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resources for locating such a soil. Some blenders have a three-hopper blender that can mix sand, soil and peat in one process. Without this, the material swill have to be mixed twice, or it will be necessary to batch mix the sand and soil on the ground with end loaders and then run it through a blender to add the peat and thoroughly mix all three components. Extra blending means additional cost. Blending usually costs around $3 per ton of mix.

Sod should be carefully selected to promote stability in the first year and to avoid soggy surface conditions.

Field stability

Field stability is critical, especially for football. The dynamic relationship that occurs between a player's foot and the field is very complicated. There are an endless number of player variables including shoe/sole type, player skill level and weight and type of foot action. Field variables include things such as type of surface, grass species, soil type, moisture content and surface mat. Though work is in progress, there are currently no standards for stability in natural grass fields.

When sand is tested for athletic fields, the coefficient of uniformity (Cu) is typically reported. Cu is a dimensionless number that indicates the gradation of a sand. It has been suggested that optimum Cu values for athletic fields should be between 2.5 and 3.5. Lower Cu values indicate a narrow gradation—all the sand particles in the same approximate size range. Sands with low Cu values will not pack tightly, resist compaction and are less stable. Sands with higher Cu values are widely graded—indicating that many different sand sizes are present. Widely graded sands pack tighter and therefore are theoretically more stable. But a sand rootzone with a high Cu value will not automatically provide a stable surface.

In my opinion, the stability of a sand-based field is determined more by the type of sod and initial rooting and less by the Cu of the sand rootzone. In any case, maximizing the amount of silt and clay in the mix will increase compaction and Cu and promote better rooting. This all translates into a better chance of making a stable surface during the initial year of establishment.

Sod should be carefully selected to promote stability in the first year and to avoid soggy surface conditions. Some specifications call for sod that is grown on sand that meets the same USGA specifications as the rootzone mix. This

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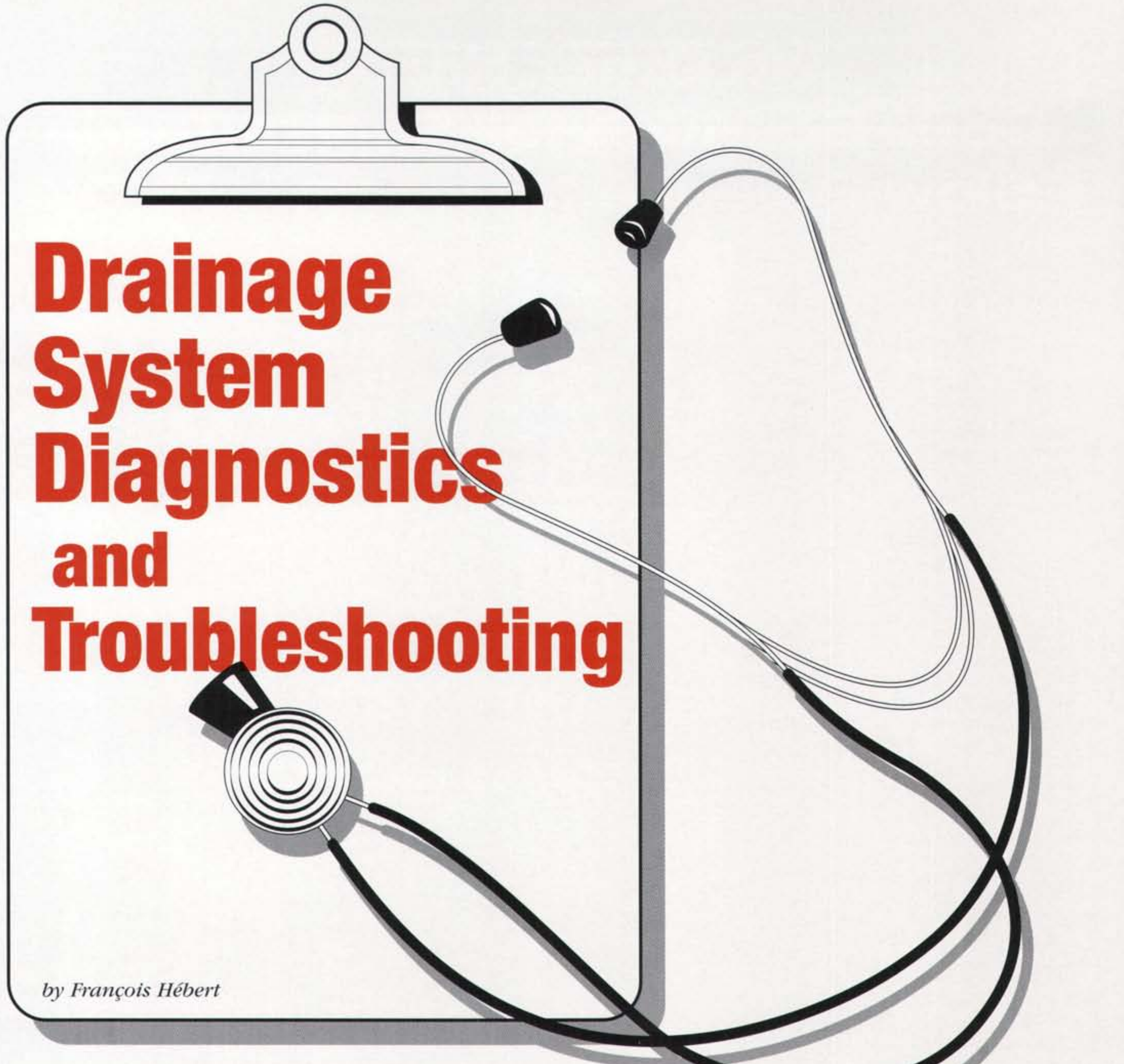
Drainage System Diagnostics and Troubleshooting



