Greens Firmness Management Project: Preliminary Report

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Summary

On January 23, Santa Ana Country Club and the PACE Turfgrass Research Institute embarked on a multi-month study to study the issue of greens firmness by characterizing the current situation and then identifying management practices that can help to achieve more consistent greens firmness throughout the year.

Factors contributing to greens firmness were identified, with soil moisture a key component. Greens were characterized by golfers as performing well, with good surface firmness, on the 1/23/06 evaluation date. Based on data collected 1/23/06, a tentative range of 15 – 25% soil moisture was identified as the target for producing optimal levels of firmness (tentatively characterized as ranging from 70 – 125g on a Clegg meter).

Maintaining this level of performance throughout the year will be difficult, especially during the hot summer months when irrigation demand is highest. However, practices including modified aeration, topdressing and irrigation strategies, along with a soil moisture and surface firmness monitoring program, will assist in achieving the best firmness possible while still maintaining turf health and quality.

PACE will return to SACC during the spring (to complete the GPS mapping of all greens and irrigation heads and to develop an irrigation approach for the summer months) and again during the summer to monitor results, to adjust recommendations as necessary, and to collect data to produce a final report and recommendations by the end of 2006.

Background

Describing the problem

The golfer controversy over greens trueness and firmness has been ongoing for many years. The following quote from the May 1947 United States Golf Association “Timely Turf Topics” illustrates the persistent focus on firm and true greens:

“Putting surfaces should be firm to avoid foot printing and should be resilient so that a properly-played shot will hold, but should be sufficiently solid so that a poorly-played shot will roll over.

The surface should be smooth and true as a billiard table. Density of the turf should be so great that individual grass blades are crowded to a true vertical position. “Graininess,” “sponge” or “mat” destroy the accuracy and Fun in golf. Governing factors include: choice of grass, soil texture, drainage and aeration, fertility level, and watering practices.”

Not much has changed in the desire of golfers for a firm and true greens surfaces since 1947. Despite this, methods for addressing the problem have not been extensively researched and documented. This is partly because the nature of the problem varies widely from one golf course and one group of golfer’s perceptions to another. It is also because the management practices that are required to improve firmness frequently require long-term overhauls of the greens.

Factors involved

At Santa Ana Country Club, the governing factors that will influence firmness are the same as those listed in the quote above. Unfortunately, major re-construction is required to modify the factors most directly implicated in greens firmness; these are the nature of the root zone sand (which should optimally be changed to a firmer mixture), the turfgrass variety (which should optimally be changed to bentgrass, which provides a firmer surface than poa) and improved drainage (which by allowing water to move more easily through the soil profile, would increase the firmness and homogeneity of the greens). Without these major changes, greens firmness cannot be fully maximized at Santa Ana Country Club.

There are, however, several less dramatic management practices that can lead to some improvements. These include modifications in aeration, topdressing and watering practices.

An increased frequency of aeration will lead to firmer greens, but the compromise is that the trueness of the surface will be impacted for about 14 days following each aeration event. New, smaller diameter aeration tines may improve recovery and allow more frequent aeration to increase firmness, but increased aeration to improve firmness will have to be weighed against the negative (though temporary) impact on surface trueness. Even if increased aeration can not be tolerated, application of sand as topdressing without aeration is a practice that might be evaluated to increase the firmness of the greens during the summer.

A second, and more controversial factor is watering practices. Is it possible to reduce summer time irrigation or hand watering while maintaining healthy poa? Irrigation water reduction to increase firmness carries the greatest risk. Once the soil has dried to a level that exceeds the ability of the poa plant to extract the water, the plants will wilt and die. If the poa dies, a minimum of 6 weeks of conducive weather conditions will be needed before the stand of poa will return to acceptable putting conditions – in the peak heat of the summer, this period of time will be longer and if traffic is allowed on the damaged areas, the time to recovery will be extended further.

