

Managing Bunkers

There are many factors that impact bunker playability.

BY TODD LOWE AND BOB VAVREK

The USGA defines a bunker as a hazard consisting of a prepared area of ground, often a hollow, from which turf or soil has been removed and replaced with sand or the like. The term “sand trap” has been used to describe bunkers but should be avoided, especially when dealing with Rules officials. The terms “waste bunker” and “grass bunker” have also been used, but these areas are not hazards according to the Rules of Golf. The terms “waste area” and “grassy hollow” are more appropriate.

When describing bunkers, it depends on who you ask. Golf course architects might describe bunkers as aesthetic or strategic features, whereas golf course superintendents might describe them as “money pits” that consume endless resources. Furthermore, golfers may view bunkers as dangerous areas to be avoided or safe havens that provide easy recovery shots.

However they are perceived, bunkers are areas that receive an inordinate amount of attention at most golf facilities. From their simple origins as hollows on the leeward sides of sand dunes that sheltered livestock from cold sea winds, bunkers have experienced considerable evolution of design, construction, and maintenance over the years. So too have golfer expectations for playability and consistency. The objective of this article is to address common bunker issues and offer tips to conserve resources.

BUNKER DESIGN 101

Bunkers come in all shapes and sizes. The golf course architect has the greatest influence on bunker design, but it is important to consider golfer skill level and required maintenance when designing bunkers. Some bunker features that may be more visually appealing can be difficult to play from and costly to maintain.



Flashed bunker faces provide a certain architectural appeal, but they require more maintenance to relocate sand that washes downward following rainfall.



Drainage is a key factor to bunker performance, both inside and outside bunkers. Poorly draining bunkers are costly to maintain and provide undesirable playing conditions.



String trimmers are used to mow turf surrounding bunkers on a regular basis and are especially needed on bunkers with steep mounds or narrow capes.

Flat bunkers have little to no exposed sand faces. As such, sand in flat bunkers is rarely displaced by heavy rain, and flat bunkers generally provide a more consistent playing surface than bunkers with steep, flashed faces. The face of a flat bunker may roll gently down toward the base of the hazard and be constructed with steep grass mounds or revetted with sod.

Flashed bunkers consist of steep sand faces that create a certain architectural appeal. The height and slope of flashed bunker faces affect the potential for downward displacement of sand and maintenance costs required to redistribute sand onto bunker faces following displacement. Often, sand that is redistributed onto flashed

bunker faces is softer, creating a greater likelihood of fried-egg lies.

As sand repeatedly migrates downward in bunkers with high, flashed faces, the underlying soil becomes exposed and can eventually contaminate the bunker. Bunkers with white sand develop a discolored or stained appearance as they become contaminated with silt or clay, and they eventually develop poor drainage and firmer playing conditions. As a result, bunkers with flashed faces typically require more frequent renovation than flat bunkers.

Other architectural features that affect bunker playability and maintenance are the type of mounds and contours surrounding bunkers. It is sometimes impossible to advance from

a revetted bunker; the only option may be to hit the ball sideways or backward. Revetted faces also require more frequent restoration as they collapse or become unsightly. Large, steep mounds surrounding bunkers and bunkers with numerous capes or intricate edges are more eye-catching, but they also require more hand labor for trimming, irrigation, and fertilization.

Resource management should be an important factor for all areas of the golf course, including bunkers. The article "[Design For Maintenance](#)," written by Jeff Brauer, golf course architect, lists several helpful tips to reduce maintenance costs when designing bunkers, including:

- Avoid soft fabric liners that can be pulled up by mechanical rakes.



This bunker has changed considerably from years of wind erosion and wear from a mechanical bunker rake.



Stacked sod (revetted) bunker faces are visually appealing but can be difficult to maintain. At only a few feet high, this one is rather mild.

- Have multiple access points for motorized rakes.
- Match the turning radius of the motorized rake, normally 7 to 8 feet, to the edge of the bunker to reduce the need for hand-raking.
- Make bunkers flat enough to reduce sand wash from rain. This varies by region, but a slope of 25 percent should be the maximum.
- There should be no surface drainage flows into bunkers.
- Extensive herringbone drainage systems are recommended.
- Match the mower turning radius and maximum slope for bunker capes. These vary, but about a minimum 9-foot radius and a maximum 33-percent slope will reduce the need for hand mowing.
- Narrower capes should be wide enough to allow for down-and-back mowing with mechanical trim mowers.