by François Hébert

Whether from a design standpoint or when we are faced with trying to diagnose and correct water related problems on an existing sports field, drainage should be considered as a complex and integrated process rather than as a mere assembly of pipes and mechanical systems.

Drainage performance is dependent on how a sports field was designed and constructed and the nature and quality of materials used. It's important to keep in mind that very seldom is a single factor the cause of the breakdown of a sports field's drainage performance. We will briefly browse over some of the physical factors involved in drainage system performance and attempt to illustrate some of the inter-relationships which should be explored when diagnosing drainage problems on a natural sports surface.

In order to understand a given drainage situation and formulate lasting corrective measures, it is critical to draw a comprehensive picture which also takes into account less tangible factors such as the intensity of use of the quality of maintenance, among others. These factors are just as instrumental in the long term in maintaining the quality of the playing surface and the integrity of it's drainage potential.

PHYSICAL FACTORS

One approach to diagnosing drainage system problems is to follow the paths the water will take when exiting a sports surface. Besides evaporation, it will do this by three main avenues

Over the surface as runoff;

Through the soil profile, and eventually;

Out of the profile and into an underground drain network.

Drainage problems will thus occur along one or a combination of these paths, and diagnosing the causes of a breakdown of drainage performance is best done by investigating each of these separately and then in combinations.

Surface Drainage

Surface drainage by runoff is the turf

manager's first line of defense in the fight against water-related damage. In many cases where sports fields are built with heavy native soils, runoff is often the only immediate means of drainage. If there isn't sufficient sloping of the surface, water will stand, saturating the soil and contributing to the deterioration of the turfgrass cover over time.

The wear, tear and pounding caused by player activity will inevitably lead to a modification of the fine grading of a playing surface. This results in low spots in which surface water collects. This is often compounded by the deeper compaction of the underlying soil profile. In this case, one easily perceived surface problem hides a more insidious soil related compaction problem. So, when correcting the former, the latter must be addressed.

Surface drainage problems are the most visible and easily diagnosed. The important thing to keep in mind is that they are often symptomatic of more hard to perceive soil-related problems.

Drainage by Percolation

The deterioration of a sports field drainage performance is most often due to a breakdown of the soil's inherent characteristics and properties.

Percolation is the vertical movement of water through the network of larger pores in the soil. When this pore network is obstructed, constricted or otherwise interrupted, percolation is inevitably affected.

Identifying soil type

Soil analysis should be the first step taken when drainage problems occur. A particle size distribution curve will tell you what type of soil you are faced with and what problems you can expect. This way, you can anticipate compaction problems and include preventive measures in your maintenance program. In new construction projects and cases where renovation work is contemplated, the soil analysis can help in formulating a soil amendment scheme which can greatly improve drainage performance.

Compaction

The pressure caused by player and maintenance equipment traffic compresses the soil mass, reducing the overall pore space and the individual pore sizes.

In more extreme instances, the soil's very structure can be destroyed and percolation breaks down dramatically. This often occurs in soccer goal mouths and other areas of concentrated traffic. But compaction also affects other less trafficked areas of sports fields. This process occurs over longer periods of time and is less easily detected, but is just as serious in the long term. These compacted areas will be identifiable by a change in the turfgrass texture, the presence of weeds in greater numbers and eventually standing surface water when the compaction has caused a great enough depression of the soil.

Stratification

Certain construction, maintenance and repair operations can induce a problem called stratification. Thin layers of soil can find themselves trapped in the root zone. These can be caused by topdressing, sod repairs or other operations where outside soil is laid on the surface. These layers accumulate over time. The problem they create is that they interrupt the downward flow of drainage water. Each layer encountered further slows down this flow.