Even though soil water management to levels that provide firm greens without damage to the poa plant is a risky venture, one of goals of this project will be to determine if there is a way to reduce the risk of drying out poa greens. How dry is safe? Can we monitor soil moisture to better adjust irrigation practices? What levels of soil moisture are adequate for the plant yet low enough to provide the desired firmness?

Soft greens have been described as greens that do not have sufficient ball bounce and roll after driving onto the green. In addition, soft greens are more susceptible to severe ball marking. These subjective measures of firmness will help guide management practices and development of objective measures of firmness. The current firmness of greens was reported to be nearly ideal by golfers at Santa Ana Country Club during the day of sampling (1/23/2006). The range of firmness measured during this preliminary study will therefore be used as a benchmark against which to measure the impact of future management practices. These guidelines will need to be re-evaluated during the year to be sure that they are valid and that the health of the poa is not compromised.

Fertility is sometimes mentioned as a factor in greens firmness. Fertility has been monitored at SACC for more than 10 years. Soil nutritional guidelines have been managed within the range needed for good greens performance. Attempts to reduce fertility with the goal of firming greens will compromise the integrity of the poa and increase susceptibility to diseases such as anthracnose and susceptibility to wear damage.

Measuring firmness

Firmness has been measured using a variety of tools. Baker et. al. 1996, used simulated golf ball launchers that mimicked the impact of a ball hitting a green with the impact that might be typical for a 5 iron (53 degree impact angle, velocity of 22.7 m/s, backspin 750 rad/s) and a 9 iron (53 degree impact angle, velocity 18.8 m/s, backspin 880 rad/sec). This unique research equipment is not available for us to use, but fortunately, Baker et. al. found that there was a significant correlation between firmness evaluated using the ball impact simulators and the Clegg Impact Soil Tester (Clegg). Based upon their fairly extensive surveys of golf courses in Britain a range of Clegg measurements between 70 – 120 g (gravities) was considered to result in good ball bounce and roll – not too soft and not too hard. In a similar study conducted in New Zealand, Linde found that greens reporting Clegg values of less than 50 g were too soft and greens that reported Clegg values of more than 140 g were too hard. The average for high-end golf courses in New Zealand ranged between 78 and 122 g. Based on this information, we have identified a range of 70g to 125g as an initial target for SACC; this range will be modified, if necessary, as our work progresses.

The Clegg values observed at SACC during this preliminary study ranged between 62 and 125g. Based upon this initial research, the greens are currently performing almost completely within the guidelines considered ideal for golf play (only two readings were below the guideline of 70g). Golfer's positive evaluations on firmness, obtained January, 2006, confirm this conclusion. It is expected that as hot weather and increased irrigation demands occur during the summer months, firmness may decline. It is during the warmer months that the greatest challenge in terms of maintaining green firmness occurs.

Measuring soil moisture

Soil moisture conditions were also monitored during the January 23 evaluation. The correlation between low soil moisture and firm conditions were confirmed at SACC (Figure 3). Soil moisture levels ranged between 14 and 32% soil moisture, although the majority of readings were within the guideline of 15-25% moisture. For sand-based greens, we generally target a range of roughly 15% – 25% for optimal turf growth and optimal firmness. Although moisture levels below 15% produce good firmness, turf health may be seriously compromised. A reading of 12% soil moisture resulting in turfgrass stress and damage. Targeting soil moisture from 15-25%, and with poa plants having roots that can extract water from the top 1.5 inches of soil during the summer, the plant will have just enough water to make it through a maximum water demand (evapotranspiration) day in the summer – about 0.3 inches of water. For that reason, the surface moisture in the top 1.5 inches of soil will almost have to be replenished on a daily basis. If the poa plant were capable of forming longer roots, less water would need to be applied on a daily basis because the deeper roots would have access to deeper soil moisture. The ultimate problem we will encounter when trying to manage poa at lower soil moisture levels is that the short roots will require almost daily irrigation or syringing. Compounding the high water demand of poa is that water must be applied through the surface of the green resulting in a higher water concentration at the surface of the green.

