Surveying Basics

by Jim Puhalla

Sports field managers generally consider surveying to be something that's best left to specialists, but surveying is an important tool in our work. A basic knowledge of the tools and processes of surveying helps sports turf professionals make good decisions about field design performance, renovation, and even maintenance.

Field managers need to know how to use simple surveying equipment to perform such tasks as fixing wet spots, surface leveling, and installing drainage systems. To a degree, visual observations can help solve these problems, but it's a mistake to rely on your first look.

We recently visited a baseball diamond with a bad muddy area along the third-base line. After taking a look at the problem, the staff had scooped out a trench from the mud spot to the edge of the field.

Water *did* flow steadily through the trench, but unfortunately it flowed onto the field, not away from it. Because they didn't understand the field's contours, the staff actually dug a canal to conduct water *onto* the field. A simple knowledge of surveying would have prevented this mistake.

Every sports turf professional should have a basic knowledge of the tools and processes of surveying. *Courtesy: Jim Puhalla*

In fact, drainage problems on skinned areas are impossible to solve unless you understand field contours, and that requires a simple understanding of surveying principles. This holds true for installed drain systems, too. They work right only if they have a consistent downward slope. Simple surveying lets you solve problems like these without guesswork.

Practical considerations

When surface drainage problems occur, you can use surveying equipment to check the contours of the

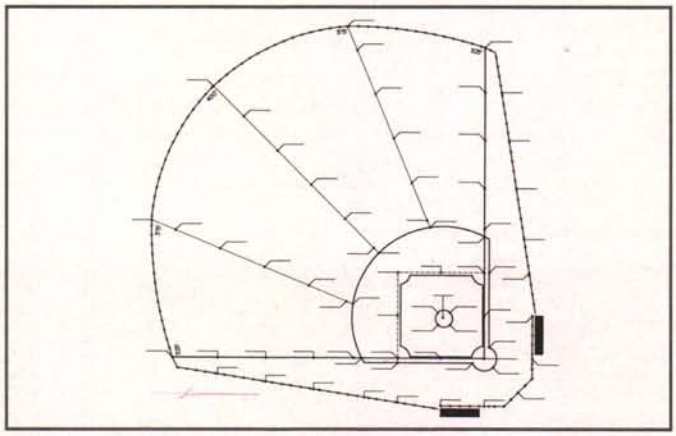
field. Take readings at several points around the wet area and in a larger ring around the first set of points. You may also need to survey part of an out-of-bounds area, since water sometimes flows onto the field from there.

When surveying an entire field, it's tempting to lay out a grid pattern (commonly on 50-ft. centers). This is a simple approach, but it doesn't work. The gridlines seldom fall at the actual points where elevation changes.

Instead, check center lines, end lines, side lines, and critical areas like the skinned area of a baseball diamond; grid patterns will miss these points. Out-of-bounds areas, fences, and other structures also need to be checked; grid patterns will miss these points, too.

Use a survey worksheet that shows the points at which you want to take readings (see **Figure 1**). Write existing elevations on top of each line, and if changes are to be made, write proposed elevations underneath.

Figure 1. Survey worksheet for a baseball diamond



Basic equipment

Basic sports field surveying equipment includes levels and transits. You'll also need an elevation rod for grades and a long tape measure.

Combined with an elevation rod, a level helps you measure differences in grades. A simple builder's level is least expensive. It costs about $250.00 to $500.00, including tripod and elevation rod.

Unless your level is perfectly calibrated, there's a good chance that when the scope is turned 180°, it will fall slightly out of level. It's best to place the instrument at a point on the field where a 90° turn of the scope is all that's needed to measure all elevations.

Figure 2. Builder's level

Automatic levels provide another good choice for surveying sports fields. This type of instrument automatically re-levels itself when it's turned to any angle. Automatic levels are more accurate than builder's levels, and they don't cost that much more (typically $500.00 to $1,500.00, with tripod and elevation rod).

Figure 3. Automatic level

Both the builder's level and the automatic level require two people to perform elevation readings. One person looks through the scope and one holds the rod. Laser levels, on the other hand, can be operated by a single user.

These instruments shoot an invisible beam at a rod with a level eye. When moving around the site, the level eye can be moved up or down the rod until an audible tone becomes constant.

There's also a more expensive laser level that can be digitally adjusted to a constant percentage of slope. These instruments are great for building fields or installing drain pipes that require a percentage of slope with no deviation in grade. Costs start at about $5,000.

