One of Scioto's cored greens. Photo: Bob Becker

them up," says general manager Greg Wolf. "The sensors told us the work we did putting channels into the greens didn't help at all."

SELLING IT TO MEMBERS

Yoder and Becker showed Wolf the results of their experiment.

"It's always different when it comes from the general manager, not the superintendent," Becker says. "Members sometimes think the superintendent is just making excuses."

Yoder and Becker eventually presented the data to the green committee, which made a recommendation to the board of directors. In turn, the membership needed to vote on the suggested greens renovation because the project would change the golf course and the cost required approval from a voting majority. At a town hall meeting about the proposed renovation, members expressed concern about closing their course for a year. That concern was addressed when the club purchased rounds at nearby, recently opened Pinnacle Golf Course. The renovation project was approved by 88 percent of the membership.

"I never thought the members would approve the project to rebuild the greens," Becker says.

The golf course closed July 9, 2007, and reopened April 29, 2008.

CHOOSING AN ARCHITECT

The Scioto team chose Hurdzan as the architect for several reasons: He's local, he's been a friend of Yoder's for 30 years and Scioto leadership recognizes the quality of work he does.

"Not everybody will trust you to dust the Mona Lisa," Hurdzan says.

Several years ago, Hurdzan proposed a golf course improvement plan, including bunkers, that the Scioto membership approved.

"Everyone liked the way the golf course was," he says. "Membership didn't want to change what they had because it was good. I thought a few changes could make it better. I won the confidence of the membership. Then I got more aggressive with the renovation."

Hurdzan says his work on the greens renovation was a continuum of the bunker renovation he did in 2005 and 2006.

"They kept expanding my services in order to satisfy their concerns about the greens," he says.

NEW GREENS

Using LIDAR, Hurdzan mapped out the greens down to one-inch contours, conducted a slope analysis and presented the information to members.

"Some greens were too steep with today's green speeds, so we softened them a bit," Wolf says. "With the help of a computer program, we were able to increase the size of the pinnable areas."

Hurdzan and Norm Hummel from soil testing lab Hummel & Co. were involved with selecting the greens mix from six options.

"The members wanted to make the greens firm and fast, so we added 5 percent soil to the root-zone mix," Hurdzan says. "It's a touchy thing to do because the greens can become like concrete. We tested the soil and made sure it remained acceptable."

The team used an 8-1-1 sand-based root zone that included a soil component at 10 percent to create the desired firmness. The last 10 percent was Profile, which helped keep the performance characteristics of the mix. Before settling on the mix, the team used many variations of each of the mixes on practice greens built on the range in the year leading up to the project.

Wolpert Engineering staked the USGA-spec greens, Becker's crew stripped them, and Dayton, Ohio-based builder Topp Shape cored them. Then the team restaked the greens and installed the gravel and mix.

"We couldn't disrupt the outside of the greens – the collars and edges remained the same," Hurdzan says. "So there was a lot of hand labor."

In 1989, the greens were regrassed with Pennlinks, and in 1999, they were regrassed again – this time with G2 bentgrass. In 2003, the G2 greens weren't performing very well, so Becker built a nursery green to test different varieties.

Eventually, Yoder and Becker recommended a combination of A-1, A-4 and T-2 (alpha) on the new greens. The decision was based on a blind test – selecting the plot that survived the practices the best. Becker liked the addition of the T-2 because the A-1 and A-4 are so similar genetically, and he wanted another variety in the mix for diversity. Yoder and Becker educated the project committee about the different varieties, showed them the plots, and the committee approved the superintendents' recommendations. All the greens were seeded three ways at one pound per 1,000 square feet August 31, 2007.

"We told the members we wouldn't push the greens," Becker says. "The height of cut is a little higher. We got to a speed of 9 on opening day and now we're a 12 on the Stimpmeter at the same height as opening day. We started rolling twice a week, and now we're up to four days a week. They're single cut and groomed daily. Next year, we'll push the greens to what members want."

NICKLAUS' TWO CENTS

On May 28, 2007, six weeks before the start of the renovation project, Jack Nicklaus, an honorary member of Scioto, called the club and said he loved the old course and because he grew up there and felt responsible for bringing in Dick


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Wilson, he wanted to be involved. Nicklaus came to Scioto and drove around the course with Hurdzan and committee members.