A further challenge with regards to managing soil moisture relates to the inherent flaws in today's irrigation system designs. Compounded by the irregular shape of greens, it is unfortunately the case that portions of the same green may be irrigated from anywhere between two to five different irrigation heads. This results in uneven application of water and therefore uneven soil moisture levels. To compensate, the superintendent must combine a series of tactics, including targeted hand watering (to areas that receive too little water), irrigation system adjustments (micro-management of irrigation head run cycles) and constant adjustment and re-adjustment of the system. By monitoring soil moisture and surface firmness parameters throughout the year, this study hopes to identify irrigation practices that can combine that sometimes contradictory demands of keeping the turf quality high while at the same time keeping the playing surface as firm as possible.

A final soil moisture challenge relates to the need for periodic leaching (high volume irrigation) of the greens, especially during the summer months. Due to lack of rainfall in Southern California between April and November, salts from irrigation water rapidly accumulate in the soil, where they cause problems including turf stress and death, destruction of soil physical properties and instigation of turf diseases such as rapid blight and anthracnose. In other words, without leaching, the survival of poa is highly unlikely. Surface firmness following leaching events will be compromised, but this is unavoidable. Improved movement of water through the greens via the recommendations below will decrease the intensity and duration of the problem, however.

Recommendations

(for implementation beginning February, 2006)

- Target soil moisture between 15 and 25% using a Spectrum TDR300 using 4.8 inch probes. Purchase of a soil moisture meter is recommended. The TDR 300 soil moisture probe ($1195.00) is available from Spectrum Technologies www.specmeters.com/about.html (800) 248-8873

- Target Clegg Impact Soil Tester (CIST) 2.25 kg hammer deceleration between 70 and 125g.

- In the spring, aerify using 3/8" hollow tines on a 2"x2" spacing and sand fill the holes using Caltega 7 USGA Specification sand.

- A more aggressive aerification program than the one described above can be substituted if SACC is willing to tolerate some disruption of optimal golf play in order to achieve more dramatic results.

    - In the spring of the year, aerify using 5/8" hollow tines and collect the plugs. Apply ¼ inch depth of Caltega 7 USGA specification silica sand. Vertidrain using 3/4" solid tines and sweep the sand into the holes and fill all holes to the top. This process will aid in firming the entire root zone but it will require a repeat of the process for at least three years in the spring before the process can be terminated. This aggressive program will disrupt the trueness of the greens for an extended period of time and may result in stronger poa growth in the aeration holes that will result in a slightly bumpy surface. This negative impact can be partially managed using Primo and increased fertility.

- Lightly topdress weekly using a #30 sand applied at approximately 50 lbs/green (1 bag dry sand) using a Scotts or similar rotary spreader. Nighttime irrigation will move the sand into the upper thatch layer. Although thatch has been very well managed, poa plants are continually producing more thatch. Application of increased levels of top dressing sand will help modify the thatch and mat layer and firm them up.

- During the irrigation season, implement a monthly Aqueduct (4 oz/1000 sq ft) application program to improve water movement through the soil profile to drain.

- With poa greens, do not expect optimum greens performance during the months of July, August, and September. Prevent turf loss during these months so that fall winter and spring greens performance will be premiere. It is unlikely that optimum performance can be provided throughout the year. If summer is the target for good performance, more aggressive aeration will be needed at other times of the year to improve the root zone composition and allow deeper rooting and improved drainage.
- PACE will return to SACC during the spring (to complete the GPS mapping of all greens and irrigation heads and to work with you to develop an irrigation approach for the summer months) and again during the summer to monitor results, to adjust recommendations asnecessary, and to collect data to produce a final report and recommendations by the end of 2006.

Citations

Baker, S.W. Hind, P.D., Lodge, T.A., Hunt, J.A., Binns, D.J. 1996. A survey of golf greens in Great Britain IV. Playing quality. J. Sports Turf Res. Inst. 72:9-23.

