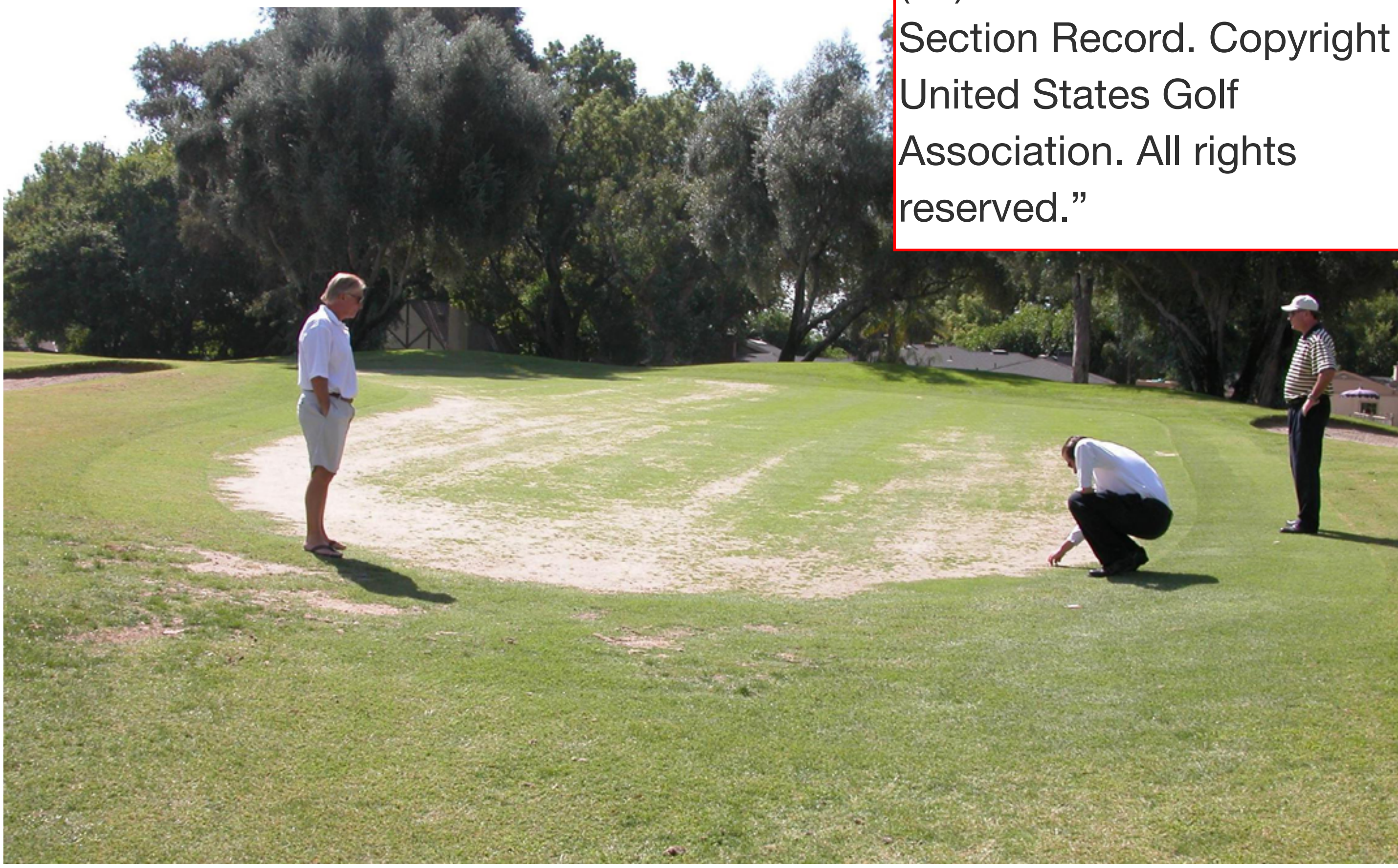
Time to Rebuild the Putting Greens . . . Or Is It?

Many factors must be considered before undertaking a putting green reconstruction project.

BY JOHN FOY AND LARRY GILHULY



Poor putting green performance or failure can be the result of several factors. A methodical evaluation should be performed to determine if reconstruction is necessary or if there are other options that will improve putting green performance.