"Jack said, 'If you want my input, call me,'" Hurdzan says. "Jack called back and was passionate about the job. The committee said, 'Mike's our architect.' Jack said, 'Fine, we'll work together.' Jack came back seven or eight times during the project. I give him credit for making the project better. When Jack says something, people listen more intently.

"I came at this purely from an architectural view," Hurdzan adds. "Jack looked at it from a player's view, but we came to the exact same spot. We met dead in the middle. We had a strict budget and weren't going back to the club for more money."

Nicklaus moved the greens on holes 8, 10 and 17 closer to water to make shots more challenging. He also moved a few greenside and fairway bunkers.

"He had a lot of fantastic ideas to get the course the way it used to be," says Tom Topp, v.p. of Topp Shape, who previously worked for Nicklaus at Muirfield Village. "Hurdzan and Nicklaus worked great together. Scioto got the best out of them."

WIDENING THE SCOPE

What started out with just rebuilding the greens expanded into regrassing the fairways and adding two sets of tees.

"We changed our philosophy," Becker says. "The members wanted firm and fast and developed a little threshold for browning, so we changed from *Poa annua* to L-93 bentgass in the fairways. Now we're using one-quarter of the water, less chemicals and we have better playability."

Members were able to evaluate L-93 at several courses in the area before choosing to use the variety in the fairways.

"We have an older membership, and they like a little roll, but they didn't have that with the *Poa* because we had to water a lot to keep it alive," Wolf says. "The course is playing more difficult now."

When it came to the additional tee boxes, the team used the earth removed from the greens to build championship tees, short tees for juniors and higher handicappers, and member tees. There are now six sets of tees.

The crew seeded the fairways during the last 10 days of August 2007 and seeded the tees in

Chunks of concrete that were found in the greens. Photo: Bob Becker

September.

"We need 10 to 12 weeks of good grow-in and we got it," Becker says.

WORKING TOGETHER

Members weren't assessed for the project – the funds came from a capital budget. Scioto purchased everything for the project, and if anything went wrong, Yoder and Becker were responsible. They communicated to members hourly and cleaned up the site every evening.

"Members would come out every night and ask questions," Becker says. "It's traumatic to see the golf course they love torn up. They wondered how it would be back the following year. We were visible and answered all questions. It's a member golf course, and we needed to deliver what they wanted us to do."

Topp, who had worked for Scioto in the past, was a little stressed about the project but got off to a good start.

"The grounds crew under Becker – their direction and cooperation – had a lot to with the success of the project," he says. "I can't say enough about the greens staff. They were always pitching in and helping out. Nobody was trying to take all the credit. The Scioto job was one of the most exciting jobs I've had. The project was neat because of the way Mike and Jack worked together and trusted us to put their ideas on the ground."

Hurdzan praised Topp for doing a herculean job at a high standard.

"He worked long periods of time and did what most thought would be impossible," he says.

Overall, the project was smooth sailing, Hurdzan says.

"We all had the same focus to produce the best golf course," he says. "To continue my relationship with Scioto was enormously exciting and rewarding. It's one of my all-time professional highlights. We took a great golf course and made it better."

The renovation, though, was about the future, Wolf says.

"This project was about making a championship golf course for the next generation," he says. **GCI**


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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 (HCO_3)	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

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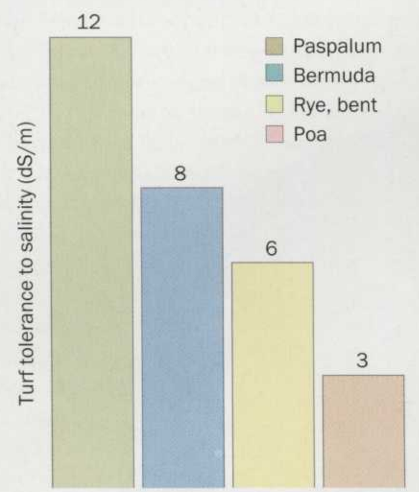
Figure 1. Different turf types differ markedly in their ability to tolerate soil salts.



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 cool-