Rootzone Compatibility Testing for Putting Green Resurfacing, Expansion, and Recontouring

How to select a compatible rootzone material when resurfacing, modifying, or enlarging existing putting greens.

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Sod from an on-site nursery was used to expand this putting green. The expansion is not performing as well as the existing turf due to a coarser, drier rootzone mixture.

There are many reasons to renovate putting greens. Upgrading to new grasses can offer better putting surfaces and reduce water and nutrient consumption. Renovation can also address architectural concerns by softening severe slopes or enlarging putting surfaces to increase the area usable for hole locations. Whatever the motivating factors, renovation can save a lot of money and significantly reduce course closure time by leaving well-functioning rootzone material in place rather than performing a complete reconstruction.

At minimum, most putting green renovation projects require removing several inches of rootzone mixture to eradicate existing grasses and remove organic matter and fine materials — i.e., very fine sand, silt, or clay — that may have accumulated over time. Selecting a compatible rootzone material to fill the void is critical to optimize the performance of renovated greens.

THE IMPORTANCE OF ROOTZONE COMPATIBILITY

Selecting rootzone material for a renovation project is not as simple as purchasing sand that meets USGA Recommendations for a Method of Putting Green Construction. It is also not as easy as choosing the blend that was originally used during construction. Cultivation and topdressing programs, wind-blown silt and clay, dissolved solids in irrigation water, and salt accumulations can change the root-

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zone characteristics of aging putting greens.

While removing the top 4-5 inches of rootzone may resolve most problems, the remaining mixture may still have layers of organic matter or fine material. It is imperative that the new rootzone material have similar porosity and infiltration rate values as the existing rootzone. Simply selecting a local sand that is typically used for putting green construction can cause layering issues or droughty conditions that lead to problems with localized dry spot, inadequate moisture and nutrient retention, and soft or unstable surface conditions. The key is to ensure that the new rootzone has similar performance characteristics as the existing rootzone. This article will help guide you through the process of selecting a new rootzone that maximizes putting green performance.

DUE DILIGENCE BEFORE RENOVATION

Before you spend a dime on renovation, perform due diligence on all existing putting green sites to determine if anything is limiting healthy turf growth. If greens have underperformed due to poor growing environments or inadequate surface or subsurface drainage, renovation may not improve the situation. The USGA article "Troubleshooting Problem Putting Greens" will help you evaluate why putting greens are not meeting expectations. The article encourages a full audit of each green before considering renovation. Do not make the mistake of renovating putting greens without first addressing performance-limiting issues.

REBUILD OR RESURFACE?

Common perception is that USGA greens only last 20-25 years, but they can last much longer if properly built

Putting green expansion areas will likely perform differently from the original greens during the first few seasons. Simultaneously resurfacing the original greens and the areas where the greens will be expanded will overcome this issue.

The plug in this image was moved from the original portion of this green into an expansion area. The rootzone mixtures do not match in performance characteristics, so turf quality does not match either.

and managed at a high level. Research has shown that the physical and chemical soil characteristics of aging greens within the original 12-inch rootzone mixture can remain intact for decades. However, as greens age, a zone of enriched organic matter accumulates on top of the original 12 inches of rootzone. It is almost always in this surface zone where organic matter and fine materials negatively influence putting green performance. Removing just this surface zone, rather than rebuilding an entire green, can reduce course closure time and save a substantial amount of money.

SUCCESSFUL RENOVATION STARTS WITH ANALYSIS

Before deciding on resurfacing, it is essential to have undisturbed soil cores from several greens tested by an accredited soil testing lab to determine the integrity of the original 12-inch rootzone. Information gleaned from this exercise is invaluable when determining which renovation procedure will be the most efficient and cost-effective. If the original rootzone material has retained good performance characteristics and an audit of the drainage system reveals that it is in good working condition, resurfacing rather than rebuilding is a viable option. The USGA article "Rebuild or Resurface" provides further reading on resurfacing or rebuilding greens.

COLLECTING SOIL CORES

Undisturbed soil cores are typically harvested with specially designed equipment or by using a beveled segment of PVC pipe. Contact an accredited soil-testing lab for specific sampling instructions. Make sure that the lab assesses more than just the top few inches of the soil profile. The rootzone mix underlying any surface organic matter layers must be evaluated to make sure its properties are still favorable. Also, it is a good idea to harvest a portion of the gravel layer to evaluate whether any issues have developed at the sand/gravel interface or if the gravel has degraded.