Linde, D. 2005. Assessing golf course conditions in New Zealand. Golf Course Management

Figure 1. Operation of the Clegg Impact Soil Tester. The hammer of the tester contains a sensitive decelerometer that measures the speed of deceleration upon impact with the greens surface. The 2.25 kg hammer is lifted to a height of 18 inches and dropped. The measurement unit is gravities (g). In the example below on green 7, the CLEGG recorded a firmness of 81g. Values between 70 and 125 are desired for firm greens surfaces.

Figure 2. Average of four drops of the Clegg hammer (IMPACT) at each of four sites for each of four green evaluated. G represents the average number of gravities of deceleration (a measure of firmness) for each of the four greens. Greens performance was near ideal at the time of sampling indicating that these values are within the target guideline for firmness at SACC. Good performing greens range between 70 and 125 g.

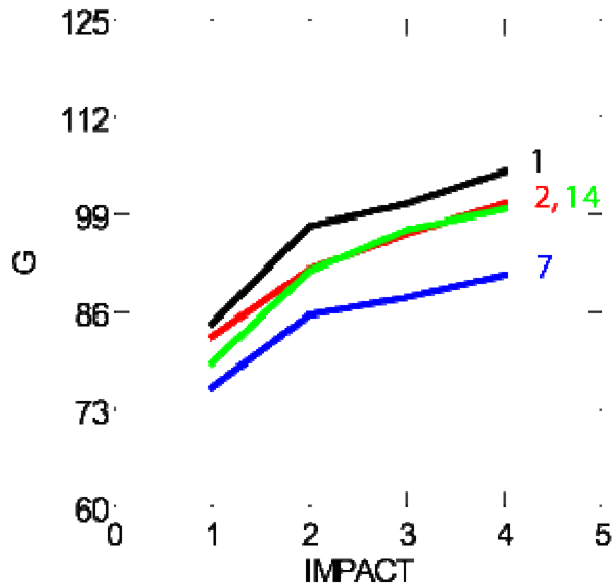


Figure 3. Relationship between TDR300 VWC (volumetric water content as a percentage) and Clegg deceleration (G). Higher G values indicate increased firmness. Note that firmness drops when soil moisture levels increase above 25%. The upper left graph represents the first drop of the Clegg hammer, the upper right graph represents the second drop of the Clegg hammer, the lower left represents the third drop of the Clegg hammer and the lower right represents the fourth drop of the Clegg hammer.