CONSTRUCTION

Simply removing turf, excavating a hole, and filling it with 4 to 6 inches of sand may be an acceptable type of bunker construction, but only for a small percentage of golf courses. Much more thought and planning are

necessary when constructing most modern golf course bunkers, particularly when it comes to drainage, sand selection, and deciding whether or not to line bunkers.

Drainage: Drainage is important for all areas of a golf course, including

bunkers. Poorly draining bunkers are a headache to maintain; they must be pumped repeatedly following rain events and are prone to algae and overly firm playing conditions. Trenched herringbone drainage systems with 4-inch perforated pipe or tile surrounded by gravel are still the most common bunker drainage method. Drains can become clogged or collapsed if improperly constructed or damaged, and they may require reconstruction if they do not function.

In addition to making sure that bunkers drain well, it is also necessary to divert surface drainage away from the bunker. Bunkers that receive runoff from surrounding areas are prone to continual bunker sand erosion during rain events. Repeatedly repairing washouts can be labor intensive and creates softer playing conditions. Mounding or interceptor drains can be installed in upslope areas to divert water away from bunkers.

Sand Selection: There are several factors to consider when selecting bunker sand, with the most important being those that affect playability. Bunker sand particle size, particle shape, crusting potential, and uniformity all affect playability, but it is impossible to predict bunker sand



Some bunkers can be converted to grass hollows to reduce labor without losing their strategic value.

performance based solely on its physical properties. See [How to Select the Best Sand for Your Bunkers](#) and [Physical Analysis of Sands for Golf Course Bunker Use](#). Evaluating several bunker sands with an on-site test bunker is recommended so that golfers can compare several different types of sand side by side. There may be differing opinions on bunker playability, but developing a consensus from your golfers will reduce future complaints about sand selection.

Subangular to angular sands create firm playing conditions and fewer plugged lies. The use of angular bunker sands has increased greatly over the past few years. Subangular to angular sands were once trucked from a certain region of the U.S. to other areas, but now many local sand suppliers create their own angular sands through a crushing process. Whatever the shape, buying local sand saves a considerable amount of money compared to hauling it in from other regions, so try to find local sand that works well at your facility. See [Making Low-Cost Bunker Sands Work](#).

Liners: Liners can be installed between the bunker sand and the underlying soil to reduce washouts. An older technique that is still employed on a few golf courses uses a sod liner. Other techniques have been developed over the years, and it is recommended to discuss which liners perform best in each region with your local USGA agronomist. Examples include:

Soft Liners: Geotextile fabric liners, e.g. Sandtrapper® II, SandMat®, and BunkerMat®, have been used more often over the past few decades and consist of a permeable material that is stapled to the base of the hazard. Fabric liners do reduce sand erosion from flashed faces, but some issues have occurred. These include fabric tearing by mechanical rakes, staples being displaced by frost heaving, and the loss of permeability due to silt and clay deposits.

Durable Liners: More sophisticated techniques for lining bunkers have been developed over the past five to 10 years and are gaining popularity (see [The Bunkers Edge](#)). Better Billy Bunker™, Capillary Concrete™, and

StaLok® liners consist of a gravel base held together with a polymer, while The Matrix® liner uses asphalt. Bunker Solution™ is another durable liner that uses a thick mat that resembles white artificial turf. Each system drains well and reduces washouts and soil contamination. The costs of newer methods are steep and rival those of some modern-day putting greens (see Table 1). However, modern bunker liners can help mitigate the expense of bunker maintenance and refurbishment. Since some of these technologies are rather new, it is unknown how they withstand time, the stress of daily maintenance, and weathering.

bunkers to their original design, whereas other facilities may redesign bunkers to change aesthetics and playability completely. When restoring or redesigning bunkers, make certain that there are ample resources, particularly staffing, to maintain the new designs. Flashed faces, steep mounds, or narrow capes are features that require a considerable amount of hand labor.

There may be too many bunkers on a golf course and selectively removing or replacing them with grassy hollows or other features may be warranted. While this may take architect approval, consider removing bunkers that have

Table 1
Current Cost Comparisons of Several Newer Bunker Liners*

	Cost (ft ²)		
	Material	Labor	Total
Better Billy Bunker™	\$1.25 - \$1.50**	\$0.50 - \$0.75	\$1.75 - \$2.25
Bunker Solutions™	\$1.75 - \$2.00	\$0.75 - \$1.00	\$2.50 - \$3.00
Capillary Concrete™	\$1.25 - \$1.60**	\$0.75 - \$1.00	\$2.00 - \$2.60
Matrix®	***	\$0.35 - \$0.50	***
StaLok®	\$2.60 - \$3.00	\$0.60 - \$0.80	\$3.20 - \$3.80
Sand Trapper® II (fabric liner)	\$0.65 - \$0.80	\$0.40 - \$0.50	\$1.05 - \$1.30

*Costs estimated by one golf course builder for an 18-hole facility with 100,000 ft² of bunkers. Prices may vary considerably for your bunkers depending on number of bunkers, region, and builder.

