Specifications for a Method of Putting Green Construction

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United States Golf Association®

Specifications for a Method of Putting Green Construction©

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Editor

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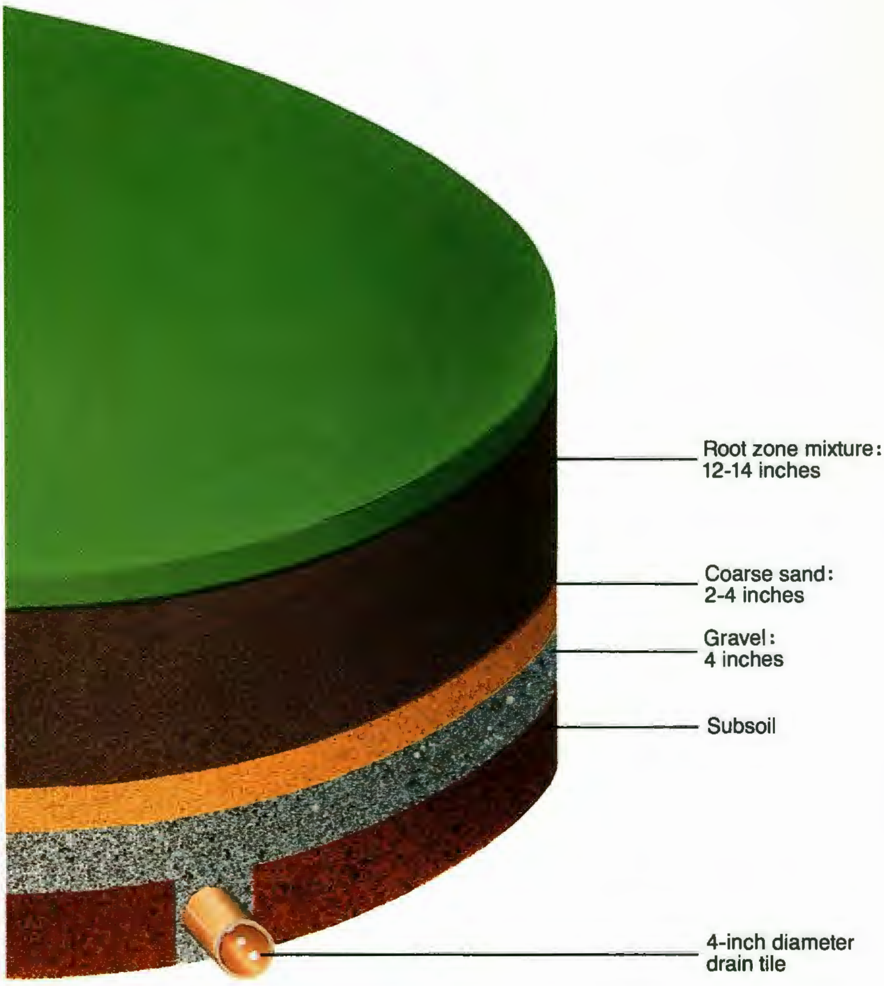
PROFILE OF A GREEN BUILT TO USGA SPECIFICATIONS



In 1960, after years of scientific research sponsored by the USGA and several universities, the Green Section's "Specifications for a Method of Putting Green Construction" were published. At the time, they were considered revolutionary and a major departure from what was then the accepted norm; *i.e.*, a soil mix generally comprised of equal parts sand, soil and organic matter. The new Specifications called for the use of locally and readily available sand, soil and organic materials. They are mixed in scientifically determined ratios to insure desirable physical soil characteristics. They are based on scientific data relating to water movement in soils, the physical properties of soils and the causes of compaction and poor internal drainage. They are based on documented research and extensive field experience over many years and by many individuals.

Thousands of putting greens around the world have been successfully built to the exact Specifications. They have performed extremely well. At the same time, unfortunately, many other new greens have been built with so-called "modified specifications". The modifications were arbitrarily made by golf course architects, course builders, committees, superintendents and others willing to compromise and risk long term successful results. Invariably, these are the "Green Section Greens" which have failed.

There is nothing complicated about Green Section Specification construction. However, if you intend to build USGA Green Section Greens, *every step* in the Specifications MUST be followed *exactly as outlined.*

MAKE AND ACCEPT NO CHANGES. Contact your nearest USGA Green Section Regional Office for assistance or clarification if you have questions. The steps involved must not and cannot be compromised.

Having taken this rigid position, one would think the Specifications found here are the same as those originally put forth in 1960. They are not. Certain small, subtle changes and improvements have evolved and are incorporated in today's recommendations. Nevertheless, the original, basic precepts remain. The problem of construction procedures and physical behavior of soils cannot be separated.

