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new strategies and technologies...

DRAIN IT!

Beyond the day-to-day tasks of mowing greens, raking bunkers and the usual maintenance routine, one of the most persistent and ongoing challenges facing golf course superintendents is drainage. Greens, tees, fairways, bunkers — you name it, it requires supplemental drainage.

Rarely is a golf course built on the ideal site, with gently sloping terrain, low water table, friable soils and perfect location of streams and ponds. During construction, even the best architect and shaper can't grade a course to perfection. It's next to impossible to predict all areas of poor drainage, and install mechanical drainage systems with 100% accuracy and foresight. Thus, golf course drainage is an ongoing process.

In this issue and next, we'll try to better understand the complexity of golf course drainage, while taking a look at new strategies, technologies and equipment superintendents can use to optimize drainage. This month, we spoke with Dennis Hurley, president of Turf Drainage Company of America. Based in Marrero, Louisiana, Hurley's company designs and installs drainage systems nationwide, and also markets its *Turf Drain®* waffle drain material through a distribution network.

"There are two types of drainage problems that need to be addressed on the typical golf course," said Hurley. "The obvious one is surface water that puddles after heavy rainfall. That is best collected by an open inlet leading to a catch basin," he advised.

"The second type of drainage problem is water trapped in the soil profile due to a high water table or other factors. In this instance, surface water may not be present," Hurley said. "This is best dealt with through seepage drainage. While the keys to a properly functioning open inlet system are pipe size and capacity, the critical factor for a seepage system is *depth*. The object is to drain the soil profile deep enough to increase the field capacity to the point where the soil will be able to absorb the next rainfall."

Superintendents have three options when deciding how to best correct drainage problems on their golf courses: regrading, an open inlet system, or seepage drainage. "Many try to correct a situation with only one strategy or technique," said Hurley, "when in fact the key is to design a drainage system with the right combination of surface and seepage drainage for each particular situation," he concluded.

While the keys to a properly functioning open inlet system are pipe size and capacity, the critical factor for a seepage system is *depth*.

When soil moisture levels are below field capacity, water naturally moves by capillary tension from areas with large soil particle sizes and air spaces to smaller ones. This is how water becomes available in the rootzone of plants. Once a soil reaches field capacity, however, water tries to reverse course and move by gravity from smaller to larger particle sizes and air spaces. This is where seepage drainage comes in — creating areas of higher permeability at a grade to move collected water away from the saturated area.

Based on mathematics

The basis of all seepage and drainage engineering, according to Hurley, is a formula developed by Dr. Karl von Terzaghi, the "Father of Soil Mechanics", at MIT in the 1940s. The formula is widely used for determining the relationships

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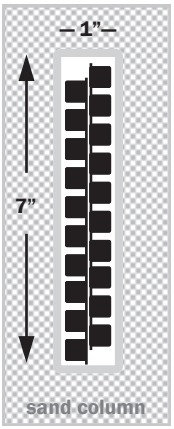
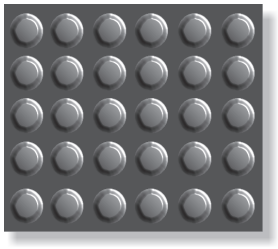
between particle sizes of different soil materials, porosity and percolation rates. It served as the foundation of the revised USGA green specifications introduced in 1993. With respect to turf drainage, the formula is used to determine the best sizing of backfill material relative to the native soil for optimum porosity and minimal clogging with fines.

"The Terzaghi formula indicates that the coarse gravels so widely used for subsurface turf drainage very rarely match up properly with native soils," explained Hurley. "That is why we recommend and use sand exclusively as a backfill material. To build a technically correct drainage system, the native soil trench should be backfilled with a sand column around a geotextile-wrapped pipe," he continued. "Most superintendents are aware that greens mixes with even relatively large particle sizes just barely match the specs for the downsized gravel currently recommended by the USGA for greens construction. So, it stands to reason that native silts and clays would fail to match." Hurley's point is that the guidelines of the Terzaghi formula should be applied to all drainage installations — not just greens.



Cross-section of *Turf Drain™* wrapped in geotextile, in a sand column. The air spaces between the inner core and the geotextile fabric create the permeability differential that makes the system work.