The prospect of having to rebuild one, a few, or all of the putting greens is never popular at any course because of the major disruptions to golfers and course operations and the cost. There are multiple factors that affect turf growth, putting green performance, and the type of conditioning that can be provided. A basic understanding of these factors, along with accurately assessing whether or not there are options other than complete reconstruction, will be reviewed in this article. If it is determined that agronomic weaknesses and/or architectural limitations cannot be overcome without rebuilding, course decision makers will be provided with additional information on what to do next.

TURFGRASS GROWTH REQUIREMENTS

Sunlight: The game of golf is played on grass. In order to provide consistent, good-quality putting green conditions — i.e., smooth, true ball roll and appropriate speed — a dense, healthy turf cover must be maintained. While there are differences in the agronomic requirements to maintain healthy bentgrass, bermudagrass, *Poa annua*, seashore paspalum, or zoysiagrass, there is one common denominator — they all must have sunlight.

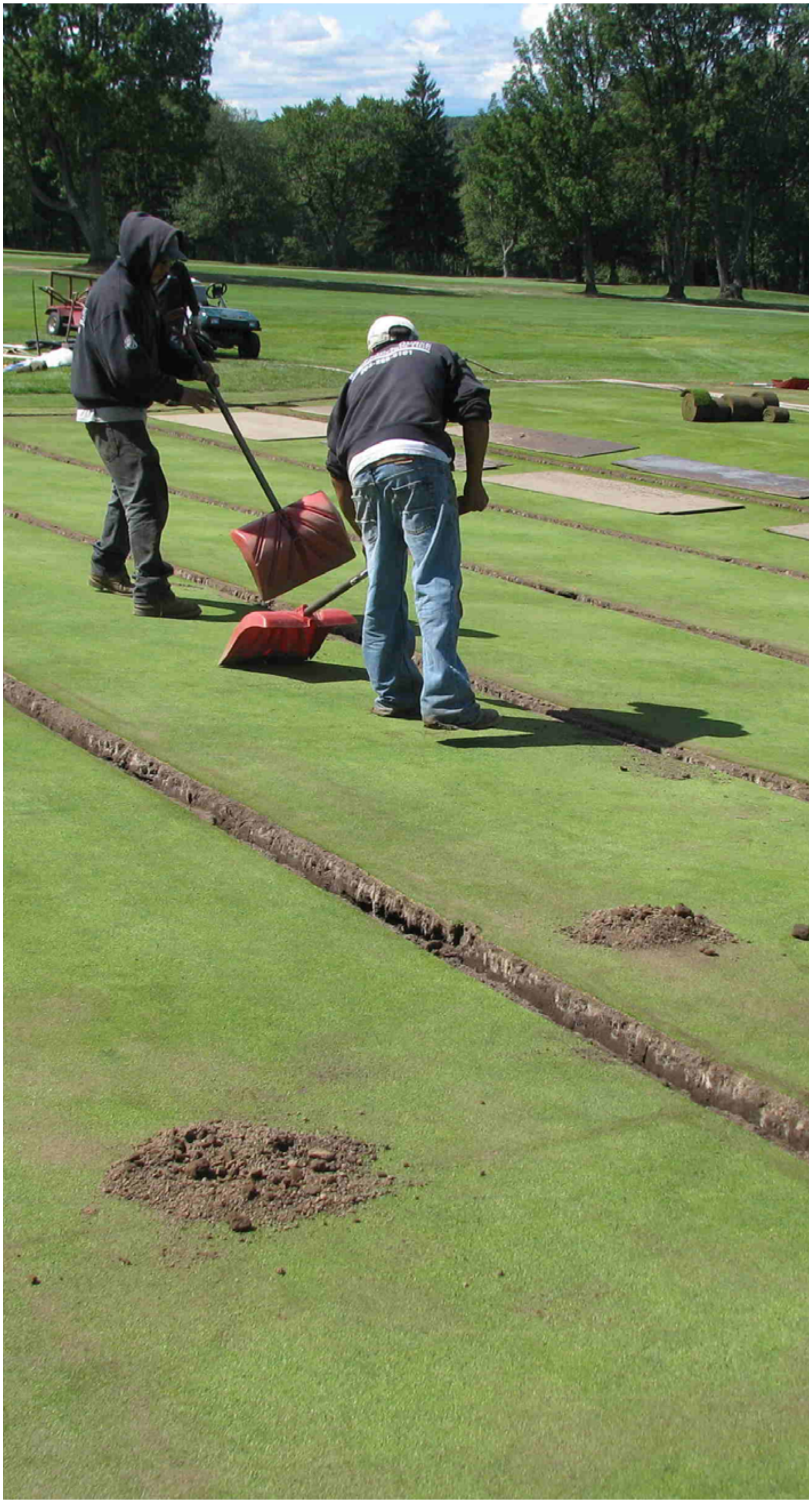
For healthy growth and optimum performance of bentgrass, bermudagrass, and seashore paspalum, a minimum of eight hours of direct sun must be provided. *Poa annua* and the zoysiagrasses being used on putting greens have better shade tolerance, but they still need several hours of direct sunlight to ensure dense, healthy turf cover. Conducting a sunlight assessment on poorly performing putting greens is the first step in evaluating key factors that affect green performance. Historically, assessing sunlight has been accomplished simply by using a compass. However, today there are high-tech options like mobile device apps, light meters, and contract services that can accurately evaluate if sufficient sunlight is being received and identify exactly where tree and vegetation removal needs to be performed. The USGA Course Care video Identifying Sun Angles and How They Impact Turf Performance, as well as the article Made in the Shade or Mud in the Shade, provide additional information on this subject.