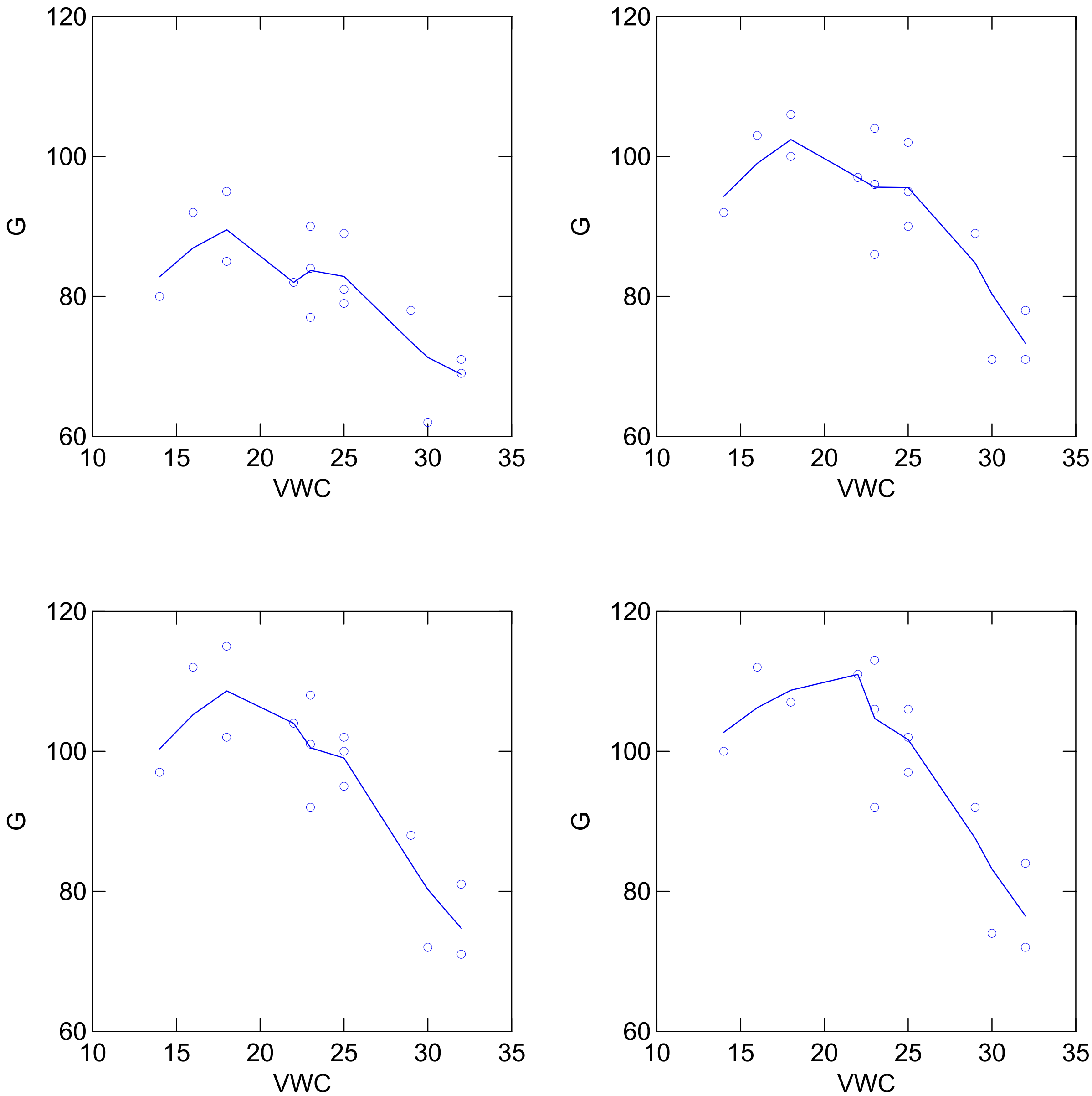
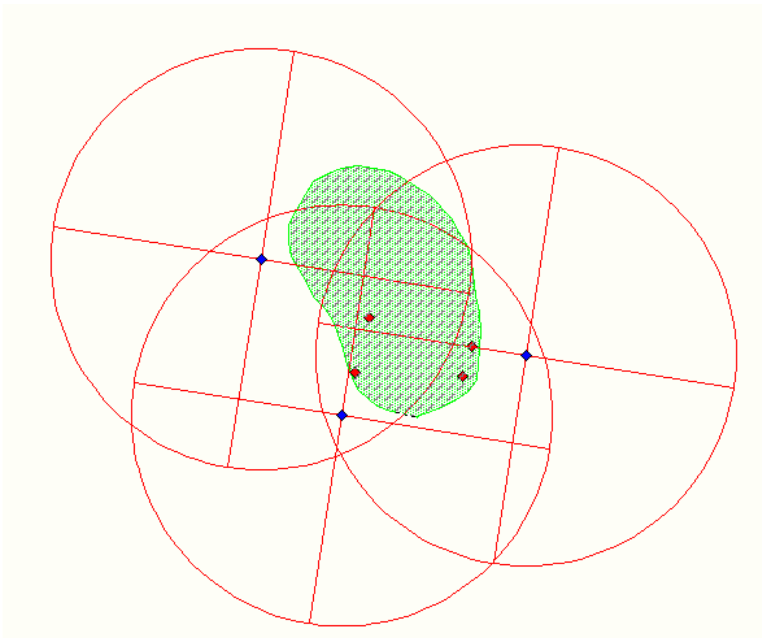


Figure 4. Green 2.

