeable sodium percentage (ESP) also tend to rise. Without the later indicators, carbonates or bicarbonates alone will not indicate the total problem present but will indicate the likelihood that calcium and magnesium are going to precipitate out of the water solution. That means they turn to solids and are not easily taken up by plants. Calcium and Magnesium carbonate compounds are strong 'marriages' in soil chemistry and are broken with acids. If carbonate and bicarbonate levels are high, there are no free Ca^{++} or Mg^{++} ions for easy uptake by the plants.

The following are general tolerance levels of CO_3^{2-} and HCO_3^-. But note that the true hazards associated with carbonates and bicarbonates must be assessed using the Residual Sodium Carbonate (RSC) along with SAR and ESP.

Carbonate tolerance levels:

- **0 – 12 ppm:** Satisfactory
- **13 – 62 ppm:** Possible problem developing
- **>62 ppm:** Likely problem with key nutrient precipitation

Bicarbonate tolerance levels:

- **0 – 111 ppm:** Satisfactory
- **112 – 525 ppm:** Possible problem developing
- **>525 ppm:** Likely problem with key nutrient precipitation

RESIDUAL SODIUM CARBONATE (RSC). RSC is equal to the sum of the carbonate and bicarbonate ion concentrations minus the sum of the calcium and magnesium ion concentrations. This is figured out using the meq/l values, not parts per million. The conversion is done by

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dividing the ppm values by the milliequivalent weights of each ion. The weights of key elements are Ca = 20 mg/meq, Mg = 12 mg/meq and Sodium (Na) = 23 mg/meq. For example, analysis shows 62 ppm Ca. 62/20 = 3.1 meq/l for calcium.

RSC is a key indicator as to whether Sodium (Na+) may build up or not. Sodium is the weakest held ion in the soil system so if beneficial ions are in abundance, sodium will not build up. This is dependent on the ability of the soil solution to drain adequately. If drainage is absent, then the presence of any salt will build up over time. If after completing the RSC calculation, or from reading a water test, if RSC is a negative value, then Sodium is likely not going to build up as it indicates that there are more beneficial Calcium and Magnesium ions than sodium ions. If a positive value is present, then sodium buildup is possible.

The tolerance levels for RSC are:

- **0 – 1.25 meq/l:** low Na hazard with some Ca and Mg removal
- **1.25 – 2.5 meq/l:** moderate Na hazard with appreciable Ca and Mg removal
- **> 2.5 meq/l:** unsuitable irrigation source, sodium will accumulate

SODIUM ABSORPTION RATIO (SAR). SAR is a measurement of sodium against calcium and magnesium. Its calculation is: SAR = Na / ((Ca + Mg)/2)½ in meq/l. SAR alone, as many of the variables on a water test, will not tell us all we need to know about water quality. For instance, we may have a low SAR (< 6.0) but an appreciable EC (> 0.5) but have an acceptable water source since the salts causing the EC do not include much sodium compared to other beneficial salts. As SAR rises above 6.0, even with a low EC (low salt content), we have a problem developing in relation to sodium. As SAR rises above 9.0, we have a sodium problem for sure and this must be addressed by adding free calcium, magnesium, potassium or other beneficial salts to offset the more weakly held Na+ ions.

pH. pH is a logarithmic measurement of free hydrogen (H+) ions. The more hydrogen ions, the more acidic the water is. The absence of hydrogen ions and the abundance of hydroxide ions (OH-) raise pH and causes alkaline conditions. In most cases, when a water test report shows a high pH, it is an indicator that we may have precipitation problems with calcium and magnesium. Acidifying the water source will lead to improved conditions. But only after reviewing all of the key water test values as indicated in this article can we determine exactly what the problem is and how to address it. Ideally, if we have a pH of 6.0 to 6.9, we have a healthy water source, but again, knowing other values from the water test will tell us if we have sodium or some other metal present that may not be impacting pH but will certainly impact turf health. Topical soluble applications of key elemental products on the turf can offset the negative effects of a not so healthy water source, but before you waste your money, understand what your water test is truly telling you.

The most significant problem we typically see in water quality includes the relationship of 'bad' salt ions to good ones. Remember that having a salt problem does not necessarily mean having a sodium problem. And if we have sodium present in the water, we can address it with adding key beneficial elements. In all cases, having the ability to move water through the soil profile by implementing drainage and fundamental cultural practices is always a best management practice to follow. **GCI**

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