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Side effects

Consider agromonics when negotiating reclaimed water contracts

Water is a limited resource that's in increasing demand as populations, and particularly urban populations, grow. Reclaimed water use – sometimes called effluent or recycled water – on golf courses is a logical response to conserving water, but one that should be appreciated for the increased financial and agronomic demands it can make on turf management operations. Reclaimed water can cause problems if superintendents don't make adequate preparations.

Because reclaimed water frequently – though not always – is of lower quality than traditional water sources, turf quality can be seriously compromised unless aggressive leaching programs, improved irrigation systems, modified soil amendment and cultural programs, and the flexibility to replace salt-sensitive turf varieties are taken into account. Even if all of these changes are incorporated, turf quality will still suffer unless a supplier can guarantee delivery of a prescribed quality and volume of reclaimed water.

Golf courses that rely on reclaimed water have dealt successfully with most of these problems by instituting soil monitoring programs and cultural practices that optimize turf health under low-quality water irrigation conditions. In the future, negotiating strong contracts with suppliers might further reduce the potential hazards of using reclaimed water.

Negotiating tips

Here are a few pointers to consider when negotiating reclaimed water contracts:

- The price of reclaimed water should be keyed to current water prices and should consider water quality. Expect a 15- to 20-percent cost per unit reduction compared to domestic water.
- Define maximum acceptable quality limits. If water-quality limits are exceeded, the contract might be voided by the golf course without penalty to the golf course. Use the values in Table 3 as rough guidelines, tailoring them to meet your unique conditions.
- Define delivery guarantees, including access to the pump area to allow restarts and guaranteed pump repair times.
- Include costs of fairway cultivation and amendment programs you'll need to prevent soil damage from long-term use of reclaimed water.
- Include costs of monitoring equipment, such as in-line electrical conductivity and flow meters.
- Include the costs of soil testing and management consultations.
- Estimate a 5-percent to 10-percent increase of water use to compensate for leaching fraction increases.

Table 1. Comparison of reclaimed water sources used for golf course irrigation in Southern California. Blue shading indicates the reclaimed water exceeds the recommended guidelines in Table 3. Yellow shading indicates the value is within 10 percent of guidelines, and green shading indicates the value falls within recommended guidelines.

Factor	Average domestic	Big Canyon	Dove Canyon	Laguna Woods	Bear Creek	El Niguel	Oakmont
EC (dS/m)	0.8	1.6	1.0	1.2	1.0	1.6	1.1
SAR	1.9	5.3	2.8	3.6	4.6	3.7	3.4
SARadj	3.4	11.2	5.3	6.1	7.5	6.6	6.12
HCO3 (ppm)	173.8	243	134	125	156	134	203
B (ppm)	0.17	0.52	0.26	0.41	0.62	0.42	0.64
Cl (ppm)	81.7	244	122	228	158	211	106
Na (ppm)	70.0	194	112	151	147	168	115

THE PROBLEM'S SOURCE

All irrigation water contains dissolved salts – such as calcium, sodium, sulfates, chloride, magnesium, potassium, bicarbonates – whose presence can be beneficial to turf when they're present at low concentrations. However, if irrigation water contains high concentrations of dissolved salts, excessive levels can build up in the soil – enough to kill turf plants through salt toxicity or by robbing the plant of water. Of all the dissolved salts, sodium (Na) can be the most damaging to turf.

In most cases, reclaimed water is of lower quality than the domestic water source from which it originates. This is because the reclamation process isn't able to remove all the salts and other materials that are added to the water in its first use by the community. For this reason, there's usually about a 10-percent increase in total dissolved salts in reclaimed water versus the original domestic water source.

High levels of nitrogen in some reclaimed water sources also can be a threat to turf quality, unless fertility programs are adjusted to take this into account. In fact, we've seen more turf quality problems that result as a consequence of high-nitrogen reclaimed water than we have as a result of high salts.

The impact of reclaimed water on a golf course, however, can be evaluated only by comparing the reclaimed water to the irrigation water that it will replace. For example, golf courses that use low-quality well water might see an improvement in turf health if the reclaimed water is of slightly higher quality (see Table 3 on page 52). In most cases, though, reclaimed water has lower quality than current domestic water sources. Tables 1 (page 46) and 2 (below) illustrate the dramatic differences that occur among different reclaimed water sources and the types of problems most frequently encountered.

LEACHING

The increasing accumulation of soil salts that results throughout time from use of low-quality reclaimed water will result in shorter roots and unhealthy plants unless leaching programs are implemented.

A leaching fraction is the amount of water that must be applied during irrigation to maintain soil salts below levels that are damaging to the plant. To calculate the leaching fraction, one needs to know the electrical conductivity of the irrigation water and the electrical conductivity that's tolerated by the turf type managed (see Figure 1 on page 50).

$$\text{Leaching requirement} = \frac{\text{EC water}}{5^{*}\text{EC tolerated} - \text{EC water}}$$

For example, if irrigation water has an electrical conductivity of 1 dS/m (= 1mmho/cm or about 640 ppm total dissolved salts) and the turf type is *Poa* (which, according to Figure 1, can't tolerate more than 3 dS/m), then the leaching fraction is 1/14 = 0.07. This means 7 percent more water will need to be applied to move salts beyond the root zone. Another way of saying this is that if you're irrigating for 10 minutes to replace the water lost by evapotranspiration and saturate the root zone, you'll need to add another 0.7 minutes of irrigation – for a total of 10.7 minutes – to prevent accumulation of salts to plant-damaging levels.