**Depends on cost of gravel.

***Material purchased directly by the owner due to the requirement of certification of a qualified asphalt plant capable of producing porous asphalt liner mix.

Reconstruction: Some type of bunker refurbishment generally occurs over time, whether in the form of sand replenishment, restoration, redesign, or bunker removal. Bunkers age and some courses simply remove old, contaminated sand, repair drainage when needed, and install new sand. Depending on the level of expectation at any given facility, bunker renovations may never occur or may occur as frequently as every five to seven years.

Bunkers change in size and shape from processes like sand accumulation from play, weather, and maintenance. Some facilities choose to restore

less impact on the strategy of the hole and bunkers that see little play. Also, consider reducing bunkers that affect high-handicap golfers, which should improve pace of play and enjoyment for all golfers.

Independence Golf Club in Midlothian, Va., recently renovated its golf course with the help of golf course architect Lester George. Reducing bunker size and severity was a major focus of the renovation, as bunkers were reduced from 130,000 square feet to 85,000 square feet, and flashed bunker faces were softened and reshaped to provide additional entry

and exit areas. Lastly, a durable Better Billy Bunker™ liner was installed to reduce sand erosion from bunker faces. Other changes were made throughout the golf course, including removing trees, reducing rough heights, and regrassing putting surfaces. The end result improved the pace of play by more than 45 minutes and saved a considerable amount of labor by reducing washouts. Dan Taylor, golf course superintendent at Independence Golf Club, has been quite pleased with the improvements and has been able to reduce the daily bunker maintenance staff and mentioned that washouts are no longer a concern.

MAINTENANCE

Bunkers require maintenance practices such as raking, edging, debris removal, weeding, and trimming to maintain good aesthetics and playability. Many golf course officials do not realize the resources required to maintain high-quality bunkers, but it is an important topic, especially as some facilities are forced to conserve resources. See [The Money Pit](#) and [Bunkers: Can Your Golf Course Afford Them?](#)

Raking: Bunkers are raked to remove footprints, fix washouts, and improve playability. At some golf courses, every bunker is raked daily, either by hand or with motorized bunker rakes. Hand raking is the norm for small bunkers and along bunker edges. Motorized rakes are used to reduce labor and help soften bunker sand with cultivation tines when necessary. Bunker raking techniques can be changed to be more or less aggressive based on bunker sand firmness. Deeper cultivation tines help loosen bunker sand, while leaf rakes or skirts merely smooth the upper sand layer. Raking techniques also may need to be altered depending on the weather.

To conserve resources, minimize daily raking to bunkers that see a high volume of play and only touch up low-play bunkers. A technique used at some courses is the “Aussie” method of mechanical raking bunker bases and sparingly raking perimeters with the smooth side of a rake. Several golf course superintendents who use the



Durable mat liners, like this Bunker Solution™ material, can be rather costly initially, but they have helped reduce maintenance costs and, perhaps, improve the longevity of bunkers.



Sand being installed atop the stabilized gravel liner of this Better Billy Bunker™.

“Aussie” method report firmer conditions on bunker faces and fewer washouts than with conventional raking techniques. Some superintendents feel that the “Aussie” method requires just as much labor as conventional raking, but others have seen a considerable labor reduction. Some unforeseen issues have occurred with the “Aussie” method, including increased weed emergence and algae on bunker faces that are only occasionally smoothed, but most seem to find the method favorable.

Sand Depth: The USGA recommends an average sand depth of 4 to 6 inches at the base of a bunker and 2 to 3 inches on bunker faces. Following this recommendation reduces plugged lies on bunker faces and allows for a full swing through the sand without digging into the liner or subsoil.

Bunker sand migrates over time from processes like heavy rain and motorized raking. The maintenance staff should periodically measure and redistribute sand to maintain consistent depth throughout the bunker (see [Refurbishing Bunkers](#)).