Rootzone testing should analyze particle size distribution, organic matter content, infiltration rate, total porosity,

Approximately 4 inches of existing rootzone mixture was removed from this green to eradicate existing grass and organic matter. A new rootzone with desirable performance characteristics was installed.

capillary porosity, and aeration porosity. Ideally, if the green was originally constructed following USGA recommendations, the rootzone mix below any surface-layering issues will still have properties that meet USGA recommendations. If not, further evaluation may be necessary to determine if the existing mixture can support healthy turf and deliver desired playing conditions without rebuilding.

If the existing mix meets USGA recommendations or if there is high confidence that the mix has favorable performance characteristics, then any new rootzone mixture added during the renovation process should have properties comparable to the existing mix.

HOW TO RE-ESTABLISH A DESIRABLE SOIL PROFILE AFTER THE OLD ROOTZONE HAS BEEN REMOVED

Review soil test results to decide how much of the existing rootzone mix needs to be removed to achieve desired performance characteristics. Many courses find that removing 1-5 inches of rootzone from the surface and replacing it with a compatible mix achieves their goals. The more material that is removed, the costlier the project. The cost of purchasing enough material to replace just 2 inches of rootzone mix over a 5-acre resurfacing project at $60 per ton of delivered mix is roughly $144,000. Replacing 4 inches will more than double the cost.

With such hefty expenses, you may wonder if cultural strategies such as shallow and deep aeration or rototilling can be effective alternatives to removing rootzone material and replacing it with a compatible mix. Unfortunately, our experience indicates that in most cases some amount of rootzone material has to be removed to address serious performance issues.

HOW MUCH OF THE EXISTING ROOTZONE SHOULD BE REMOVED?

Consider these factors when deciding how much of the existing rootzone to remove.

Existing turf variety — It may only be necessary to remove the top 1-3

inches of rootzone material if the existing turf is a cool-season species. However, if the existing turf is a warm-season species such as bermudagrass, 4-5 inches of rootzone will probably have to be removed.

Contours — Recontouring severe slopes may require removing 4 or more inches of rootzone. However, be sure that the final grade is no shallower than 12 inches above the gravel layer, if present, plus or minus 1 inch.

Excess organic matter and fine material — Typically, organic layers are 2-4 inches thick in bentgrass and *Poa annua* greens but can be as much as 6 inches thick in bermudagrass or seashore paspalum greens. When present, removing the entire organic matter layer is recommended. Wind-blown fine material — i.e., silt, clay, and very fine sand — is most likely confined to this layer as well.

ADDITIONAL QUESTIONS TO CONSIDER REGARDING ROOTZONE REMOVAL

Question: There is excessive organic matter in the upper 2 inches of the rootzone but no fine material, and the mix beneath is performing well. Can I just rototill to distribute the organic matter over a greater depth, such as 6 inches, effectively diluting it?

Answer: No. Doing so potentially compromises the physical properties of the rootzone below the organic layer. Also, rototilling rarely results in a homogenous mix.

Question: What if I have 4-5 inches of excess organic matter and fine material, but I only remove 2 inches of the rootzone and till in new rootzone mix? Will that improve overall rootzone conditions?

Answer: This option is riskier and less desirable than complete removal of the organic layer, but it could result in improved performance. Rototilling rarely produces a homogenous mix; therefore, this scenario may result in an inconsistent mix containing varying amounts of organic matter and fine material. The mixture at the surface is likely to have less organic matter following the incorporation of new rootzone mix than the mixture deeper in the profile. Unless the rototiller can consistently mix the full depth of any remaining organic layer with the new rootzone mix, the resulting rootzone will contain varying amounts of organic matter or excess fine material at different depths.

SELECTING COMPATIBLE ROOTZONE MATERIAL

If due diligence and analysis of soil tests have determined that you need to remove several inches of existing rootzone, use the test results to select a replacement mix that closely matches the characteristics of the rootzone material that still performs well.