A couple of additional turf growth limiting factors associated with trees and dense vegetation near putting greens are restricted air movement and competition from feeder roots. The impact of restricted air circulation across cool-season turfgrass putting greens during periods of high temperatures and humidity has long been recognized. When air circulation is restricted, higher turf canopy and soil temperatures develop, which negatively impacts general turf health and increases the potential for disease outbreaks. However, because of its poor shade tolerance, the impact of restricted air circulation on bermudagrass has been overlooked for many years. As is the case with cool-season putting greens, when selective vegetation removal is not sufficient for increasing air circulation across bermudagrass putting greens, fans are an option that can help maintain healthier turf cover during periods of intense environmental stress. The article Using Turf Fans in the Northeast discusses this topic in more detail.

Tree feeder roots can extend outward a distance equal to or greater than their height. The fine feeder roots of a large, mature tree directly compete with turf for available nutrients and moisture and can significantly impact a large portion of a nearby putting green. Tree root pruning is a simple and effective means of alleviating this problem. As stated in the article Getting to the Root of the Problem, root pruning typically needs to be repeated every three to five years.

Internal Drainage: While height of cut is not the total answer to providing smooth ball roll and medium-fast to fast green speeds, regular close mowing of putting greens is necessary for

Low-cut putting greens must have adequate sunlight for the promotion of dense, healthy turf. Conducting a sunlight assessment should be one of the first steps in evaluating the agronomic factors affecting putting green performance.



Improved methods and materials being used for installing subsurface drainage systems in existing putting greens make this practice a viable alternative to rebuilding in some cases.

providing consistent, good-quality conditioning. However, regular close mowing does exert significant mechanical stress on turf and negatively impacts root system development. Thus, it is extremely important that the growing medium, or rootzone, is not also a growth-limiting factor.

Like sunlight, all turfgrasses also require water. Yet the persistence of excessive moisture in the upper rootzone is just as detrimental to turf health as a lack of moisture. The persistence of excessive moisture results in displacement of soil oxygen content. When soil oxygen content becomes too low, turfgrass root systems literally begin to suffocate, which can ultimately lead to turf death.

It has long been recognized that a sand-based rootzone is best for putting greens and sports fields because a sand with the majority of the particles in the medium to coarse size range provides the desired balance of macro (air-filled) and capillary (water-filled) pore space to support healthy root systems and turf cover. Sands with an appropriate particle size range also are more resistant to compaction. Foot and equipment traffic both result in the progressive buildup of soil compaction, which negatively impacts porosity, moisture infiltration, and gas exchange. An additional concern is the buildup of thatch and organic matter in the upper rootzone that occurs over time with all turfgrasses.

The negative impact of a persistent, moisture-saturated upper rootzone caused by excessive organic matter accumulation or distinct layers on turf health has been well documented (Surface Organic Matter in Bentgrass Greens, Surface Organic Matter in Bermudagrass Greens: A Primary Stress?). Another diagnostic measure for determining if organic matter accumulation is a primary limiting factor is to submit samples to an American Association for Laboratory Accreditation accredited physical soil testing laboratory that can determine organic matter by weight, using the American Society for Testing and Materials Test 1647. The test results can be used to decide if changes in maintenance practices can be made to modify and improve rootzone conditions. USGA Green Section agronomists also recommend submitting intact core samples from representative putting greens for complete physical analysis of the entire profile to determine if there are additional concerns affecting putting green performance.