Soil based, 3540 sq ft. The steep front of this green was not evaluated. The green area illustrates the orientation of the green with north at the top of the illustration. The blue dots illustrate the location of irrigation heads. The red circles illustrate the 67 ft throw of each irrigation head. The red dots illustrate the location of each soil moisture and CLEGG reading. Note that two of the samples receive irrigation from two heads and the remaining two receive irrigation from three irrigation heads. The graph illustrates the mean gravity (G) recorded for each impact with the hammer. The vertical bars illustrate the standard error of each mean.



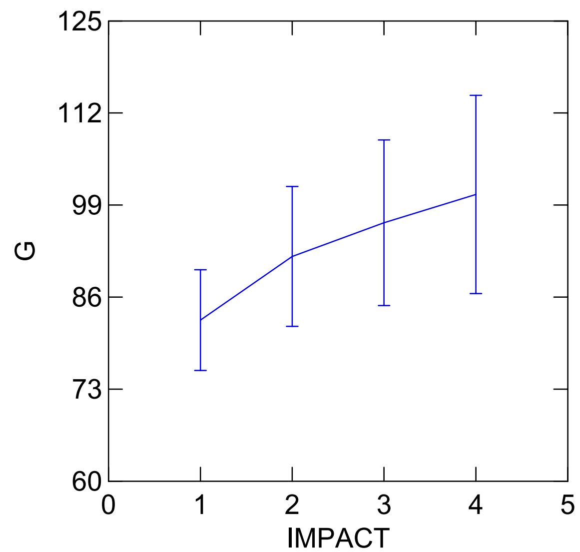
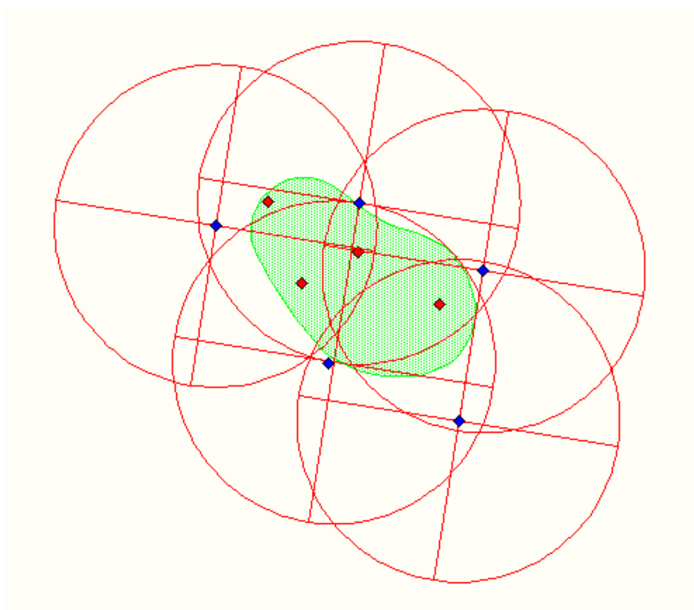


Figure 4. Green 14.

Soil based 5083 sq ft. This green has been described as the softest green during the summer irrigation period. The green area illustrates the orientation of the green with north at the top of the illustration. The blue dots illustrate the location of irrigation heads. The red circles illustrate the 67 ft throw of each irrigation head. The red dots illustrate the location of each soil moisture and CLEGG reading. The sample locations represent areas that are irrigated by 2, 3, and 4 irrigation heads. The graph illustrates the mean gravity (G) recorded for each impact with the hammer. The vertical bars illustrate the standard error of each mean.