The original Specifications emphasized drainage and resistance to compaction. To achieve these characteristics, other desirable, but less immediately important, agronomic qualities had to be sacrificed. For example, a highly permeable soil is loose in structure and may, in the early stages, create difficulty when changing cups. These soils require greater skill, at least initially, in managing fertility levels and in developing surface resiliency. Nevertheless, these are minor problems when weighed against the advantages of rapid drainage, good aeration, deep rooting, lessening disease factors, protection against salt problems and developing a putting surface that holds a proper shot without being overly wet.

The methods and specifications outlined in the following pages represent the best thoughts and practical experiences of the Green Section staff [with over 250 years of accumulated, intensive golf course experience] plus soil scientists who have given serious attention to the problem for the past 30 years. The Green Section believes this technique of putting green construction will provide the most satisfactory and least troublesome putting greens devised by science and the experience of man. And please remember, change not a step in them.

STEP 1. The Subgrade

A good builder will ensure that the contours of the subgrade [*i.e.*, the sub-base upon which the green will be built] will conform to the contours of the proposed finished grade. Strive diligently for a tolerance of plus or minus one-inch. Failure to balance the contour of the subgrade with that of the final grade may cause wet spots in low areas, and droughty areas where the finished grade is substantially greater than the average.

The subgrade should be established approximately 16 to 18 inches below the proposed finished grade. The subgrade should be thoroughly compacted to prevent future settling which might create water-holding depressions and disrupt effective tile line operations.

It is not necessary to elevate or build up the green unless design considerations make it necessary.

Layers of materials above the subgrade will consist of at least four inches of gravel, two to four inches of an intermediate layer of coarse sand, and a minimum of 12 inches (uncompacted) of root zone mix. Thus the total depth will be approximately 18 inches. Experience indicates that this material will settle to about 16 inches once it is brought into place. However, the amount of settling will vary according to the materials used. The physical soil testing laboratory will project the amount of shrinkage at the time of soil analysis.

STEP 2. Drainage

Tile line installation is essential. Tile lines should be at least four inches in diameter and spaced so that water will not have to travel more than ten feet to reach a tile drain. Any suitable pattern or tile line arrangement may be used, but the herringbone or gridiron design will fit most situations.

Cut ditches or trenches into the thoroughly settled subgrade so tile lines slope uniformly. The tile should be laid on a firm bed of gravel, sized ¼ to 1 inch. The depth of the gravel in the trench may be varied to ensure a positive slope [i.e., a definite fall] along the entire run of tile. Before covering the tile, spot check with a carpenter's level or transit to ensure proper down slope throughout the entire drain line system. The trenches may then be backfilled with additional gravel, taking care not to displace

The herringbone drainage pattern.

any of the tile or top covering over the joints. Be sure all tile lines have a positive grade with a minimum fall of 0.5 percent. Steeper grades can be used but putting green tile lines seldom need grades steeper than three to four percent.

Tile may be agricultural clay tile, concrete, corrugated plastic, or any other satisfactory drainage-type tile. Waffle drainage material is not advised. Agricultural tile joints should be butted together with no more than ¼ inch space between joints. The tops of tile joints should be covered with asphalt paper, fiberglass composition or with plastic spacers or covers designed for this purpose. The covering prevents gravel from falling into the file. Fabric sleeves around tile lines are not recommended.

Even with good subsurface tile drainage, design consideration should be given to putting green surface drainage in at least two or three directions.

STEP 3. Gravel and Coarse Sand Layers

At this stage of construction, grade stakes should be placed at frequent spacing throughout the putting green site. Once driven into the subgrade, each stake should be marked at 4 inch, 6 inch to 8 inch, and 18 inch to 20 inch above the subgrade. These elevations correspond to the planned depth of the gravel, coarse sand and top mix layers required in the green profile. The grade stakes will be invaluable, accurate depth indicators as the various layered materials are added in the construction process.

With grade stakes in place, the entire putting green subgrade should now be covered with a layer of clean, washed gravel or crushed stone to a minimum thickness of four inches. The preferred material for this purpose is washed pea gravel (¼ inch to ⅜ inch diameter particle size). If, for economic or other reasons, larger gravel sizes are preferred for use as the gravel over the subsoil, they should be topped off with a least one inch of pea gravel-type material (¼ inch). It is important that changes in particle size between succeeding layers not be too great. Otherwise smaller particles from overlying material will wash into the gravel, eventually clog the pores or drainage ways, and thereby reduce the gravel's effectiveness.