Core aeration and sand topdressing are the main cultural management practices for reducing and controlling organic matter accumulation and compaction. Although aeration is one of the most disliked cultural management practices, modern aeration equipment can effectively modify and improve upper rootzone performance characteristics. Based on field experience, using coring tines that are at least 0.5 inch in diameter is recommended when rootzone modification and improvement are primary objectives. Along with ensuring removal of an adequate amount of material, using larger-diameter coring tines facilitates incorporation of topdressing sand and the ability to completely backfill aeration holes.

In addition to heavier topdressing applications in conjunction with core aeration, regular light application of topdressing sand is a very important practice that helps manage organic matter accumulation through dilution. Given the great diversity of conditions across the United States, regional USGA agronomists should be consulted to help determine site-specific programs for organic matter and general rootzone management.

Sand injection is another cultural management practice that has been gaining popularity. It causes less surface disruption compared to traditional coring, but it is able to incorporate a large quantity of material into the rootzone and increase dilution of organic matter accumulation. The channels or columns of sand that are created by sand injection also increase moisture movement into the lower portion of the rootzone. Sand-injection equipment can have an effective operating depth of 9 to 11 inches and can be used as an alternative to deep-punch or drill-and-fill operations. However, while sand-injection and deep-aeration operations are options for rootzone modification at a greater depth, they are not a substitute for standard putting green coring. Furthermore, it may take several years of sand injection, drill and fill, and aeration to produce the degree of modification needed to realize a significant and permanent improvement in putting green performance.

Excessive organic matter accumulation and layers in the upper rootzone can be a deadly combination. Both of these conditions severely restrict moisture infiltration and result in the depletion of oxygen that is necessary to support a healthy root system. Conventional core aeration and deep aeration can modify and improve soil profile characteristics, but several years and multiple replications will be required.

Adequate internal or subsurface drainage is another very important consideration, especially in regions where frequent and, at times, heavy rainfall occurs or poor-quality irrigation water is being used. If moisture infiltration below the upper rootzone is restricted, a saturated profile will occur, depleting soil oxygen content. Furthermore, when irrigation water that contains moderate to high levels of salts is being used, preventing the buildup of toxic levels of salts in the primary rootzone is an ongoing management concern. Effectively leaching salts out of the rootzone is difficult to impossible without subsurface drainage systems.

Before the introduction of the USGA's Recommendations for a Method of Putting Green Construction in 1960, greens were rarely, if ever, built with subsurface drainage systems. As already discussed, it is possible to modify and improve internal drainage of the upper rootzone of older soil-based or push-up type putting greens. However, when subsurface drainage is severely restricted or nonexistent, there inevitably will be times when it is difficult to maintain both healthy turf and desired playing conditions. Even in the decades after the introduction of the USGA's construction recommendations, putting greens have been built without subsurface drainage because of the belief that it was an unnecessary additional cost.

Advances in the procedures and materials used to install subsurface drainage systems in existing putting greens have been made over the past 10 to 15 years. The very precise methods being used to excavate trench lines, install small-diameter drainage pipe, backfill the trenches, and replace the previously removed sod are producing marked improvements in internal drainage and can be completed quickly with minimal

The buildup of topdressing sand and organic matter in collars that restricts surface drainage is becoming a frequent problem. Unrestricted surface drainage from putting greens must be maintained to ensure a healthy turf cover and consistent performance.

disruption. While typically performed by golf course construction contractors, satisfactory results have been achieved with in-house drainage-improvement projects.

USGA Green Section agronomists in the Northeast and West Regions stress a few key points based on experiences at courses where subsurface drainage was installed into existing putting greens. First, the best results are being achieved at courses where a good sand topdressing program has been in place for several years, combined with deep-tine or drill-and-fill aeration programs. Next, it is recommended to work with a physical soil testing laboratory to determine the most appropriate material for backfilling drainage trench lines. If the backfill mix does not have sufficient moisture retention, the drain lines will dry out rapidly and require extensive hand watering. It is further recommended to continue with deep-tine or drill-and-fill aeration after installing subsurface drainage.

Surface Drainage: Surface drainage is as important, if not more important, than internal and subsurface drainage. Even with USGA greens that have sand-based rootzones and subsurface drainage systems, surface depressions or low-lying perimeter areas where surface drainage is blocked will experience problems. When water is trapped and concentrated, the upper rootzone will remain saturated for extended periods of time and turf failure ultimately can occur due to anaerobic conditions. Increased disease, algae, and black layer problems also are commonly experienced on putting greens with poor surface drainage.