To estimate the increase in water use that reclaimed water will produce, compare the leaching fraction for the water you're currently using versus the leaching fraction you'll need with reclaimed water.

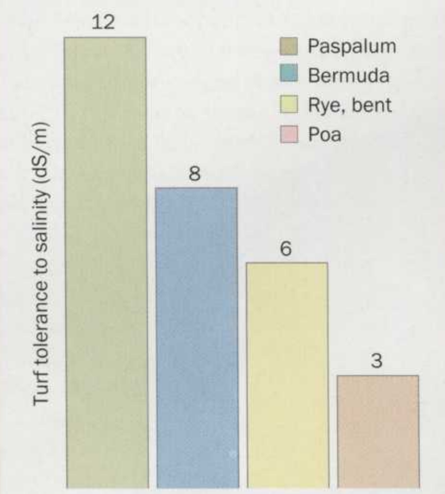
MONITORING AND CULTURAL PRACTICES

Leaching alone won't solve all salt-related problems if drainage, soil quality and irrigation distribution aren't perfect. To increase the effectiveness of leaching programs, and to help you keep on top of salt-related problems, the program outlined below is recommended. Implementing this program will cost money and time, but the savings it will produce

Table 2. Recommended maximum limits for reclaimed water negotiation for use on sand-based bermudagrass fairways. These limits don't ensure the water might be used in a sustainable fashion for turfgrass irrigation. They only prevent the reclaimed water quality from exceeding reasonable guidelines and reduce the hidden costs of using reclaimed water. Reclaimed water with quality factors falling within these guidelines might not provide a high-quality golfing experience.

Factor	Average domestic	Average reclaimed	Maximum limits
Electrical conductivity	0.7 dS/m	1.1 dS/m	1.5 dS/m
Sodium absorption ratio	2.7	4.0	5.7
Bicarbonate (HCO3)	134 ppm	201 ppm	250 ppm
Boron (B)	0.22 ppm	0.42 ppm	0.50 ppm
Chloride (Cl)	74 ppm	149 ppm	250 ppm
Nitrogen (N)	3.2 ppm	7.3 ppm	8 ppm
Sodium (Na)	85 ppm	147 ppm	200 ppm

Figure 1. Different turf types differ markedly in their ability to tolerate soil salts.



in terms of turf protection are well worth it. The recommended monitoring and cultural practices guidelines are:

- Implement an annual aerial photography program to help identify and correct salt accumulation in turf hot spots and declining trees.
- Initiate annual soil sampling and analysis programs to identify soil chemistry problems before they become serious. Make sure total nitrogen (nitrate plus ammonium) is included in the analysis. Compare results against recommended guidelines, such as those provided at www.paceturf.org.
- Monitor soil salinity using a TDS-4 meter or equivalent. Leach to prevent accumulation of salts to levels above the tolerance of your turf variety.
- Based on soil testing results, apply amendments to compensate for accumulation of sodium or for elemental deficits that might occur during leaching. Adjust nitrogen fertility programs if total nitrogen in the soil exceeds 20 ppm, or if ammonium levels exceed 7 ppm.
- Aerate fairways at least twice annually using a deep tine – to a 9-inch depth, if possible. Apply required amendments such as gypsum in conjunction with aeration.
- Consider a sand topdressing program if organic matter accumulation and/or poor water movement is a problem.
- Consider trimming free foliage to prevent contact with irrigation spray.

IRRIGATION DISTRIBUTION

While leaching programs can be effective to reduce salt damage, they also highlight irrigation distribution problems and soil drainage problems. Frequently, more wet spots and/or bare areas occur as a result.

To alleviate these problems, follow these suggested water management guidelines:

- Avoid using reclaimed water on coolseason turfgrass greens.

• Implement a periodic irrigation distribution monitoring program to ensure optimum distribution – greater than 75 percent distribution uniformity – is maintained.

• Install a water flow meter on one fairway to enable accurate calculation of leaching fractions. Consider installing an in-line electrical conductivity meter to monitor water quality fluctuations.

• Become even more meticulous about irrigation system maintenance, including replacing misaligned, sunken, broken or poorly selected sprinkler heads and dealing with pressure fluctuations.

• Implement a leaching fraction for areas where reclaimed water is used.

• Require the water district to provide access to daily, weekly and monthly summary values for water quality indicators. Of particular interest is electrical conductivity, sodium, chloride and boron levels. Consider conducting independent water test for more complete evaluations.

Despite all of the efforts outlined above, some reduction of golf course playability because of salt-related turf and tree damage might result. Addi-

Table 3. Comparison of well water sources used at several golf courses in Southern California. Note that in several cases (Fairbanks Ranch, Vista Valley, and San Diego) well water quality is inferior to reclaimed water quality values reported in Tables 1 and 2. These courses would benefit from use of higher quality reclaimed water.