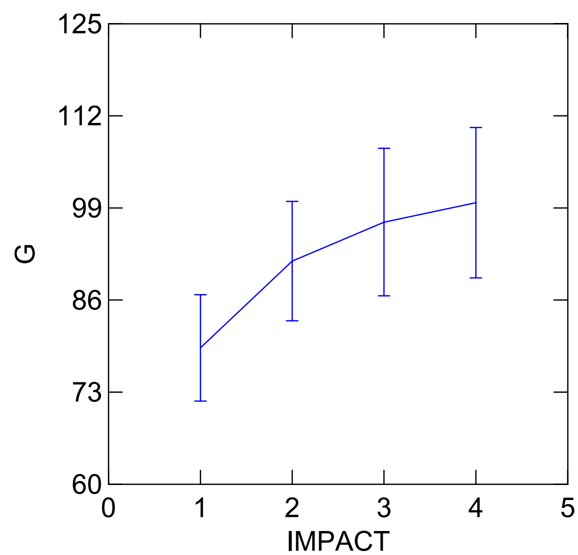
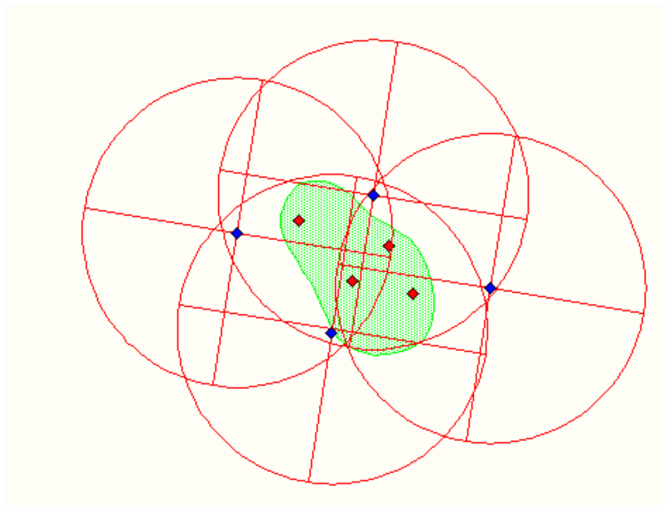


Figure 6. Green 1.

Typical construction, 80% washed plaster, 20% Turf and Tee amendment, 3230 sq ft. The green area illustrates the orientation of the green with north at the top of the illustration. The blue dots illustrate the location of irrigation heads. The red circles illustrate the 67 ft throw of each irrigation head. The red dots illustrate the location of each soil moisture and CLEGG reading. The sample locations represent areas that are irrigated by 3 and 4 irrigation heads. The graph illustrates the mean gravity (G) recorded for each impact with the hammer. The vertical bars illustrate the standard error of each mean.



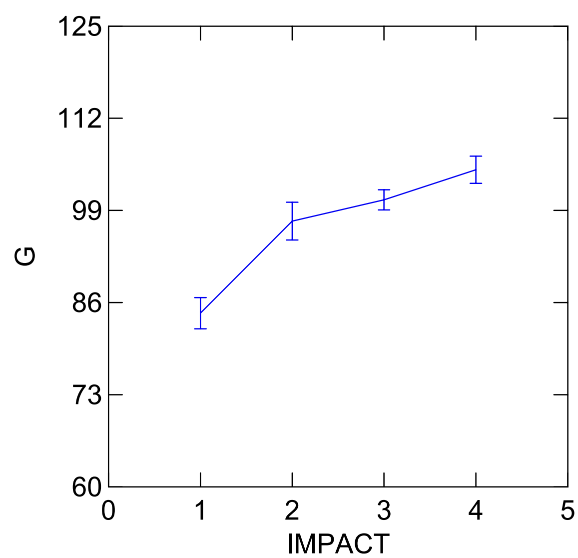


Figure 7. Green 7.

Typical construction, 80% washed plaster, 20% Turf and Tee amendment, 4344 sq ft. The green area illustrates the orientation of the green with north at the top of the illustration. The blue dots illustrate the location of irrigation heads. The red circles illustrate the 67 ft throw of each irrigation head. The red dots illustrate the location of each soil moisture and CLEGG reading. The sample locations represent areas that are irrigated by 2, 3, 4 and 5 irrigation heads. The graph illustrates the mean gravity (G) recorded for each impact with the hammer. The vertical bars illustrate the standard error of each mean.