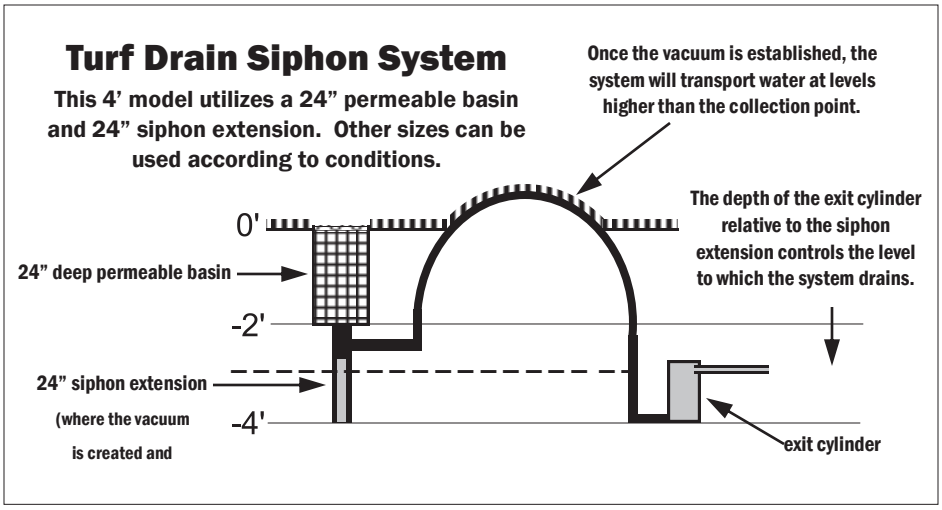
The *Turf Drain™* inner core.

In an effort to increase the efficiency of the perforated pipe-and-gravel seepage systems commonly used at the time, Hurley introduced the concept of a "waffle drain" material to golf courses back in 1984. His *Turf Drain®* product (with others now available on the market) is a 1" wide by 7" high extruded polyethylene "waffle" core wrapped with geotextile and positioned vertically in a 3" wide trench. The air space created between the convoluted sidewalls and the geotextile allow water to seep through the entire sidewall of the waffle drain, rather than having to concentrate itself into the perforations of a pipe. The result is substantially increased water collection rates — **equivalent to a gravel drain 1' deep and 5' wide, or a sand drain 1' deep by 20' wide.**

"Many people see the primary benefit of a waffle drain system to be the relatively non-invasive 3" wide trench," said Hurley, "when in fact the real strength of the design is that it's a better collector of water than perforated pipe. Pipe is a better *transporter* of water from place to place, but waffle drains do a better job of collecting water from the soil profile. They can be used anywhere you might have previously used perforated pipe." In accordance with the Terzaghi guidelines, Hurley backfills his waffle drain trenches exclusively with sand.

Siphon it!

Regardless of whether using open inlet or seepage drainage systems, waffle drains or perforated pipe, the challenge remains to transport the collected water away from the desirable turf areas to a body of water, storm sewer or other relief point. Normally, the collected water travels by gravity through a complex network of precisely graded pipes and basins to its destination. For areas where the slope of the land to the relief point is very slight, or obstacles such as rock, tree roots or mounds make trenching to grade difficult and expensive, Hurley developed and patented the **Turf Drain Siphon System**.



The Turf Drain Siphon System is a transportation system for water collected by any means — open inlet or seepage. The difference is the system can transport water at an elevation *higher* than it is collected, without the need to grade the pipe. All that is required is an elevation change between the collection point and the relief point. The pipe connecting the two ends of the drainage system must be air-tight, but doesn't require a constant fall as is the case with a gravity installation. It's important to note that the system will not *relieve* water to an elevation higher than which it was collected — you would need a pump to do that. The system will, however, transport water *through higher elevations* on its way to the ultimate (lower) relief point.

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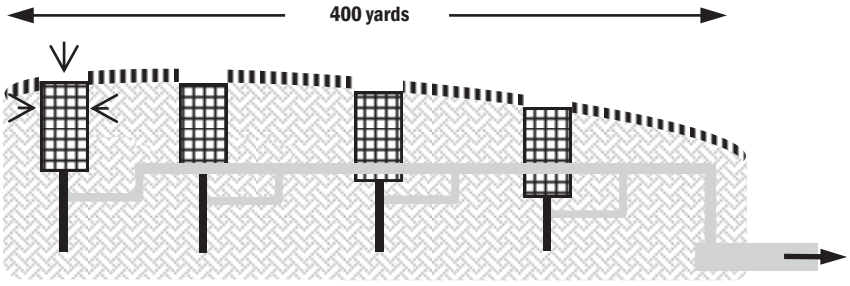
How the heck does *that* work?

Let's refer back to most everyone's basic knowledge of siphons — the "gasoline-in-the-mouth" trick. You need to move gasoline from the tank in your car through a transportation system (hose) to a relief point — your gas container. As long as the container is at a lower elevation than the tank, the gas will move through the hose when the air is expelled by vacuum or by pumping liquid through the hose to "prime" the system. If the gas container is left on the ground, the siphon will continue to empty the tank (beyond the capacity of the container) until air enters the system to break the vacuum. If the container is lifted to an elevation equal with the tank in the car, the siphon will stop (but remain primed) when the fluid in the two containers (tank and gas can) reaches the same level. Raise the can slightly and the fluid moves back into the tank. Drop it slightly and more flows into the can. An equilibrium is established.



By adjusting the depth of the permeable basins and siphon extensions, you can take advantage of the maximum elevation change at all parts of the drainage system, no matter how far from the relief pipe.