With frequent topdressing programs being performed on putting greens, a problem courses across the country encounter on an increasing basis is the development of collar ridges or “sand dams” that restrict surface drainage.

This problem tends to be especially pronounced on bermudagrass putting greens with long growing seasons resulting in a high rate of thatch and organic matter generation. In addition to problems maintaining dense, healthy turf cover, collar ridges can negatively impact approach and chip shots onto putting greens.

An annual program of double core aeration with large-diameter tines followed by debris removal and rolling with a 1- to 2-ton roller or using a vibratory plate compactor is one strategy for alleviating and preventing the development of collar ridges. In some cases, this process needs to be performed two or even three times to re-establish unrestricted surface drainage patterns. However, there are cases where collar ridges are so severe that it is necessary to remove sod and regrade the collars and surround areas. It may be necessary to resod with new material, but the sod can be replaced if it does not have excessive thatch. Installing perimeter smile drains in low-lying and approach areas is an additional measure that sometimes is performed to ensure that drier, firmer conditions persist.

OTHER AGRONOMIC CONSIDERATIONS

Other factors affecting putting green performance that need to be evaluated are the base turf cover, water quality, and irrigation coverage and control. The first question to answer is whether or not the base turf is the best adapted for the average and extremes in weather conditions of the area. Over the past two to three decades, several new turfgrasses have been introduced with improved environmental stress tolerance and pest resistance. There also are varieties or cultivars that have finer leaf blades, greater shoot density, and are able to tolerate lower heights of cut. These characteristics help ensure that putting green conditioning can meet current standards on a consistent basis. However, the need to convert to a better-adapted base turf does not mandate complete reconstruction. Rebuild or Resurface provides an excellent review of the factors that need to be evaluated before resurfacing putting greens and the basic steps involved in such a project.

Again, a lack of water can be just as detrimental to turf health as too much water. Even in regions that receive moderate to high rainfall annually, supplemental irrigation of putting greens is necessary and is one of the most important basic turf-management practices. The water requirements of very low-cut putting greens are distinctly different from those of higher-cut surrounding turf areas. An irrigation system audit is another recommended step for determining what adjustments, changes, or upgrades to the irrigation system could be performed to maintain healthy turf and desired conditioning. Yet even with the most sophisticated state-of-the-art irrigation systems, there still will be times when hand watering putting greens is necessary.

Deficiencies in irrigation system coverage and control alone rarely would be justification for putting green reconstruction. However, if the use of a poor-quality — e.g., high salt content — water source becomes necessary, reconstruction could be required. Along with conversion to a more salt-tolerant turfgrass, having increased rootzone porosity and subsurface drainage is essential for being able to effectively manage and prevent the buildup of excessive salt levels.

ARCHITECTURAL CONSIDERATIONS AND LIMITATIONS

The early 20th century (1900 to the 1930s) commonly is referred to as the Golden Age of Golf in America because of the rapid increase in the popularity of golf and the construction of more than 5,000 courses. Legendary golf course architects like Donald Ross, A. W. Tillinghast, George C. Thomas, C. B. MacDonald, and Seth Rayner were in their heyday and designed some of the country's greatest golf courses. However, none of these architects could have imagined that the game would become as popular as it has or that there would be the dramatic increase in putting speeds that now are routinely maintained.

