DRAINAGE PRINCIPLES FOR ATHLETIC FIELDS

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It is rare to find an athletic field without some type of drainage problem. The reasons for the problem can vary. Soil structure may be unsuited for the continuous traffic that these areas are subjected to, surface and subsurface contours may have been improperly formed at the time of construction, there may be a thatch layer inhibiting water movement, or there may be a combination of these factors. Whatever the reasons, most athletic field managers count poor drainage as one of their biggest problems.

The subject of drainage carries with it its own set of terminology, and it be best to start with a discussion of these terms.

TEXTURE AND STRUCTURE

Soil **texture** refers to the size of particles within the soil media. Sands are the largest particles, silts are intermediate, and clays are the smallest. **Structure** refers to the arrangement of particles. Small particles can aggregate (join together) and form larger particles to give the soil a desirable **structure** that will allow water to readily infiltrate.

Whereas, texture is fixed (the ratios of sand, silt, and clay do not readily change unless the soil is artificially modified), structure is not. Structure of finer textured soils is very delicate. It can be destroyed with foot and vehicular traffic and once it is lost it is very difficult to regain. Many of the drainage problems associated with athletic fields are due to structural changes caused by heavy traffic.

SATURATED, FIELD CAPACITY, AND WILTING POINT

Other terms associated with the principles of drainage deal with the water status of the soil. A **saturated** soil is one in which the pore spaces between particles are filled with water. Soils with poor drainage will often become saturated after a rain or following irrigation because excess water is prohibited from readily leaving the soil. This is a very undesirable condition for plant growth. Plants, of course, require moisture, but they also require oxygen in the root zone. If all pore spaces are filled with water, the plant may be starved for oxygen and it can actually wilt, even though its roots are surrounded by moisture.

Field capacity represents a condition where the adhesive forces that hold water to soil particles balance with the gravitational forces that pull that water into the underlying soil. This represents an ideal condition for plant growth, where both water and oxygen are available in proper amounts. One of the goals in establishing good subsurface drainage is to remove excess water and allow the soil to reach field capacity within a reasonable time after water is applied.

The **wilting point** of a soil is the moisture content at which the roots can no longer pull moisture away from soil particles. It is a very dry condition at which plants can no longer grow. The water available for plant growth is that found between the **field capacity** and the **wilting point**. The plant available water varies with soil texture and structure and the goal in designing artificial rooting media for turfgrass areas is to maximize this plant available water without developing a soil that will readily compact and lose its structure. Developing these mixtures requires very detailed soil physical tests and proper interpretation of the results. Professional help should always be used in developing mixtures of this type.

SLOPE AND GRADE

Two terms that are often associated with construction operations are **slope** and **grade. Slope** is defined as the number of feet of vertical fall in a 100 foot horizontal distance. It is expressed as a percent (%) and can be calculated as follows:

$$\%\ \text{slope} = \frac{\text{ft. vertical drop}}{\text{ft. linear distance}} \times 100$$

Example:

12 ft. of vertical drop

300 ft. of linear distance

$$\%\ \text{slope} = \frac{12\ \text{ft.}}{300\ \text{ft.}} \times 100$$

$$= 4\%\ \text{slope}$$

This tells us that there is an average of 4 ft. of vertical drop in every 100 ft. of linear distance. **Grade** is a term used by contractors to describe the slope in a single direction. Once the desired slope is determined, wooden stakes (grade stakes) are placed on the site to serve as guides in establishing the proper contours.

Poor drainage can result in a number of plant stress related problems for athletic field managers (Table 1).

Table 1. Problems caused by poor drainage on athletic fields and other turfgrass areas.

-- reduced rooting
-- changes in microbial populations
-- increased disease infestation
-- frost heaving
-- compaction
-- delay in use
-- excess water loss due to run-off

Saturated soils resulting from poor drainage will restrict rooting, shift the microbial balance in soil, and generally increase stress levels on the turf. This can increase disease infestation and other stress related problems. Excessively wet athletic fields are more prone to compaction, which will eventually lead to decreased water use efficiency through run-off and evaporation. Poor drainage can also delay use due to standing water on playing surfaces.

Strategies to improve drainage must take into account both surface and sub-surface drainage. Most of those who consider improving drainage generally think of sub-surface drainage, such as the use of tile. But surface drainage is just as important if not more important. If surface contours result in standing water, it is unlikely that even the best sub-surface drainage system will eliminate the problem. A slope of at least 1 - 2% should be established on turfgrass areas with grades established to drain the water off-site. Slopes on athletic fields vary with the requirement of the game to be played on the area, but whatever the game to be played, surface drainage should be carefully planned before construction begins.

On areas where subgrades are to be established and tope soil placed on the site, be sure the contours of the subgrade conform to the contours of the surface. Mistakes are often made in disregarding subgrades in the belief that good surface drainage will solve all problems. Depressions in the subgrade, however, will likely result in wet areas on the surface.

The improvement of subsurface drainage is generally achieved by using drain tile. The proper design of these systems is quite complex and should be left to an engineer, but there are some general principles that can be dealt with here:

1. Drain tile in turf areas should generally be placed between 1.0 to 4.0 ft. deep.[1]
2. Drain tile should generally be placed deeper in sandy soils, and shallower in heavy soil (In athletic fields, the depths of 1 ft. are commonly used).
3. The spacing between drainage lines will vary with soil texture. Lines in sandy soils can be more widely spaced (100 - 200 ft.) and lines in clay soils are placed closer together (40 - 60 ft. apart).

The sizing of drain lines and the slope at which they are set are governed by very specific engineering principles. There are **'Design Charts'** available to determine these criteria such as those published by Jarrett[1] for golf course areas. These charts combine information on the size of the area and the infiltration rate of the soil to determine pipe size and slope. Again, someone familiar with their use should be contacted before a plan for a storage drainage system is begun.

Where the budget allows, the entire athletic field can be constructed of a coarser textured (sandy) soil media that resists compaction and maintains proper drainage. This is often done on fields that are likely to receive excessively high traffic. The most extensive example of this type of modification is the Prescription Athletic Turf (PAT) athletic field where the entire field is constructed of sand resting on a plastic barrier. These fields have been tested successfully in a number of locations and seem to be growing in popularity with athletic field managers.

It is often said that drainage systems take on the characteristics of the slowest draining portion of the soil profile. Even the best sub-surface tile system can not overcome problems caused by surface compaction or by a thatch layer that inhibits infiltration. Management plays an important role in assuring that Athletic fields drain properly. Core aerification on a regular basis can be just as important as any of the design related matters that have been discussed. The use of proper cultural techniques to prevent thatch build-up would also be helpful. The best way to assure a well drained athletic complex is to combine a well designed facility with a properly trained turfgrass manager who knows how to care for it.

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1 Golf Course and Grounds Irrigation and Drainage. A. R. Jarrett. 1985. Reston Publishing Company, Reston, VA.

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