The maximum allowable discrepancy appears to be five to seven diameters. In other words, if stone of one inch diameter is used, it is necessary to include a layer of ¼ inch pea gravel to prevent smaller soil aggregates from moving into the stone.

When the four inch gravel base is in place and ¼ inch pea gravel covers the entire surface, spread a layer of coarse, washed sand (in the range of 1.0 mm to 2.0 mm) to a uniform thickness of two to four inches over the entire gravel base. Again, particle size differences should not be greater than five to seven diameters. In other words, if ¼ inch pea gravel [about 6.0 mm] is used as the base, then the majority of the particles of the overlying coarse sand should not be less than 1.0 mm in diameter.

The two inch intermediate sand layer is easily spread by hand.

Note: There are some who vigorously contend that the two to four inch intermediate sand layer is not necessary and is very expensive to install. The Green Section has studied this particular Specification requirement carefully over the years and now definitely concludes and POSITIVELY RECOMMENDS INCLUDING THE INTERMEDIATE SAND LAYER IN ALL USGA GREEN SECTION GREENS. It is an integral part of the perched water table concept. Its function is undeniable, and serious functional consequences may result if it is eliminated. Failure to follow this requirement means you are not building a USGA Green Section green.

Is the installation of the intermediate sand layer excessively costly? No, the facts simply do not support this contention. For example, a 7,000 square foot green will require about 42 cubic yards of coarse sand for the intermediate two inch sand layer. Place the sand in piles around the perimeter of the green. Using grade stakes randomly located throughout the subgrade of the new green and the back of wooden or aluminum rakes to distribute the sand piles, three people can easily move 42 cubic yards of sand uniformly over the gravel base to a two inch depth in less than one hour's time. The cost of materials and labor to install the two to four inch intermediate layer is insignificant, particularly when compared to the total cost of building or rebuilding a modern putting green.

One additional word of caution. The intermediate coarse sand layer must be spread by hand labor, not machine. It is very difficult to uniformly spread a two to four inch layer of sand with a tractor or bulldozer.

Questions are sometimes asked about the use of geotextile fabric as a substitute for the intermediate sand layer. The Green Section does not recommend such a substitution at this time.

Collar areas around greens should be constructed as closely as possible to the same specifications as the putting surface itself.

STEP 4. The Root Zone Mixture

The success of the Green Section's method of putting green construction depends on the proper physical characteristics of the root zone mixture, and the relationship of that soil to the drainage bed underlying the green.

Native soils that meet these physical characteristics are almost nonexistent. Therefore, the putting green root zone mixture must be compounded from available sand, soil and fibrous organic amendments. Because of extreme local variations in these materials, however, a high degree of expertise is necessary to determine which root zone blends have the desired properties. Different lots of sand from the same pit may vary considerably in particle size and shape. Native soils also vary greatly in particle size and shape, as well as in degree of aggregation, acidity, fertility, and soluble salt and organic matter content. Perhaps the most variable of all these materials are the fibrous organic amendments. Laboratory testing is imperative since organic materials may differ in plant material origin, degree of decomposition, mineral impurities (such as silt and clay) as well as in acidity and fertility. Manufactured or processed organics also differ widely from natural organics.

It is unlikely that golf course architects, builders, or superintendents can cope with variabilities in construction materials when formulating root zone mixes and topdressings for greens. Therefore, since successful construction depends on the proper combination of physical and hydraulic properties in the root zone, a laboratory physical soil analysis must be made of the available construction materials before they are procured. At this stage, one should also determine whether enough of each material is available to complete the entire job.

A competent physical soil laboratory will be concerned with the following tests and data:

A series of tests are performed at a soils laboratory to determine if potential ingredients are suitable for green construction.

Infiltration and Percolation Capacity

Laboratory infiltration values are used as indicators of potential field behavior. Since this value changes markedly in the field as the green matures, it should not be used as the sole criterion for selection or rejection of a putting green soil mix. An experienced laboratory will evaluate many variable factors before determining if a particular mix is suitable for seed bed use. This is one reason why an experienced, independent laboratory is needed.

Porosity

Compacted root zone mixtures that have been allowed to percolate water for 24 hours and then drained at a tension of 40 cm of water should have a total pore space volume between 35 and 50 percent. The volume of non-capillary pores at a tension of 40 cm of water should not be less than 15 percent, nor more than 25 percent. The permissible levels of capillary pore space have the same limitations.

Bulk Density

Topsoil mixtures compounded with sand as the chief component ideally should have a bulk density between 1.25 and 1.45 grams per cubic cm. The minimum acceptable bulk density for such mixtures should be 1.20 grams per cubic cm and the maximum should be 1.60 grams per cubic cm.