Factor	Average domestic	Fairbanks Ranch	Vista Valley	San Diego	Arrowhead	Friendly Hills	Oakmont
EC (dS/m)	0.8	2.8	2.8	4.0	0.5	0.7	0.9
SAR	1.9	3.2	2.8	5.2	0.8	1.2	1.6
SARadj	3.4	8.2	6.7	13.3	1.4	2.4	3.1
HCO3 (ppm)	173.8	366.1	389.5	363.9	189.5	244.1	185.4
B (ppm)	0.17	0.05	0.21	0.41	0.15	0.13	0.13
Cl (ppm)	81.7	322.7	609.3	1004.2	9.8	59.6	73.2
Na (ppm)	70.0	195.0	194.8	406.5	24.6	44.4	65.3

tionally, development of wet areas because of leaching programs might be difficult to avoid. It's critical to communicate with golfers so they adjust their expectations for high-quality turf.

If, after several years of efforts, the above management programs don't provide effective salinity management for the soil-turfgrass system, it might be necessary to switch turfgrasses to more salt-tolerant types such as bermudagrass or paspalum.

As mentioned, the quality of reclaimed water is in the eye of the beholder, and might be a benefit in some situations, as illustrated in Table 3 on page 52. The value of reclaimed water must be judged on a case-by-case basis. GCI

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IMPACT ON THE BUSINESS

Learning from San Pedro's contract troubles

By Marisa Palmieri

Coming off the late June settlement of a four-year-old lawsuit about an effluent water contract, the management staff at San Pedro Golf Course in Benson, Ariz., can't stress enough the due diligence managers and superintendents must perform when entering a contract with a government entity. Though Dan Wickman, PGA golf course manager, and superintendent Brad Quiring weren't around when the contract was created, the two have endured many difficulties during the past few years as a result of the litigation and running out of water.

"Watching your course die in Arizona in May and June is painful," Wickman says. "My superintendent and I had some long days."

In August 2004, the course's owner filed the suit, alleging the city of Benson failed to provide the amount of effluent water stipulated in a contract between the city and the course. Benson, from which San Pedro's owner originally leased the course's land, had promised to provide 180 million gallons of effluent water per year but was about 30 million gallons short, says Quiring, who joined the crew after construction and grow-in.

Though the city said, in the contract, it would make up for any water shortfalls from a nearby well, that water was never tested before the contract was signed. It turns out the salty well water was unsuitable for growing turfgrass, but no one discovered this until Quiring tested the water well after the course's effluent water storage facility, a 9-acre lake, was close to running dry.

The maintenance staff made due with the unsuitable water for a short time, supplementing the turf with gypsum and soil treatments to combat the poor water quality. After a while, the city provided some relief, allowing the course access to fire hydrants, Quiring says. Thankfully, the original superintendent on the project overestimated the amount of water the course would need, and the maintenance staff was successful at limiting water use thanks to an efficient irrigation system.

IMPACT ON THE BUSINESS (continued)

The staff's efforts to work with what it had weren't without significant changes and financial losses, Wickman says. Unsure when the suit would be settled, management opted to reduce the turf area and switch from a rye blue course to bermudagrass. This change shut down the course for almost three months during reseeding. Additionally, the course's owner purchased a nearby piece of land equipped with a well for a supplemental water supply.

Though the city settled the lawsuit, which turned over ownership of the course, valued at $1.4 million, to the lessee, Arizona Golf Systems, the settlement didn't come close to the estimated damages, which topped $5 million. Damages include costs of reseeding the course, sodding several areas, lost revenue from a year's worth of grow-in delays and the effects on the business value's from poor course conditions early on.

"If people come in to play and the course isn't in good shape, they might never come back," Wickman says. "We really struggled for the first three years. If we opened correctly, would the business be under those circumstances?"

Though Wickman says the development team did many of the right things when signing the original contract with the city, going a few steps farther and probing the city about its effluent water-producing capabilities might have raised some red flags that could've prevented the lawsuit.

"Unless you've been through what we just went though, you probably wouldn't think a city could run out of water, but they did," Wickman says. "If I were part of another development, that's definitely something I'd look at. It's something I wouldn't have known to question before, but it's something I'll never forget."

In addition to recommending traditional contract procedures, such as having an attorney review everything, Wickman encourages superintendents to get involved in evaluating the water quantity and quality terms of effluent water contracts. One thing to consider is including a buffer amount of water based on weather-related fluctuations.

"You need a buffer, and it can't just be a couple thousand gallons," Wickman says. "You'll have hot years and dry years, and you can't count on the weather."

Also, consider a contingency clause stipulating that any supplemental water sources must be suitable for turfgrass grow-in and maintenance. Don't forget to test these sources, and ask questions.

"Most people are going to trust a government entity can live up to the terms it's promised," Wickman says. "Don't feel like you're the little guy compared to the government. If there's something that doesn't meet your needs, get it changed." **GCI**