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course irrigation water can be quite variable," says Rain Bird's Roche.

That's why golf course superintendents should test their water frequently. So what are some elements that, if found in water, could be bad news for your turf?

Boron, for one. According to Larry Lennert, North Central territory manager for Aquatrols, boron can be toxic to some turfgrass species at concentrations as low as 2 to 4 ppm in the soil. Irrigation water should contain less than 1 ppm.

"Boron can be leached from sandy soils, but it accumulates and is more difficult to leach from fine-textured soils," Lennert says. "Also, it is more commonly a problem

Bryozoa can gum up sprinkler heads.

For *more* ...

Looking for more information on this topic? The USGA's Brian Whitlark recommends the following resources. Simply enter the following URLs into your browser to access the online content.

- **Water Quality Testing**
  The agony and the ecstasy.
  bit.ly/1dhDZ4L
- **A Step-By-Step Guide For Using Recycled Water:**
  An outline of the costs and maintenance practices necessary to manage this valuable resource.
  bit.ly/IB7SUq
- **Interpreting Water Tests: It's as easy as 1-2-3.**
  bit.ly/J7hWVu

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TURFONOMICS™

Chapter 1

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Reclaimed water can harbor unwanted microorganisms.

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Hear it *first...*

Check out this podcast featured on GCI's Superintendent Radio Network which features Larry Lennert, territory manager for Aquatrols, who discusses soil salinity by outlining management practices. To listen, simply enter bit.ly/JHHUir into your browser.

in landscape plants than in mowed turf."

Chlorine is usually only present in minor amounts in recycled water sources where chlorine-containing compounds are commonly used as a disinfectant. Residual chlorine levels above 5 mg/L can be toxic to turfgrass. Also, chlorine is generally unstable in water and will form chlorides – different than chlorine.

"Chloride is an anion (or negatively charged ion) commonly found in irrigation water and can be a major contributor

to the overall salinity of water," Lennert says. "Chloride is not particularly toxic to turfgrass, but many landscape plants are very sensitive to it."

Carbonate and bicarbonate are interesting, too. They are anions in alkaline irrigation water that commonly react with calcium cations (positively charged ions) in higher pH soils and precipitate out as calcium carbonate, also known as calcite or free lime.

"Less commonly, magnesium cations can also precipitate out of alkaline irrigation water or the soil solution in higher pH soils to form magnesium carbonate ($MgCO_3$)," says Lennert. "Either of these events will elevate the sodium absorption ratio."

Rain Bird's Roche explains that the sodium absorption ratio (SAR) indicates the amount of sodium in the water in relation with calcium and magnesium.

"There are different types of acid products that can be used to help manage waters that have a high SAR," says Roche. "Acid products are typically injected at the pump station using proportional pumps that work in conjunction with the pump station's flow meter so that a balanced amount of material is added to the irrigation water throughout an irrigation cycle at variable flow rates. In some areas of the country, a permit must be used to install acid injection equipment, and containment areas and backflow prevention devices must be in place to contain and prevent any spillage or leaks and to protect from back siphonage into the water source."

So what about sodium, that common element found in water? High concentrations of it will increase the total salinity of the water. Salinity and organic components are two of the top issues with water,

An example of bryozoa clogging a bottom filter, reducing efficiency.

says Brian Whitlark, agronomist with the USGA Southwest Region.

"The warmer the weather, the more types of organisms you'll find in water," he says. "Bryozoa, protozoa and clam shells can be problematic in gumming up the screens at the base of sprinkler heads. If you don't have a good filtration system

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at the pump station, you'll be chasing around with heads that get stuck or don't come on at all."

Whitlark relates the story of one superintendent he ran into at a meeting who showed him a photo of his pump station filled with bryozoa. Despite the fact that it was a self-flushing system, they had to mechanically remove the filters and clean them off every three weeks; otherwise, they were pumping at reduced efficiency, which, of course, costs energy. This was a new pump station, too – prior to acquiring it, the mess was living in his irrigation lines.

Treating those types of organisms can be dangerous, Whitlark says. Potassium per-

For *more* online...

Looking for more information on water quality issues? Check out the following USGA Green Section articles by entering the following URLs into your browser.

- **Phosphorus Remediation**
  Improving water quality with phosphorus removal structures.
  By Chad Penn, Greg Bell, Jason Warren, and Josh McGrath
  bit.ly/K677CM

- **Purple Gold**
  A contemporary view of recycled water irrigation.
  By Dr. M. Ali Harivandi
  bit.ly/1dw7m1R

- **Acid Substitutes and pH Reduction**
  An evaluation of the new acid-replacement products for improving water quality and the soil rootzone environment.
  By Brian Whitlark
  bit.ly/K6auK4