A geotextile-wrapped Perma Basin during installation.

Hurley's siphon system begins with his patented *Perma Basin™* collection basins (which can be used in gravity systems as well). They are 12" in diameter and available in 1-4' depths to suit specific requirements. Constructed of heavy duty aluminum grate bars, vertical members and wire screen walls, they are purposely designed to be porous — as opposed to creating "porosity" by drilling holes in typical plastic basins — so they collect both surface water and seepage water from the soil around the basin. The permeable basins slide into a geotextile bag, and are then installed into a pit of sand and sodded over.

When used in gravity systems, the Perma Basin has a universal sleeve for connection to the piping system, thus eliminating different sized fittings for each size of pipe that may be used. It also provides considerably more flexibility in positioning of the piping than solid-wall basins do. The sleeve wraps around the pipe, and then slides into the basin after the wire sidewalls are cut at a point to give the desired elevation. The lateral piping must still be graded properly when using the basins with gravity systems.

In a siphon system, the basins are positioned over siphon extensions, which are vertical pipes used to extend the functional depth of the basin to the desired point of field drainage. This is also where the vacuum is created and maintained. While the basin depth determines the depth the field drains, the extensions help make up the difference in elevation between all the basins on the system. All extensions must be slightly lower than the top of the exit cylinder, to maintain prime and keep the vacuum permanent. In a typical installation, a 4' deep basin with a 1' extension might be used to drain a saturated soil profile, where a 2' deep basin with 1' extension would be used to collect primarily surface water. The connection to the lateral piping in a siphon system is actually to the siphon extension, not the permeable basin.

Since the trench from the collection basins to the relief point doesn't need to be graded, there are fewer elevations to shoot prior to installation. All that is required is the elevation difference between the points at which the collection basins will be installed, and the point at which the water will be relieved.

A permanent connection to the irrigation system is part of a siphon system installation. This enables the superintendent to prime the system by opening a normally-closed valve to fill all the pipes with water and expunge all air. It also provides an easy way to flush trash and debris out of the system without hoses or snakes, merely by opening the valve for 3-4 minutes. The valve can be activated manually, or automatically by connection to an irrigation clock. Depending on the situation, flushing is required anywhere from monthly to bi-monthly to annually, according to Hurley.

A connection to the irrigation system primes and flushes the system.

Once the siphon system is installed and primed, the system operates without floats, valves or pumps. With the siphon extensions positioned properly relative to the exit cylinder, the system should stop draining at the depth of each basin bottom, but still maintain prime.

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"The niche for siphon technology is primarily seepage drainage," said Hurley, "although a siphon can be used to transport both surface and seepage water. By utilizing siphon technology, you can in fact replicate the relief point anywhere on a fairway, and not have to grade the entire length of the fairway to reach that relief point. The majority of the systems we install are 2" siphons — although some are 4", which are mostly for surface water," he added.

This fairway is divided into several drain fields, with waffle drain lines leading to permeable basins, and then into a siphon system to the relief point.

Start with a plan

Before the first trench is dug or the first pipe laid, every good drainage system starts with a comprehensive plan, according to Hurley. "When I'm called in to help with a drainage problem, the first thing I do is walk the course with the superintendent. We evaluate each particular area that needs attention, determine whether it's surface or seepage water, and where it's coming from. We may take a fairway with traditional gravity drainage running the entire length and subdivide it into several drainage fields, each with it's own waffle drain network, collection basin and relief point. A landing area or approach might be treated differently than the rest of the fairway, depending on how soil moisture affects playability," said Hurley. "In cases where we have only a foot or two of elevation change, we can create one 6' deep pumped elevation, and then replicate it with siphons all over the golf course."

With a drainage "master plan" in hand, a superintendent can converse intelligently with club officials, budget properly, and implement the plan over time with the knowledge that work done in one area won't adversely affect adjacent areas.

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Rules for Professional Attitude

Dr. Karl von Terzaghi

"The Father of Soil Mechanics"

(1883-1963)

1. Engineering is a noble sport which calls for good sportsmanship. Occasional blundering is part of the game. Let it be your ambition to be the first one to discover and announce your blunders. If somebody else gets ahead of you, take it with a smile and thank him for his interest. Once you begin to feel tempted to deny your blunders in the face of reasonable evidence you have ceased to be a good sport. You are already a crank or a grouch.
2. The worst habit you can possibly acquire is to become uncritical towards your own concepts and at the same time skeptical towards those of others. Once you arrive at that state you are in the grip of senility, regardless of your age.
3. When you commit one of your ideas to print, emphasize every controversial aspect of your thesis which you can perceive. Thus you win the respect of your readers and are kept aware of the possibilities for further improvement. A departure from this rule is the safest way to wreck your reputation and to paralyze your mental activities.
4. Very few people are either so dumb or so dishonest that you could not learn anything from them.

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