WATER RETENTION CAPACITY

The water held by a soil against drainage is the water that supports growth of the turf.

The root zone should have a laboratory 40 cm water retention capacity between 12 and 18 percent by weight. Most sand / peat greens should have 15 percent or less water retention. These are considered to be appropriate values for modern putting greens.

PARTICLE SIZE

The root zone mix ideally should contain no particle larger than 2 mm in diameter. Over the past 30 years, field observations indicate the ideal particle size range for sand used in the soil mixture to be between .25 mm to .75 mm. Fine sands [0.25 to 0.10 mm] and particularly very fine sands [0.10 to 0.05 mm] should be held to minimum levels and, when present to all, comprise no more than 10 percent of the total mix. In addition, the root zone mixture should contain less than five percent silt [0.05 to 0.002 mm] and three percent clay [smaller than 0.002 mm]. It should be noted here that the percentage of sand particle sizes under .25 mm may have to be less than 10 percent under certain climatic and other circumstances. Due to the wide variety of available materials, it is sometimes necessary to make recommendations outside these strict parameters. The ultimate test of any sand, however, is its behavior when mixed with fibrous organic material and the soil being used.

Because of the narrow acceptable limit in the physical properties of the root zone mix, it is extremely important that recommendations based on laboratory analysis be followed carefully when the components for the root zone are being mixed. If it becomes necessary to substitute a new material for one of the original materials, the mixture should be re-tested before proceeding with construction.

When the proper proportions of the root zone components have been determined, it is extremely important that they be mixed in the proportions indicated. Note that these recommendations invariably are expressed as volume units, not as weights. A small error in percentages in the case of silt or clay content can lead to serious consequences.

IT IS ABSOLUTELY ESSENTIAL TO MIX ALL ROOT ZONE COMPONENTS OFF-SITE. No valid justification can be made for on-site mixing, since a total homogenous mixture is essential to success. Be sure to read "Tips for Success and Opportunites for Error" found later in this publication.

During the construction process, quality control checks should be made periodically on all delivered soil components as well as the final mixture. At this time it is also wise to prepare and stockpile at least enough root zone mix to satisfy topdressing requirements for the first year or two.

Off-site mixing is an essential feature of top mix preparation. The use of a shredder/mixer is one method available for ensuring a thorough blending of the top mix components.

STEP 5. Top Mix Covering, Placement, Smoothing and Firming

After the root zone materials have been thoroughly mixed off-site, the mix should be transported to the green site and dumped at various points around the perimeter. Many techniques are acceptable for spreading the material, including shovels, boards, and small equipment. A small crawler-type tractor suitably equipped with a blade, for example, is useful for pushing the root zone mixture out onto the prepared base. By operating the tractor with its weight on the root zone mixture that has been moved onto the site, the base of the green will not be disturbed. Grade stakes installed earlier and spaced at frequent intervals will help indicate the depth of the 12 inch (uncompacted) minimum of top mix. There must be an absolute minimum of 12 inches of uncompacted top mix spread over the green. Man-made and natural forces will settle this mixture to just over 10 inches of compacted mix within a few months time. There is nothing wrong in starting with 13 or 14 inches of uncompacted top mix, but 12 inches is the absolute minimum.

When the top mix has been spread uniformly over the surface of the putting green, it should be compacted or firmed uniformly. A roller is not satisfactory, because it bridges the soft spots. One of the best methods of settling or firming the soil mix is with a wide tire tractor. A small crawler-type tractor will also do an excellent job. The tractor is slowly operated back and forth in numerous cross angles and figure eight patterns until every square inch is firmed. The job must not be rushed. A thorough, deep irrigation of several hours may also be necessary to wet and further firm the entire profile. If the soil is still soft after a day or two, another thorough wheel rolling by the tractor may be necessary. It is impossible to over-emphasize that the soil must be uniformly firm before proceeding further.

STEP 6. Sterilization of Top Mix and Establishment of Turf

Even today, there are those who suggest top mix sterilization is not necessary for new putting green construction. They are as wrong as they can be. In many cases, today's modern green is constructed solely from sand and organic material [no native soil used]. The rationale is that both materials are weed and disease free, and therefore sterilization is not needed. However, weed seed is easily introduced during the root zone mixing operation. Grading equipment, winds, birds, foot traffic, and any number of other possibilities exist for introducing unwanted seeds and foreign matter. It is virtually unavoidable. STERILIZATION IS ESSENTIAL.

The actual steps for top mix sterilization and uniform seed or stolon application are well known and will not be discussed here. However, be sure to read "Tips for Success and Opportunities for Error" that follows.