Sand is lost due to wind and play, so bunkers should be topped off with fresh sand when needed. Sand is also added to improve appearance, as sand color changes due to contamination from soil or organic debris. This practice, often referred to as “capping,” includes removing the upper 1 to 2 inches of contaminated sand and replacing it with new sand. However, capping only improves short-term bunker aesthetics and may not be a sustainable practice at some facilities.

Adding fresh sand usually makes bunkers soft for a period of time. Prac-

tices such as watering and compaction with cement finishers help improve bunker firmness (see [A Technique For Dealing With Soft Sand](#)), but some bunkers may simply require time for the sand to settle and firm up.

Mowing/Edging: Maintaining the turf surrounding bunkers can be quite costly. Bunkers with gradual slopes and large capes can accommodate efficient riding mowers, but steep mounds and small or narrow capes require more mowing and trimming by hand. At many courses, string trimming around bunkers takes place on a weekly basis, and bunkers with intricate edges can escalate labor costs.

Also, bunkers are typically edged every two to four weeks, depending on grass type and climate. Aggressive grasses like bermudagrass have above-ground runners (stolons) that



It is impossible to achieve the same consistency in all bunkers on a daily basis, so golfers should practice from firm and soft bunkers.

must be trimmed more frequently than some cool-season grasses. Plant growth regulators, such as trinexapac-ethyl or mefluidide, are sometimes applied to bunker faces every two to three weeks to reduce mowing and edging frequency. Backpack blowers are used on a regular basis to remove clippings, leaves, and other debris from bunkers.

Irrigation/Fertility: Steep grass bunker faces dry out faster and are more difficult to fertilize than bunker faces with more moderate slopes and, as a result, they can become unsightly. Supplemental water and nutrients are often applied by hand to bunker faces to help maintain good turf quality. Steep faces with southern exposures are especially prone to soil drying, and installation of low-volume irrigation heads, while costly at first, may ultimately reduce labor and improve

water use efficiency (see [Bunker Irrigation](#) and [Southern Exposure](#)).

When it comes to conserving resources on bunker maintenance, much depends on bunker design and golfer expectations. Daily raking and bunkers that require more hand labor due to intricate designs can significantly increase maintenance costs. However, labor can be reduced by not raking every bunker on a daily basis, as long as golfers accept occasional footprints or inconsistent lies. The article [“Bunkers: Hazards or Havens?”](#) is a valuable resource that may help golfers at your facility develop bunker expectations that better align with the maintenance budget.

PLAYABILITY

Inconsistent playing conditions can occur even in properly constructed and maintained bunkers. Bunker playability

often is contingent on sand firmness, which is most affected by moisture. Therefore, factors that affect sand moisture strongly affect bunker playability. Some factors affecting bunker sand moisture can be managed with daily maintenance practices, while other factors cannot. It is important to understand the impact of each factor on playability to help determine the degree of bunker consistency that is achievable and sustainable at your facility. Some factors affecting bunker sand moisture include:

- **Sand depth:** Bunkers with more sand are generally drier, i.e., softer, while shallower bunkers are generally wetter, i.e., firmer. It may be possible to change bunker firmness by simply adding or removing an inch or two of sand.
- **Weather:** Rainy periods keep sand moist and firm, while droughty weather can result in dry, soft sand, depending on the amount of irrigation.
- **Irrigation Coverage:** Bunkers that receive additional water from sprinkler overlap remain wetter and firmer than bunkers that receive less irrigation.
- **Shade:** Shaded bunkers dry out more slowly and remain firmer than bunkers in full sun.
- **Sun Angle:** Bunkers on north-facing slopes receive less direct sun, dry out more slowly, and are firmer than south-facing bunkers.
- **Topography:** Elevation affects bunker moisture and firmness. Low-lying bunkers that are near the water table may remain saturated and firm, despite having a functional drainage system.

The term “consistency” is often used when discussing bunker playability, but bunker consistency might be an impossible standard. Bunkers can be raked the same way and maintained at the same depth, but it is impossible to account for all of the above factors to maintain consistent playability in every bunker on a daily basis (see [Consistency in Bunkers...What Does It Mean?](#)) It should be remembered that the game of golf is enjoyed outdoors and it is rewarding to make good shots from bunkers that are affected differently by outside elements. Golfers

should understand how to make shots from firm and soft playing conditions and perhaps take a few lessons from their local golf professional.