First, find a new sand with a particle size that's similar to the existing mixture. This will maintain textural continuity through the entire profile. It would be logical to approach the original sand supplier to determine if they are still producing the mixture that was utilized during construction. If they are, submit samples of the newly produced sand to a laboratory for complete performance testing. A soil testing lab also can help determine whether any peat is needed to achieve favorable performance characteristics. If the original sand was blended with an inorganic amendment, such as a porous ceramic,

The top 3-4 inches of this rootzone should be discarded and a new, compatible rootzone mixture added before regrassing to improve performance characteristics.

plan to use the same amendment in the new mix. Consult a soil testing laboratory to determine how much amendment is needed for the new mixture to yield properties consistent with the existing mixture.

Before accepting deliveries of new rootzone mixture, schedule routine quality-control tests to make sure the material is consistent with the approved mix. Consult the USGA publication "Quality Control Sampling of Sand and Rootzone Mixture Stockpiles," for more information on sampling and testing frequency.

RENOVATION SCENARIOS

The final portion of this article presents several common renovation scenarios. This section is divided into three renovation procedures: resurfacing, expansion, and recontouring.

RESURFACING

This procedure is the most common. It requires removing existing turf and a portion of the rootzone. Remove existing turf and organic matter to a depth at or below any visible organic layers. Add a compatible new rootzone mix to the surface to achieve the desired grade. Blend the new mix into the upper 1-2 inches of the old rootzone mixture to provide a smooth transition between the two materials. This can be done with rototilling or even with a mechanical bunker rake if the depth of the new mix is shallow. Avoid aggressive tilling as it can damage peat fibers and alter the properties of the new rootzone mix.

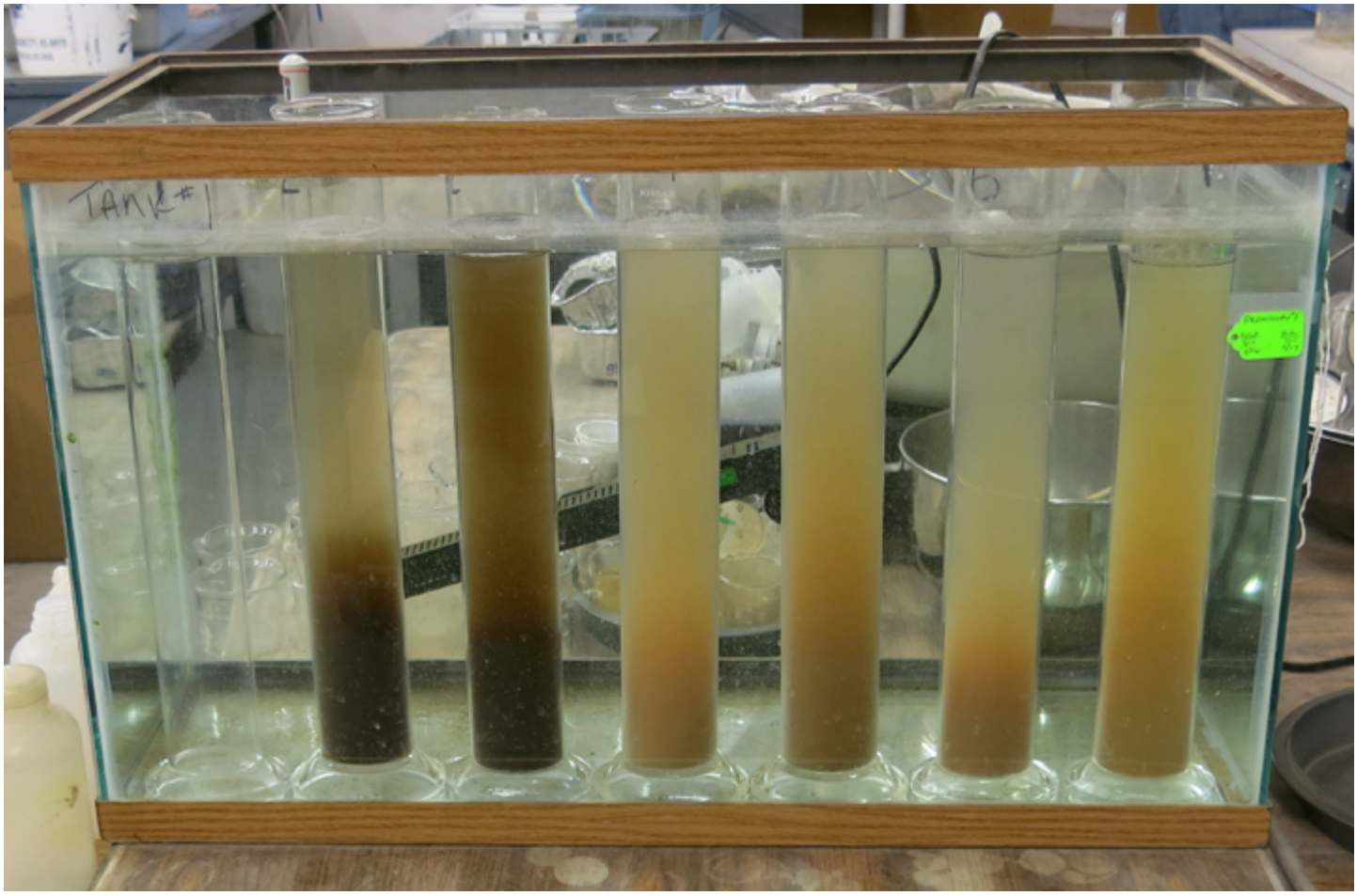
Where more than 4 inches of rootzone are removed and replaced, effective blending of the new and existing mix becomes impractical. In this case, disrupt the surface of the existing rootzone through scarification before placing the new mix on top. This will decrease the risk of a difference in bulk density between the two layers impeding water movement or root development.