Putting green soil sterilization is important just prior to establishing the turf cover.

TIPS FOR SUCCESS AND OPPORTUNITIES FOR ERROR

You are now familiar with the USGA Green Section's Specifications for A Method of Putting Green Constuction. When this method is carefully followed, exactly as outlined, you will have built a foundation that will produce the finest putting green turf possible measured by today's highest standards. It should be again emphasized that each step in construction depends upon all others. It is foolhardy to attempt to incorporate some steps but eliminate others for whatever reason. When that occurs, the green is no longer a USGA Spec Green.

In the thirty-odd years since they were first published, the Specifications have endured untold criticism. Here, step-by-step, let the Green Section staff offer you tips for success and warn you of the opportunities for errors.

The Subgrade - When a new green is built, a considerable amount of fill material may be moved away from or onto the site, as design and terrain conditions dictate. In either case, the builder must compact the subgrade as thoroughly as possible. Only in this way will future settling be prevented. If uniform layers of gravel, sand, and top mix overlay the subgrade, it is obvious that any settling below will result in a corresponding settling at the top. Therefore, a thorough compaction of fill areas in the subgrade is of paramount importance if the green is to maintain the architect's intended character of contours.

Tile Drainage - It is commonly believed that the use of a gravel layer provides adequate drainage by itself, and the installation of tile lines is a needless expense. This is scientifically incorrect and functionally untrue. When large amounts of water are moving through soil under conditions of heavy rain or excess irrigation, and where the water must move a considerable distance to reach an outlet, tile lines are essential for speedy removal of the water. Further, the tile lines should directionally carry the water well away from the approach areas to the green, bunkers or other nearby playing areas. Tile lines also assist in removing trapped water from pockets within a green.

Although difficult to believe, tile lines are often improperly installed. They *must* have a positive flow. They *must* run downhill. Level tile lines are non-functional. Under certain circumstances, the standard herringbone or gridiron tile pattern may be awkward. Putting greens of special design or unusual surface contouring may require a modified drain line pattern. This presents no problem. Tile lines may be installed in any pattern to fit the situation. Just be sure the lateral tile lines are within 15 to 20 feet spacing of each other, and that the entire green is included in the tile pattern. Again, all tile lines must have a positive flow and a definite point for water exit well away from the green and play areas.

It is frequently helpful to have some means of flushing or cleaning out a main putting green tile line. One easy technique is to extend the high point of the main tile line to the rear and/or higher elevation outside the actual green perimeter. The extension may be 20 feet or more away from the actual green. At this end of the main line, add a connecting "L", or make a 90 degree upward turn to the surface. Fashion a suitable cover for the tile end and one that may be easily removed. When flushing becomes necessary, simply remove the cover, place a hose in the tile end and flush out the main line.

Putting greens are the most expensive turf on the golf course, and require the most exacting standards for excellence. The small additional cost of a properly installed tile line is well worth the insurance it provides.

Gravel and Sand Base - In some cases, builders save installed tile lines and then assume there is no need for the gravel layer above the subsoil base. This assumption is wrong. The gravel layer provides a medium whereby water can rapidly move laterally and very easily find its way into the tile lines. The gravel also provides a barrier between the root zone and the soil below, to prevent the dry subsoil from drawing water out of the porous top mixture. Furthermore, it prevents salts in the subsoil from moving up into the root zone. The tile and gravel function as a team to provide insurance against the waterlogging within the putting green profile. Tile is normally placed in shallow trenches in the subsoil, and is spaced at intervals of 15 to 20 feet, depending on the degree and direction of slope.

The layer of coarse sand over the gravel base is of utmost importance. It provides the abrupt change in particle size required to create the perched water table upon which this construction method is based. This sharp interface cannot be developed if a top mix of primarily medium sand is placed directly atop ¼ inch pea gravel. The mixture will sift into the gravel and reduce, if not destroy, the perched water table effect.

The upper 12 inch root zone mix is porous and sandy by design. Sandy soils are naturally droughty soils. However, the interface between the coarse sand layer and the 12 inches of upper soil mix acts as a check on the downward movement of non-capillary water. This interface prevents the further downward movement of water until a point of near saturation is reached and, when that occurs, gravity overcomes the interface effect. Thus the interface permits a droughty-type soil to remain at or near field capacity for longer periods of time.