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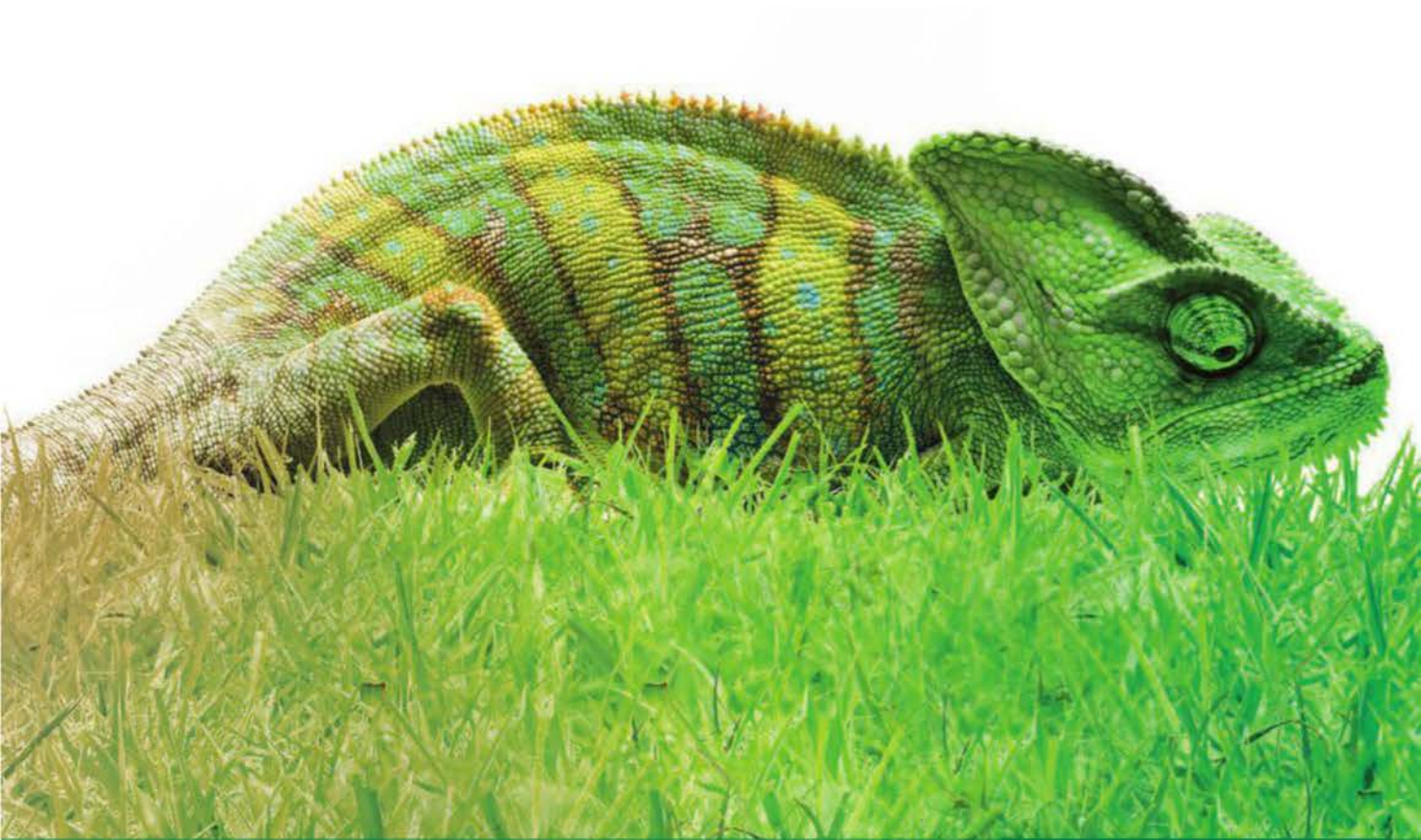

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manganate is the most popular, followed by hydrogen peroxide or some sort of oxidation strategy (even ozone) to kill the organic organisms in an irrigation lake or wet well.

"These organisms are often associated with reclaimed water with elevated nutrient levels, specifically nitrogen and phosphorus," Whitlark says.

Having nitrogen and phosphorus in your water can be helpful from the standpoint of providing, in some reclaimed water, up to four to five pounds of nitrogen per 1,000 square feet per year. But, during times of limited growth, supers run the risk of leaching those materials through the rootzone.

"In hot environments that are growing bentgrass greens, the nitrogen is a real concern," says Whitlark. "You don't want to be applying nitrogen in July and August when it's 105 degrees and elevated humidity. The additional nitrogen is unwanted and creates puffy conditions on the greens."

Whitlark has seen courses where this is a great concern form conglomerates with other courses using the same reclaimed water and work with the water provider to implement reverse osmosis or additional denitrification strategies at the plant.

"Furthermore, the nitrogen and phosphorus in the water create a good environment for algae formation in the lakes,

On-site water elements are great irrigation resources. However, on the molecular level they may harbor chemicals that can prove harmful to turf.

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and regardless of how diligent superintendents are at avoiding putting fertilizer in the lakes, if those nutrients are coming from the effluent plant, that can be a real issue," says Whitlark.

When it comes to salinity, you're trying to evaluate the water based on total salts and whether you have a sodium hazard – two different things, Whitlark points out.

"You could have high salts and sulfates and calcium magnesium that make the water salty, but the sodium is low, and that will determine whether you can treat the water or whether it's beneficial to treat the water," says Whitlark.

Water with high electrical conductivity (over 1) may start to cause problems if you have poorly drained soil. Whitlark warns that, outside of reverse osmosis, you cannot reduce the salts in water. But as far as reducing the sodium hazard, if you have a sodium absorption ratio equal to or greater than 5, you might consider treating the water with gypsum to increase calcium. If the water is high in carbonates and bicarbonates, and the residual sodium carbonate (sum of carbs and bicarbs minus the sum of calcium magnesium) is greater than 1.5, then the potential exists to cause precipitation of calcium and magnesium – which would render sodium more potentially destructive in the soil. **GCI**

Jason Stahl is a Cleveland-based writer and frequent GCI contributor.

Frequent water tests root out potential turf problems.

"Bryozoa, protozoa and clam shells can be problematic in gumming up the screens at the base of sprinkler heads. If you don't have a good filtration system at the pump station, you'll be chasing around with heads that get stuck or don't come on at all."

— Brian Whitlark, agronomist with the USGA Southwest Region

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