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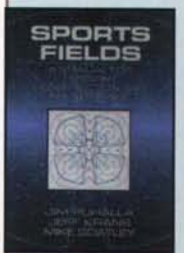

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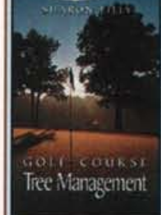

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The soil which becomes trapped in sod can have this very effect. It is important therefore to try to obtain sod grown in the coarsest material possible so that stratification isn't created at the very surface of the profile.

What is surprising and confusing when trying to understand a particular situation is that layers of coarse materials are just as disruptive as are layers of fine soils. They will cause a phenomenon called a "perched water table" which can cause the saturation of the soil profile with water. Furthermore, 1/8th of an inch of imbedded soil is enough to seriously affect drainage.

Stratification can be observed when soil cores are taken with a soil sampler. A hole dug with a square shovel will do as well. If horizontal lines can be seen in the profile when taking out the sample, this is a sure sign of stratification. Sometimes, the differences in color or texture can be very subtle.

Underground Drainage

A sports field's underground drainage network is often pointed to as the source of overall drainage problems. We see standing water on the surface and go to the system's outlet only to find little or no water pouring out. Immediately, the pipe network is held responsible. But an underground drainage system's effectiveness can be no greater than the extent to which water can reach it. A basic fact of underground drainage is that drainage pipes cannot pull water from the soil. If we chose to elaborate on soil-related problems before talking about drainage pipes, it is because the soil is a far more critical factor in drainage issues.

Depressed surface grading, destroyed soil structure and compaction: a classic example of integrated drainage problems. Photo courtesy: LANCO Amenagement Inc.

If drainage pipes have been laid correctly, with sufficient fall to ensure positive water movement toward the outlet, and there has been no heavy vehicle traffic over the pipes, the system's integrity can probably be assumed.

Of course, fine particles can migrate through the system and clog up the pipes. These should be flushed out periodically to maintain flow velocity. The use of geofabrics around the pipes or trenches as a filtering device to keep out fine particles is often held responsible for costly drainage breakdowns and many reject this practice completely. There exists on the market a myriad of different geofabric types, some designed for very specific applications, and while some are very suitable as filters to keep particles out of a system, others have the exact opposite effect and some actually repel water.

Factors to consider when looking at a drainage pipe network to diagnose

suspected problems are among others pipe depth, spacing, diameter (although in many instances there is so little water reaching the system that pipe sizing is not an issue), sloping, contamination with migrating soil particles, etc. Many of these issues are directly related to the system's design and not much can be done to correct them after construction. Clogged pipes can sometimes be flushed out with water to eliminate silting, but this won't solve the problem in the long run and it will then become a maintenance issue to keep pipes free of obstructions.

TROUBLESHOOTING AND CORRECTING DAINAGE PROBLEMS

Grading-related drainage problems can be avoided by ensuring regular maintenance in order to prevent deterioration of the surface. Frequent overseeding and sand topdressing should be integrated in the regular maintenance regimen as means to preserve grass cover and avoid slight depressions.

But topdressing cannot be counted upon for the quick fix of a pronounced low spot, even over large areas. This will have to be repaired by cutting out a patch which will then be topped off with an appropriate soil mix in order to correct the profile. The imported mix should be blended into the underlying soil to avoid stratification and alleviate compaction. This can then be seeded or sodded.

Some soils are by nature more prone to compaction than others. Because of their fine pore structure, heavy clay and slit soils hold water in rather than allowing it to flow through. In lighter sandy soils, larger sand particles lock together to preserve the pore structure, thus providing a better and longer lasting resistance to compaction. A particle size analysis can help define an appropriate soil amendment formula if you are contemplating building a new sports field or renovating an existing one and must work with the native soil in place.

Soil compaction can be controlled by proper maintenance practices. There is on the market a great variety of aeration and decompaction machines which can help check soil compaction. Typically, aeration machines will work at shallow depths and have limited decompaction action, but their repeated use can help keep the top of the soil profile looser, while helping to control thatch buildup and promoting better gas exchange between the roots and the surface.

Other machines are designed specifically for deep decompaction of a soil profile. Some of these machines are composed of tines which are pushed deep into the profile and then pulled out with a prying motion. This fractures the compacted soil, creating channels deep into the profile which will allow deep water and air movement. Over time, when this is done in conjunction with medium to coarse sand topdressing which is brushed into the openings created while decompacting, the very nature of the soil can be altered and improved and it's susceptibility to compaction reduced. This will also help the movement of surface water into the profile.

Correcting soil stratification can be tricky. The layers must be broken up in order to allow water to travel through. Sand topdressing combined with aeration and decompaction will help over time.