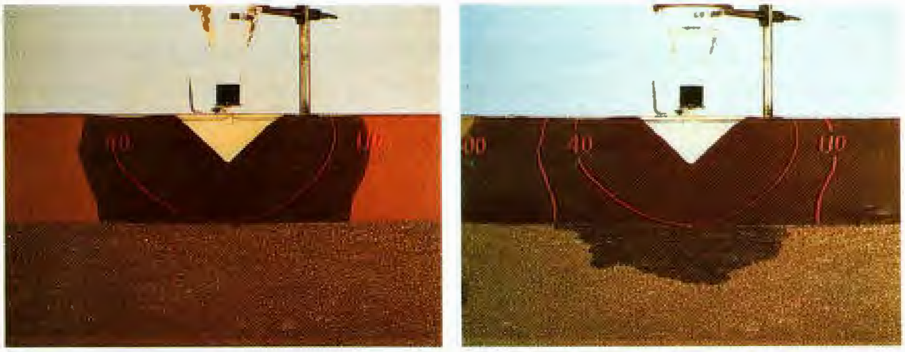


Illustration of the perched water table concept, permitting sandy soils to retain adequate moisture.

This is a desirable situation for turfgrass growth and uniformity of playing conditions. Surface tension prevents water from moving readily from one soil layer to the next. When sufficient gravitational force [weight] accumulates, the surface tension force is overcome, and water drains out through the sand and gravel. It seems paradoxical that the top mix overlying coarser sand can be made to hold more water than it would without the sand layer, but it cannot be made to hold enough water to be harmful to plants [if the root zone mix is properly prepared and is the proper depth].

Under no circumstances should the two to four inch intermediate sand layer be eliminated from the Green Section Specifications.

The Collar Area - Establishing a collar to the same Specifications as the putting green itself will be important to the performance of the total greens area. The collar is subject to heavy traffic and the same management as the green area. Therefore, to realize the best from it, construction should meet the same specifications as prescribed for the putting green proper.

The top mix at the outer edge of the collar will abut the native soil. In some cases, builders have mixed and feathered out the putting green top mix with the native soils at this interface. This blending provides an acceptable transition from the artificial to native soil, and helps eliminate excessive drying that can occur at the edge of the collar. Extreme care should be taken, however, not to contaminate the root zone mix already on the green.

Preparing the Root Zone Mixture - The proper blend of available sand, soil and fibrous organic matter in the top mixture can be accurately determined only by extensive physical soil laboratory tests. Only then is it possible for soil scientists to advise what proportions of components are to be mixed to meet the specified infiltration and physical requirements. This is CRITICALLY essential, and it allows the builder to make the best possible use of materials available within reasonable distance of the construction site.

Loss of volume in mixed materials and in firming greens after materials have been placed can be most important in calculating the quantity of materials needed for the project.

When sand and organic materials are mixed, there is a loss of volume. Four measures of sand, and one measure of peatmoss, for instance, do not total five measures when combined. The organic component is partially consumed as it fills the interstices between the sand particles. The resulting volume ranges from about 4 measures to 4½ measures, depending upon the nature of the organic material. This determination should be made in advance of ordering materials, so that adequate amounts can be stockpiled.

Different combinations of materials have very different settled volumes. It is useful to determine in advance of construction how much the materials will settle, to insure that the finished putting green mixture has adequate depth. Some mixes may lose as much as 25 percent of their volume, others as little as 10 percent.

A chemical soil analysis of the recommended root zone mixture will determine the pH and soluble salt levels. The necessary adjustments should then be made, based on laboratory recommendations.

Thoroughly mixing the sand, soil and fibrous organic material to the exact specified laboratory ratio is absolutely essential. Although there are several methods of accurately metering the various components, *off-site mixing is the only sure way of accomplishing a homogenous mix.* A key element in this task is the competence of the worker on the mixing site. If the worker is not conscientious and informed, the mixture will never be recognizable as the one recommended by the laboratory.

The components can be mixed efficiently and inexpensively by a tractor and front-end loader. One operator can accurately mix tremendous quantities of sand, soil and organic matter by metering the proper number of bucketloads of each material into a central pile. This pile is then moved by the tractor/front-end loader two or three additional times before loading it onto a truck for delivery to the green site. Each move produces a more uniform mix. To avoid contamination, a hard surface area, such as a paved parking lot or service road, is ideal for this type of root zone mixing.

Other off-site mixing methods include tumbling in an old concrete mixer; spreading the measured quantities out on a hard surface and then folding it with a blade or disc; or, through commercial blending equipment.

Rototilling has proven to be a totally unsatisfactory method for putting green soil mixing, and is definitely NOT recommended.

Once the mixing operation is underway, random samples may be collected and returned to the soil laboratory for a final check before the material is taken to the putting green site.