EXPANSION: SAND-BASED GREENS

Expanding greens may be done as a stand-alone project or in coordination with a total green renovation. Selecting a rootzone mix for putting green expansion projects is more challenging and comprehensive than resurfacing.

The expansion area, including the putting green collars, will need to be excavated to match the subgrade depth of the existing green. Once excavated, the cavity floor must be shaped to tie in with the existing green's subgrade and contours. Lateral drain lines should be installed in expansion areas and connected to existing drain pipes. Perimeter drains also should be added in any areas where water may gather immediately adjacent to the new cavity wall.

If there is a gravel layer, add new gravel to a minimum depth of 4 inches, matching the gravel layer in the existing green. Since gravel size can influence water retention in the rootzone



Undisturbed soil cores should be submitted for physical analysis to help select a compatible rootzone before resurfacing greens.

TABLE 1: SAMPLE SOIL TEST RESULTS

PARTICLE SIZE ANALYSIS (ASTM F-1632)

Lab ID No.	Sample	Soil Separate %				Sieve Size/Sand Fraction Sand Particle Diameter % Retained				
		Sand	Silt	Clay	No. 10 Gravel 2 mm	No. 18 V. Coarse 1 mm	No. 35 Coarse 0.5 mm	No. 60 Medium 0.25 mm	No. 100 Fine 0.15 mm	No. 270 V. fine 0.05 mm
34816-1	Top 4" of greens	94.2	2.4	2.3	1.1	2.8	37.5	43.9	6.9	3.1
35105-1b	6-1-3 (sand-clay additive-SG peat)	94.9	2.0	1.7	1.4	8.3	28.2	41.9	12.4	4.1
	USGA Recommendations		**≤ 5%**	**≤ 3%**	**≤ 3% gravel ≤ 10% combined**		**≥ 60%**		**≤ 20%**	**≤ 5%**

PHYSICAL PROPERTIES (ASTM F-1815)

Lab ID No.	Sample	Particle Density[1] (g/cc)	Bulk Density (g/cc)	K_{sat} Infiltration Rate (in/hr)	Total Porosity %	Aeration Porosity %	Capillary Porosity[2] %	Organic Matter[3] %
34816-1	Top 4" of greens	2.60	1.61	0.1	38.1	7.3	30.8	1.49
35105-1b	6-1-3 (sand-clay additive-SG peat)	2.59	1.47	2.4	43.1	14.6	28.5	1.97
	USGA Recommendations			**> 6**	**35 - 55**	**15 - 30**	**15 - 25**	
	Sand Channel Drainage Guidelines			**2 - 4**		**≥ 10%**	**> 25%**	

[1]ASTM D5550 [2]Determined at 30 cm tension [3]ASTM F-1647, loss on ignition method

A CASE STUDY IN SOIL-BASED GREEN EXPANSION

In 2014, a golf course in Southern California took on a project that included expanding greens and installing sand-channel drains. First, the course tested the physical characteristics of the top 4 inches of rootzone from several greens. The objective of the testing was to characterize the properties of the existing rootzone material. The test results also were used to design a rootzone mix that would be suitable for both sand-channel drainage trenches and expansion areas.