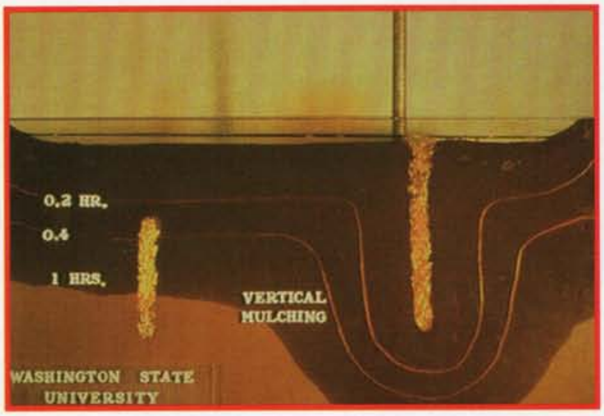
In cases where construction and renovation requires the use of soil extraneous to the site's, one very easy way to avoid stratification is to work the imported soil into the existing material. This eliminates the clean cut transition between layers which causes this type of problem.

When topdressing, fine soils should be avoided at all costs. If possible, a reliable supplier should be identified and the same material should be used every time, so that if there is a build-up of successive layers, the granular characteristics will be consistent.

SPORTSTURF DRAINAGE AND SPORTSTURF USE

Drainage problems plague a great number of sports installations situated in temperate climates. As illustrated here, there are no single or even simple solutions to these problems. And we didn't even discuss the less concrete factors such as the intensity or type of use these surfaces are subjected to.

As we mentioned, some sports fields built almost flat with heavy native soils have only evaporation as a means to evacuate surface water. Sand based constructions are meant to address the specific issue of drainage and a sports field's resistance to compaction. But this type of construction has come under scrutiny over the past years and there seems to be a trend towards a higher content of fine particles to increase surface stability and the soil's compatibility with the needs of turfgrass growth. But this inevitably affects drainage performance.



Aeration or decompaction done in conjunction with sand topdressing will help increase the drainage performance of a sports surface. Photo reproduced with the permission of Washington State University.

As the need for more and more sports field-hours increases dramatically, the drainage issue becomes increasingly pressing. Every month, new products and techniques are introduced, while time proven methods such as slit drainage resurface. So, as technology evolves, it will become important for the turf manager to gain a working understanding of the many processes involved so he or she can be self sufficient in solving the problems that arise.

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Common Sense Cultivation

by Dr. Tony Koski

Do you analyze why you perform certain turf management practices, how often you perform them and what you want to accomplish in performing them? Common sense cultivation requires careful consideration of each of these factors.

Cultivation procedures—coring, drilling, slicing, spiking, grooving, water injection—can be employed for any number of reasons. The reason for (and method of) cultivating should be determined on the basis of what problem one is trying to correct. Problems that may be corrected, at least in part, by well thought-out cultivation include:

- Surface compaction
- Subsurface compaction
- Subsurface layering
- Standing water
- Low infiltration/percolation rates
- Isolated dry spots
- Organic matter accumulation/thatch management
- Presence of high levels of soluble salts and/or sodium

Compacted and Layered Soils

Compaction reduces the rate of water infiltration and percolation and air movement within the root zone. But one must determine how deeply the compaction zone extends into the soil. To complicate things, layering can similarly impede water and air movement. To develop a successful cultivation strategy, it is essential to determine exactly where the problem lies.

Cup cutters, soil probes and shovels can be used to look for signs of root zone trouble. The careful extraction of an intact soil core or profile can reveal the presence of layers or compaction zones. Take a few cores and determine how deeply roots are penetrating. Rooting may stop at the interface between two different layers, and the layers may be visually apparent. Layers may be composed of soils of different textures, or may be due to accumulation of organic matter. They may have different colors, or may retain moisture differently.

Compaction is not as easy to visually detect from a core. Less compacted soil may separate or shear off of a plug or profile. Rooting depth may be very shallow, as roots will not grow where there is a lack of oxygen. Compaction doesn't always occur near the surface of the soil, as it most commonly does. Compaction deeper in the root zone may have occurred during construction, where soil was compacted but then only cultivated to a shallow depth prior to seeding or sodding. Deeper compaction may result from years of core cultivation (hollow- or solid-tine) to the same depth, developing a compaction layer just below the penetration depth of the tines.

Some soil testing labs that specialize in turf soils offer the testing of intact soil profiles. By close examination and testing of sample profiles they are able to suggest reasons for poor turf performance and recommend management tools for solving those soil problems.

Wet Soils

Constantly wet soil may be indicative of poor internal drainage, which could be caused by compaction or layering (which can perch a water table). Of course, heavy clay soils always may appear to hold water, even if they are not compacted or layered. Cultivation can relieve compaction and mitigate the effects of layering, but will not necessarily "fix" a heavy soil. Replacement of a "heavy"