Golf is a self-governed game that encourages each player to use etiquette on the course and rake bunkers after each use. Another bunker etiquette issue occurs when golfers damage steep grass faces by attempting to traverse them instead of exiting the low side of a bunker. Signs can be posted to educate golfers on this issue and encourage them to protect bunker faces. Lastly, the placement of bunker rakes following use is another common topic with golfers. Bunker rakes can be placed either inside or outside of bunkers, and it is up to each facility to develop its own policy. However, placing rakes outside of bunkers in areas where they are least likely to affect play is generally recommended (see [Where Should We Put The Bunker Rakes?](#)) The USGA provides some additional resources to encourage better golfer etiquette, including the video [Fore The Golfer: Bunker Etiquette](#).

CONCLUSION

Bunkers come in all shapes and sizes. Some bunkers are neglected and some receive intensive maintenance. High standards for bunker quality and consistency usually require increased inputs. The amount of labor and resources required to achieve desired bunker playability and appearance depends on factors such as bunker construction method, design, and the physical characteristics of bunker sand. The USGA Green Section is here to assist your facility in any way possible. In addition to the resources

listed in this article, we now offer a specialty [Course Consultation Service](#) visit that focuses solely on bunker performance.

REFERENCES

- Anonymous. 1921. Efficiency Edgar On A Golf Course. Bulletin of the Green Section of the U.S. Golf Association. November 15. 1(11):219-220. <http://gsr.lib.msu.edu/1920s/1921/211219B.pdf>
- Bigelow, Cale A.; Smith, Douglas R. 2008. Physical Analysis of Sands for Golf Course Bunker Use. USGA Turfgrass and Environmental Research Online. February 1. 7(3):1-9. <http://usgatero.msu.edu/v07/n03.pdf>
- Hartwiger, Chris. 2013. Making Low-Cost Bunker Sands Work. Green Section Record. November 15. 51(23): 1-4. <http://gsr.lib.msu.edu/article/hartwiger-making-11-15-13.pdf>
- Lowe, Todd. 2014. Refurbishing Bunkers. United States Golf Association. 12 slides; Audio: 05:37. <https://www.youtube.com/watch?v=wXhilRp1Dj0>
- Moore, Jim. 2009. Bunkers: Can Your Golf Course Afford Them? Green Section Record. May/June. 47(3):16-17. <http://gsr.lib.msu.edu/2000s/2009/090516.pdf>
- Moore, Jim. 2008. The Money Pit: Do Golfers Really Understand How Much Bunkers Cost? Green Section Record. July/August. 46(4):Cover, 1-6. <http://gsr.lib.msu.edu/2000s/2008/080701.pdf>
- Moore, Jim. 1998. How to Select the Best Sand for Your Bunkers. Green Section Record. January/February.

36(1):9-12. <http://gsr.lib.msu.edu/1990s/1998/980109.pdf>

Nelson, Matt. 2005. Where Should We Put The Bunker Rakes?. Green Section Record. January/February. 43(1):32-33. <http://gsr.lib.msu.edu/2000s/2005/050132.pdf>

Smith, Bunny. 2014. The Bunker's Edge. Golf Course Management. November. 82(11):64, 66-69. <http://gcmdigital.gcsaa.org/i/402226/70>

Snow, James T. 1989. A Technique For Dealing With Soft Sand. Green Section Record. March/April. 27(2):19. <http://gsr.lib.msu.edu/1980s/1989/890319.pdf>

Vavrek, Robert. 2004. Bunkers: Hazards or Havens? Green Section Record. March/April. 42(2):8-10. <http://gsr.lib.msu.edu/2000s/2004/040308.pdf>

Vermeulen, Paul. 1999. Southern Exposure. Green Section Record. May/June. 37(3):6-7. <http://gsr.lib.msu.edu/1990s/1999/990506.pdf>

Vinchesi, Brian. 2010. Bunker Irrigation. Golf Course Industry. November. 22(11):28. <http://archive.lib.msu.edu/tic/gcnew/article/2010nov28.pdf>

White, Bud. 2009. Consistency in Bunkers . . . What Does It Mean? Green Section Record. March/April. 47(2):28. <http://gsr.lib.msu.edu/2000s/2009/090328.pdf>

TODD LOWE is an agronomist in the USGA Green Section Southeast Region.

BOB VAVREK is an agronomist in the USGA Green Section Central Region.

SUBSCRIBE TO THE USGA GREEN SECTION RECORD

TEXT "GREENSECTION" TO "22828" OR [CLICK HERE](#)

Offering the latest information on golf course management, turfgrass culture, environmental issues, research and economic sustainability.