Transit

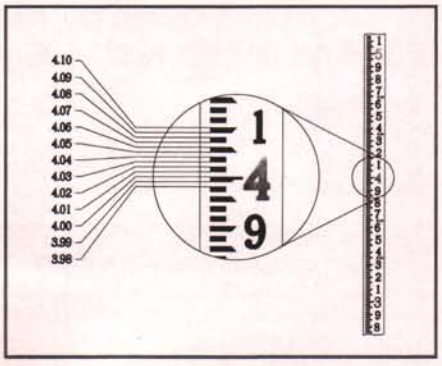
A transit sets straight lines, it sets precise angles for field boundaries, and it establishes precise slope, as for an installed drain system. Tape measures determine distances between field boundaries, the length of an installed drain line allows you to calculate the amount of fall in that distance, and so on.

A transit can also be used as a level if you can't afford an automatic level or laser level. However, transits are most commonly used to lay out fields, and are less valuable for use in diagnosing contour problems on existing fields.

Elevation rods

Elevation rods compare one elevation to another to help calculate the percentage of slope. Rods can be calibrated in either feet and inches or in feet and tenths. Using feet and tenths is easier, since it involves less calculation. With elevation rods

Figure 4. Elevation rod in feet and tenths



that use feet and inches, all readings have to be converted to feet and tenths to figure percentage slope.

Figure 4 illustrates a reading of a rod that's marked in feet and tenths. The right-hand column shows the rod's calibration, the center shows a magnified section of the rod, and the left-hand column shows how to read the rod in tenths and hundredths of a foot.

Figure 5 shows how inches compare to tenths of a foot. To convert inches into tenths, divide the number of inches by 12. To convert tenths into inches, multiply the number of tenths by 12. Although the result will be in inches, it will include decimal parts of an inch, rather than the more commonly used fractions such as 1/8 inch or 1/16 inch.

Figure 5. Comparing inches to tenths

Inches	Tenths
1	0.08
2	0.17
3	0.25
4	0.33
5	0.42
6	0.50
7	0.58
8	0.67
9	0.75
10	0.83
11	0.92

It's important to remember that rod readings are comparative values. One rod reading means nothing, but by comparing two or more readings, you can determine whether one point is higher than another.

The difference between two readings represents the amount of change in grade from one elevation to another. Remember, as the land goes down, the rod gets lower and the number gets higher. A lower reading means that the grade is higher, and vice versa.

Rod readings allow you to calculate spot elevations, which set specifications for field elevations in construction or reconstruction projects. Elevations often represent distance above sea-level. Like rod readings, elevations mean nothing unless they are compared to one another.

Spot elevations require much more mathematical computation than rod readings, which are literally read off the rod. Also unlike rod readings, lower numbers represent lower points on the field in elevation readings.

For sports fields, the most useful comparison between two elevations is the percent by which they differ. To derive this figure, take the difference between the two elevations and divide by the distance between them.

The percent slope for hard surfaces, such as skinned areas of baseball fields and clay tennis courts, should range between 0.25 percent and 1.0 percent. Grass areas should slope between 0.5 percent and 1.75 percent.

Performing a survey

When starting to survey a field, establish a benchmark so that all of your elevation measurements will be

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consistent. This fixed reference point can be anything from a catch basin lid to a curb, or any other stationary structure. Once a benchmark has been established, the surveying instrument can be moved to another location, and it can be removed and reset on another day.

Assign an elevation to the benchmark. Set up and level your instrument somewhere near the center of the area to be surveyed and place the elevation rod on the benchmark. Take a reading and add the result to the benchmark. The sum of the two figures represents the height of the instrument (HI). Subtract each subsequent rod reading from the HI to obtain the elevation at each point.

Figure 6. Establishing an elevation from a benchmark

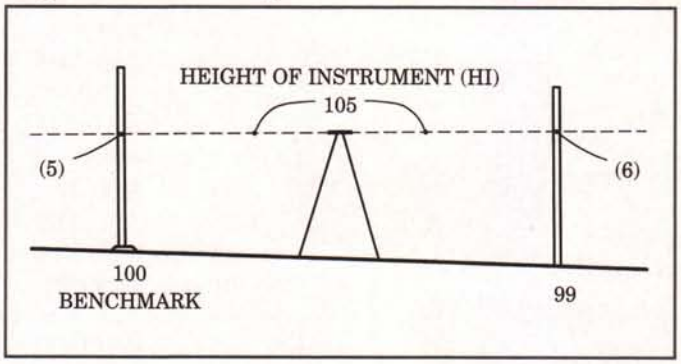

Figure 6 provides an example. The benchmark is 100. If the measurement at the benchmark reads five feet, the HI is 105. If the first point to be surveyed measures six feet, subtract that reading from the HI to yield it's elevation: (105 - 6 = 99). The elevation at that point is one foot lower than the benchmark.

Each day of surveying, and whenever the instrument is moved, you must find the HI for that instrument location. Continue subtracting readings from the HI to yield elevations at each point on the field.

Obviously, surveying is a complicated field with many considerations and nuances. However, using the simplest pieces of surveying equipment and the basic techniques described here, sports field managers can help identify and fix many of the drainage and contouring problems that occur on typical fields. ❑

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