Wet sand mixes easier and more intimately than does dry sand. Since the greater percentage of the mixture will be comprised of sand, moistening the sand at intervals during the mixing process may be necessary. The fibrous organic material also should be slightly moistened for better adhesion. To assure early establishment and early sod formation by the new grass, incorporate a complete fertilizer with the initial root zone mix operation. For example, if a complete fertilizer such as 10-20-20 is used, add 2½ to 3 pounds of the fertilizer to each cubic yard of the mix at the outset of the mixing operation. The fertilizer mixes with the root zone components, producing adequate initial nutrient levels throughout the top mixture profile and encouraging deep rooting and early sod formation by the seedling turf.

All physical soil laboratory recommendations are specific and refer to parts by volume. An 8-1-1, for example, refers to an eight parts sand, one part soil and one part fibrous organic matter mixture. Mixing sand, soil and organic matter may cause a loss in volume and this should be kept in mind when ordering the mixture components. Once the root zone mixture is placed on the site, the material should be settled, firmed and the final grade established by floating, dragging or matting with light equipment.

The green is then ready for the top mix to be sterilized. This procedure is best contracted out to an experienced company with proper agricultural permits and equipment. Methyl bromide is used most frequently, although other sterilents may be available in your area. Without any doubt, putting green sterilization is another important link to successfully establishing a new green.

"Floating Greens" provides a smooth finished grade. A light golf cart can mechanize this job.

ESTABLISHMENT OF TURF

After soil sterilization is complete and adequate ventilation time has elapsed, final grade seedbed preparation is the next step.

The application of a natural organic fertilizer [5-4-0 at 40 pounds per 1,000 square feet] or chemical-type fertilizer [10-10-10 at 20 pounds per 1,000 square feet] should be applied uniformly to the entire putting green and collar surface area. Because the prescribed root zone mixtures are quite porous, it is important to fertilize generously at this time to promote early turfgrass establishment. This is true whether seed, sod or stolons are used. After the fertilizer is applied, lightly drag the surface with a light leaf or garden rake in a long and continuous manner, forming very shallow, continuous grooves in the soil. Avoid normal, short-stroke hand raking because this frequently causes uneven and bumpy surfaces.

A light, continuous raking prepares an excellent, soft, seed bed.

You are now ready to seed, sod or stolonize. If you are seeding, apply the seed at the recommended rate and as uniformly as possible [usually at half-rate in two directions]. When sowing is complete, again drag the entire green lightly and continuously with the light leaf or garden rake, avoiding normal short stroke hand raking action. Roll the surface for necessary seed-soil contact. In some cases, hydromulching is used successfully as a means of enhancing seed establishment. Hydromulching greatly reduces erosion caused by thunderstorms, prolonged rains or faulty irrigation. Geotextile covers may also serve this purpose. The use of other mulch-type material such as straw, sphagnum, or peat moss is discouraged. Layers are too easily formed and weed seeds too easily introduced.

There is an old saying that germinating seed should be treated like a baby; put it to bed dry at night and wake it up with water in the morning. Light and frequent watering throughout each day, just enough to keep the upper ¼-inch soil surface moist, is essential for germination and rapid seedling development. Once the plants become established, gradually reduce irrigation frequency, but increase the duration of irrigation until it reaches a normal schedule.

Seeding should be done at half rate in two directions to ensure uniform coverage.

New greens should be mowed as soon as there is something worthwhile to mow. A height of ⅜-inch is a good starting point, and will allow some density and sod formation to take place. Once the new turf is well established, gradually lower the cut to your desired height over a period of several months. The primary objective at this stage is to develop resiliency on the putting surface. A cushion of ½-inch thatch intermingled with light topdressing is ideal before the green is opened to play. Fertilize lightly and frequently every few weeks until the grass matures. DON'T RUSH THE NEW GREEN INTO EARLY PLAY. At best, seeded bentgrass greens require six to eight growing months before they are ready for traffic, while Bermuda greens require two to four months of good growing weather. Caution! Do not vertical mow new greens. It is not recommended and not necessary.

Topdressings will be especially important for the new green during its first year of growth. Three or four light topdressings will not only improve the smoothness of the surface, but will encourage a tightly knit, dense turf as well. The topdressing material must be mixed to the same specifications as the original root zone mixture. Never use a different top mixture on any new green. In subsequent years, great care must be taken to adjust topdressing practices to maintain the original soil profile.

If an early opening date is of major importance for a new green, sodding is the answer. There is a trick, however, to laying sod properly, and it must be carefully done. For example, sod for putting green use should be handled flat, never rolled. Furthermore, sodding is only acceptable if the sod is grown on exactly the same root zone mix as the original construction. If grown on any other type soil, and the sod then laid on a different textured soil mix, soil layering will occur and eventual sod failure is a distinct probability. The only recourse in this case is a prolonged period of intense aeration, core removal and topdressing with the proper root zone mix.