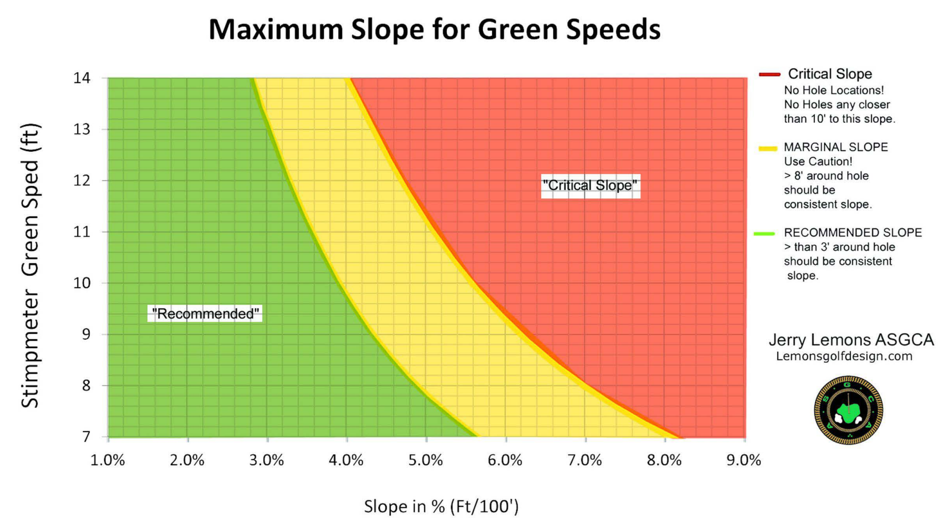
Modern-day superintendents have many turf-management tools available that can help compensate for the negative impacts of traffic wear and damage. Yet, there still are agronomic limits when managing small greens (less than 5,000 square feet), especially when more than 20,000 rounds are played annually. Sometimes, enlarging small greens is feasible, but, more often than not, expansion projects are as disruptive and expensive as reconstruction. Problems are further compounded when ingress and egress traffic around putting greens is limited by bunkers, mounds, and the location of cart paths. Along with aggressively managing traffic to spread it out over as much area as possible, measures like relocating bunkers and cart paths and softening mounds can help alleviate traffic issues. However, these measures are not the total solution to the problems experienced on small greens with heavy play.

Additional problems arise when fast to very fast speeds are maintained on putting greens that have pronounced surface contours. There is a direct relationship between putting green speed and the slope of an area that can be used for hole locations. When fast to very fast putting speeds are maintained on highly contoured putting greens, the amount of usable area for hole locations is reduced, resulting in more concentrated traffic, wear, and damage problems. This is not a problem that is limited to courses of the Golden Age era.

However, there are no rules regarding hole locations, and thus there is no such thing as an "illegal" hole location. The USGA has, however, recommended the following as general criteria for hole locations:

"An area two to three feet in radius around the hole should be as nearly level as possible and of uniform grade. In no case should the hole be located in tricky places or on sharp slopes where the ball can gather speed. A player above the hole should be able to stop the ball at the hole."

In consideration of the fast to very fast green speeds now being maintained at many courses, an 8- to 10-foot radius around a hole with a consistent slope would be more appropriate. In the article Putting



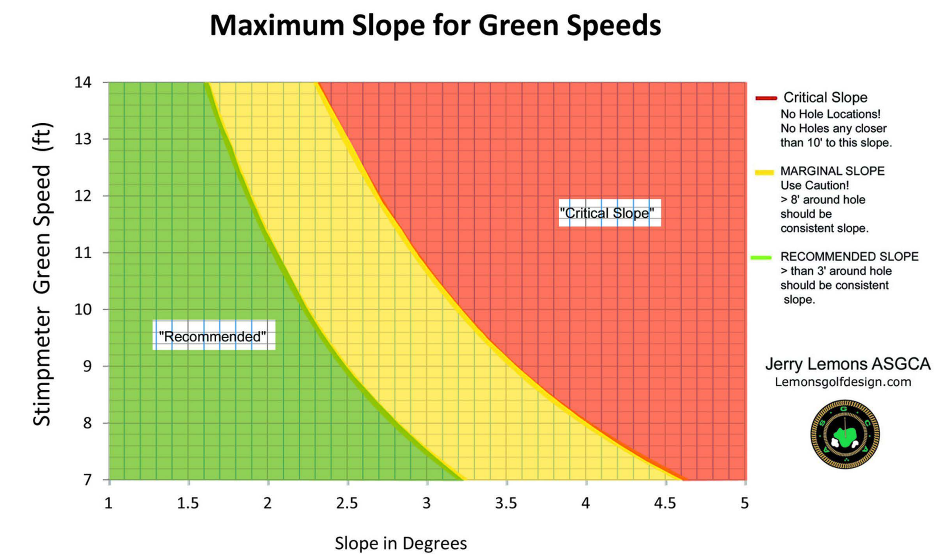


Figure 1. The combination of maintaining fast to very fast green speeds on putting greens with pronounced surface contours results in reduced area for hole locations and increased problems caused by concentrated traffic and wear damage.

Green Speeds, Slopes, and “Non-Conforming” Hole Locations, golf course architect Jerry Lemons introduced the Maximum Slope for Green Speed graph, Figure 1. This is an excellent tool for determining the number of reasonable hole locations and the amount of usable surface area of putting greens. If it is found that there are fewer than seven or eight hole locations available at the speed that is routinely maintained, turf quality as well as golfer enjoyment will be adversely impacted.