The results in Table 1 show that the existing greens had a moderate amount of fine material. Organic matter content was high but not excessive. The rootzone mix was poorly drained and had low aeration porosity and high capillary porosity. Therefore, it was not advised to exactly duplicate this mixture for use in expansion areas. Rather, the course set a goal to find a rootzone mix that would provide improved drainage and aeration porosity when compared to the existing rootzone while retaining comparable water-retention properties — i.e., capillary porosity.

After testing several rootzone mixes, the course decided that a 6-1-3 ratio of sand, soil, and peat would provide the desired performance characteristics. The mix does not meet USGA recommendations for new construction but, in this case, should perform similarly to the existing rootzone while providing some improved performance characteristics.

Remember, every case will be different, so it's important to work with a soil scientist who has experience designing and selecting rootzone mixes for unique situations.

Putting green expansion areas will likely perform differently from the original greens during the first few seasons. Simultaneously resurfacing the original greens and the areas where the greens will be expanded will overcome this issue.

mix, the gravel should be similar in particle size to that used during original construction. If no record of the original gravel exists, submit gravel samples from the existing green for testing.

Rootzone mix with properties as similar as possible to the original green should be used to fill the remainder of the cavity to final grade. It is important that the expansion have positive surface drainage to sheet excess water off the green.

EXPANSION: SOIL-BASED GREENS

Expanding soil-based greens is not as straightforward as expanding sand-based greens. Ideally, the soil profile in expansion areas will have physical properties similar to those of the existing green so it can provide consistent performance. Unless the native soil is naturally sandy, do not install a sand-based mixture in expansion areas. This often leads to disastrous outcomes.

Submit soil samples from expansion areas for particle-size and organic-matter testing. Compare the results to soil tests from the green. Often, they will be similar. However, if they are not similar and new soil must be imported to expand the green, find a soil with physical characteristics similar to those of the existing green. Soil-based greens often have a 3- to 4-inch surface layer of sand topdressing. In such cases, allow for a similar layer in expansion areas. In other words, if the existing soil is covered with a 4-inch topdressing layer, shape the soil in expansion areas to be 4 inches below final grade. Fill the remaining void with a layer of sandy material that matches the green's topdressing layer. Work with the soil testing laboratory to design a mix compatible with the surface topdressing layer in the existing greens.

It is strongly advised at this point to install sand-channel drains into the expansion areas and the original green if they are not already present. Sand-channel drains can greatly improve drainage, turf health, and playing conditions.

RECONTOURING: SAND-BASED GREENS

Recontouring may be needed to soften severe slopes to increase the area usable for hole locations. The presence of water-collecting hollows is another reason to recontour putting greens. Even if subsurface drainage systems are functioning, they should not be expected to immediately drain all of the water that collects on putting surfaces. Areas that hold water should be corrected to provide a minimum 0.5-percent slope to sheet surface water off the green.

Surface contours can be corrected without rebuilding putting greens, assuming minimal cut and fill depth. First, probe greens that need to be recontoured to determine the depth of the rootzone mix. If greens are more than 10 years old, the rootzone depth may be 2-3 inches deeper than the original construction depth. In such instances, 2-3 inches of rootzone can be removed without having to add new rootzone mix. New rootzone mix can be added to low areas so long as it matches the existing rootzone characteristics. Be aware that large changes in rootzone depth — i.e., a 4- to 6-inch depth variation — can result in inconsistent water requirements across a green, especially if the rootzone is shallower in low-lying areas than it is in higher areas. Rebuilding should be considered where large changes in grade are required.

RECONTOURING: SOIL-BASED GREENS

Changing the slopes and contours of soil-based greens is not a simple proposition. If soil must be added, a new mix with good performance characteristics should be placed on top of the soil to improve drainage and aeration. If soil is to be removed, the topdressing layer should be set aside and contouring changes made to the rootzone below. Then, replace the topdressing layer and tie it into the surrounding grades. If necessary, sand-channel drains should be installed after reaching final grade.

CONCLUSION

There are many ways to improve putting green conditions and performance if conventional management has been unsuccessful and rebuilding is not practical. The common thread is the need for soil physical testing to objectively evaluate the performance characteristics of the existing rootzone, establish the soil physical properties of a new mix that will perform similarly to the existing rootzone, and perform quality-control testing to ensure the new mix remains consistent and compatible with the existing rootzone.

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