IN CONCLUSION

These steps for constructing putting greens will provide excellent results if they are followed exactly and completely as outlined. There is nothing complicated about them. At the same time, there are no short cuts to excellence.

Some clubs have been deterred from building new greens by the Green Section method because they have been told construction costs will be excessive. This is simply not true. With proper planning and a full understanding of the steps already described, excessive construction costs are completely unnecessary. Furthermore, a properly built green is always the least expensive in the long run. Only greens that are poorly built [no matter what the cost] are expensive. Although it is impossible to list the costs for putting green construction in any specific locale or region, we can offer a list of material quantities that will be helpful in cost estimations. The following quantities of materials are required for each 1,000 square feet of putting surface:

Gravel	4-inch depth	12 cubic yards
Coarse Sand	2 to 4 inch depth	6 to 12 cubic yards
Root Zone Mixture	12 inch depth	37 cubic yards
Tile	Approximately 100 linear feet	

Please call on your USGA Green Section regional office if you have questions or need clarifications as you plan new putting green construction on your course.

LABORATORIES FOR PHYSICAL SOIL ANALYSIS

A number of soil laboratories are available today for the physical analysis of putting green components. Inquiries through regional or state Golf Course Superintendents Associations should provide a number of laboratory names and addresses customarily involved with USGA Green Section Specifications.

Agri-Systems of Texas, Inc.
15511 Baldswelle, Tomball, TX 77375
[713] 376-4412

is listed here because of its early identification and experience with the original Green Section Specifications. It is an independent laboratory, with no affiliation with the USGA Green Section.

What the Laboratories Will Need - A laboratory analysis for greens construction requires a minimum of one gallon each of the sand, soil and fibrous organic material you plan to use. If there is a choice of sands, soils and fibrous organic materials, send sufficient samples of each along with a note indicating your preference, costs, accessibility, etc. The laboratory will attempt to use your preferred materials in the recommended mixture.

When collecting representative samples for laboratory testing, use a three inch diameter plastic pipe about six feet long with one end cut at a 45 degree angle, similar to a hypodermic needle. Insert it to almost full depth into the pile to be sampled. Withdraw the pipe and place the material in a clean container. Take a minimum of eight to ten samples in this manner, and place all of them in the same container. Mix the samples thoroughly. From this mix, take a one gallon sample for laboratory testing and another one gallon sample for your own future reference. This may be used in checking all future deliveries of sand or organic material to the job site.

All sampled materials should be packaged separately and securely. Do not mix the sand, soil or fibrous organic matter. Package each one separately and firmly into strong, one gallon, plastic, self-sealing type bags [the kind often used for home freezing purposes]. Paper bags and paper labels are unsatisfactory. They should not be used. With a permanent marker pen, write your name, phone number, address and identification of the enclosed material on the outside of each plastic bag. Insert this bag sideways into a second plastic bag. Seal the second bag. Several of these bags may be packed firmly into a strong shipping carton, using newspapers or other filler material as necessary.

Be sure to include a note carrying information about the samples in the shipping carton. The more information you can provide, the better. For example, include such information as your preference and price of the material [if more than one kind of a particular material is being shipped], where the final mix will be used [greens, tees, etc.], expected number of rounds yearly, air movement, summer high temperatures and humidities, winter lows, snow covers, duration of frozen ground, altitude, whether the greens are highly contoured or more traditional, and any other unusual condition.

Where to Send and How Long It Takes - Laboratories prefer United Parcel Service. U S Mail or Greyhound Bus Systems are adequate, but usually take longer. If time is short, ship by air express. The laboratory requires one full week to complete all of the tests. Written reports may take another week to reach you after the tests are completed. If it is urgent, advise the laboratory. Express mail will help speed up the process. Try to anticipate your physical soil testing needs, and allow sufficient time for the work to be properly accomplished.

CLOSING NOTE

Please remember, there are no shortcuts to excellence. The Green Section Specifications represent years of scientific study and field observations. They are not complicated, and they need not be significantly more expensive than so-called modified versions. Simply follow each outlined step fully and carefully. Help yourself and your club to the finest putting greens yet devised by science and a half century of USGA Green Section experience.

The USGA has prepared a VHS videotape that follows the construction of a Green Section Specifications green step-by-step from initial grading to the first mowing after turf establishment. For information about purchasing a copy of this videotape, contact the USGA or your regional Green Section office.

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