Assessment of hole locations can be performed with a Stimpmeter to measure speed and a 4-foot digital level that has a percent slope readout function. Also, there is a high-tech option of digital laser scanning and three-dimensional computer modeling of putting green surface contours. After shooting thousands of points across the putting green surface, data from a laser scanner are used to do a slope analysis and provide color contour maps and hole location diagrams. This information is very useful in determining the architectural speed limit of the putting greens.

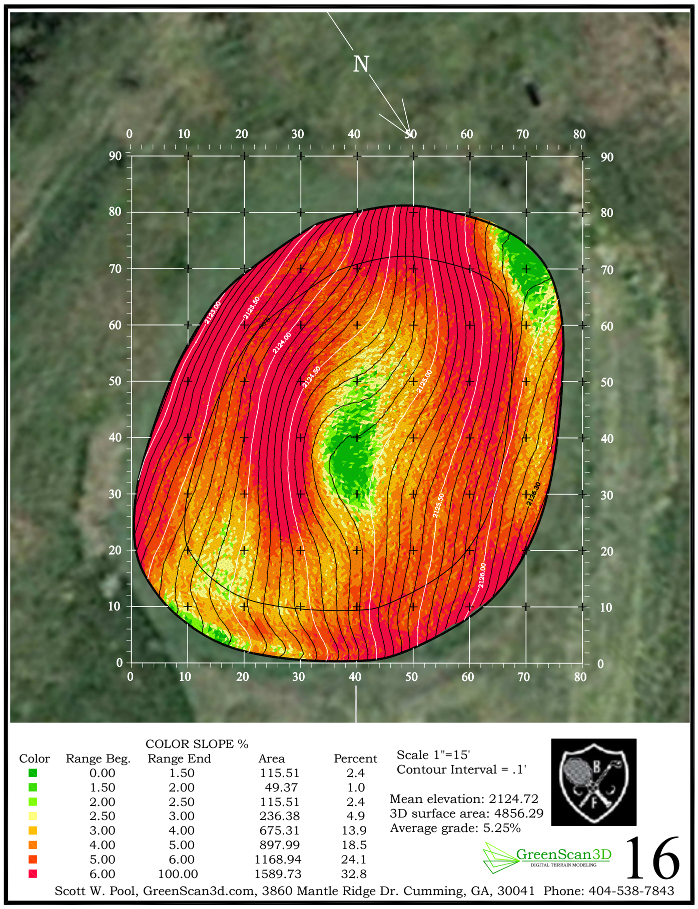
Interestingly, in the past few years reconstruction projects have been undertaken because golfer demands or expectations exceeded the speed limit of existing greens. The ability to digitally scan and precisely reproduce surface contours to a tolerance of plus or minus 0.25 inch has eliminated one of the main obstacles of rebuilding putting greens with historical significance. With this technology, it also is possible to make slight adjustments or change the “tilt” of the entire green complex to maintain original contours, increase hole locations, and gain a new, agronomically sound foundation.

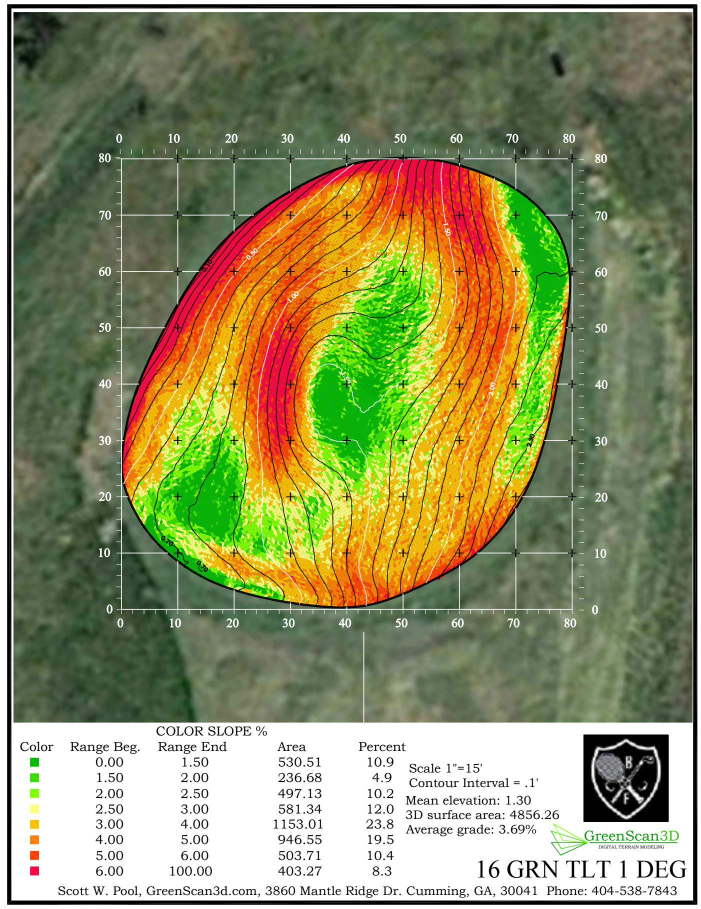
DETERMINING THE NEED AND WHAT COMES NEXT

As discussed so far, there are numerous agronomic and architectural factors that affect turf growth, performance, and the level of conditioning that can be maintained on putting greens. Golfer expectations and area competition are additional factors that need to be considered when answering the question, “Is it time to rebuild the greens?” To help course officials answer this question, regional USGA Green Section agronomists can perform a Putting Green Evaluation Course Consulting Service visit. During the site visit, each green complex will be reviewed and all of the factors that affect both short- and long-term performance will be examined and assigned a numeric grade. Any opportunities to improve performance will be identified and green-by-green recommendations provided. This impartial and science-based evaluation may ultimately determine that putting green reconstruction is necessary. If this is the case, having a “report card” similar to the one discussed in the article Helping Your Greens Make the Grade will further ensure that putting greens perform up to standards after being rebuilt. Proper putting green construction is not a substitute for a poor turf-growing environment.

The following is a brief review of what comes next when putting green reconstruction is deemed necessary:

- **Selecting the method of construction, materials, and grasses.** While there are options, the USGA’s Recommendations for a Method of Putting Green Construction have been the industry standard for over 50 years. These guidelines are





Digital laser scanning and computer slope analysis is now being used to produce color contour maps and hole location charts. This technology also makes it possible to precisely rebuild historically significant putting greens. In the above example, a 1-degree change in the tilt of the entire green was made, which increased the amount of area with a slope of 0-3 percent from 516 to 1,845 square feet.

periodically reviewed and updated as a result of scientific research and as new techniques and materials are proven reliable. A key component in the construction of USGA greens is first identifying and then testing rootzone and drainage layer materials. All material testing should be done by an accredited physical soil testing laboratory. Along with knowledge of locally available sources of construction materials, regional Green Section agronomists can provide continued assistance in selecting best-adapted turfgrasses for a particular area and establishing grow-in programs.

- **Selecting a qualified golf course architect.** A golf course architect is a very important member of a putting green reconstruction project team. Once the scope of work is determined, the architect will prepare a detailed set of plans and specifications that can be used by construction contractors to bid on the project. If an architect is not already working with a course, course officials should prepare a short list of potential candidates and arrange for them to visit, review the course, and participate in an interview to provide a summary of their ideas for addressing problems and improving the greens. The American Society of Golf Course Architects has member contact listings and additional information about selecting an architect online.
- **Selecting a construction contractor.** A major project like putting green construction is vastly different from routine course management and thus is almost always best handled by a qualified and experienced construction contractor. In addition to the golf course architect, area courses that have recently been through similar projects and word-of-mouth can be sources of information about local contractors that have experience with putting green construction. The Golf Course Builders Association of America has more information available online.

CONCLUSION

There are multiple factors that can cause putting greens to fail or not meet expectations. In consideration of all of the negatives of putting green reconstruction — like the disruptions to course operation and associated costs — decision makers should exercise proper due diligence and conduct a methodical evaluation of the agronomic and architectural characteristics of each green complex before undertaking a putting green reconstruction project. The necessity of putting green reconstruction can only be determined once every possible reason for poor and inconsistent

Submitting undisturbed core samples to a physical soil testing laboratory is another step to evaluate putting greens and determine if reconstruction is required.

performance has been addressed. At that point, it is time to bring together a team of experts to plan and implement a putting green reconstruction project that will ensure successful achievement of short- and long-term goals.

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JOHN FOY *and* LARRY GILHULY *have over 60 years of combined experience working with golf courses across the country and share the common goal of helping maintain better turf for golf.*