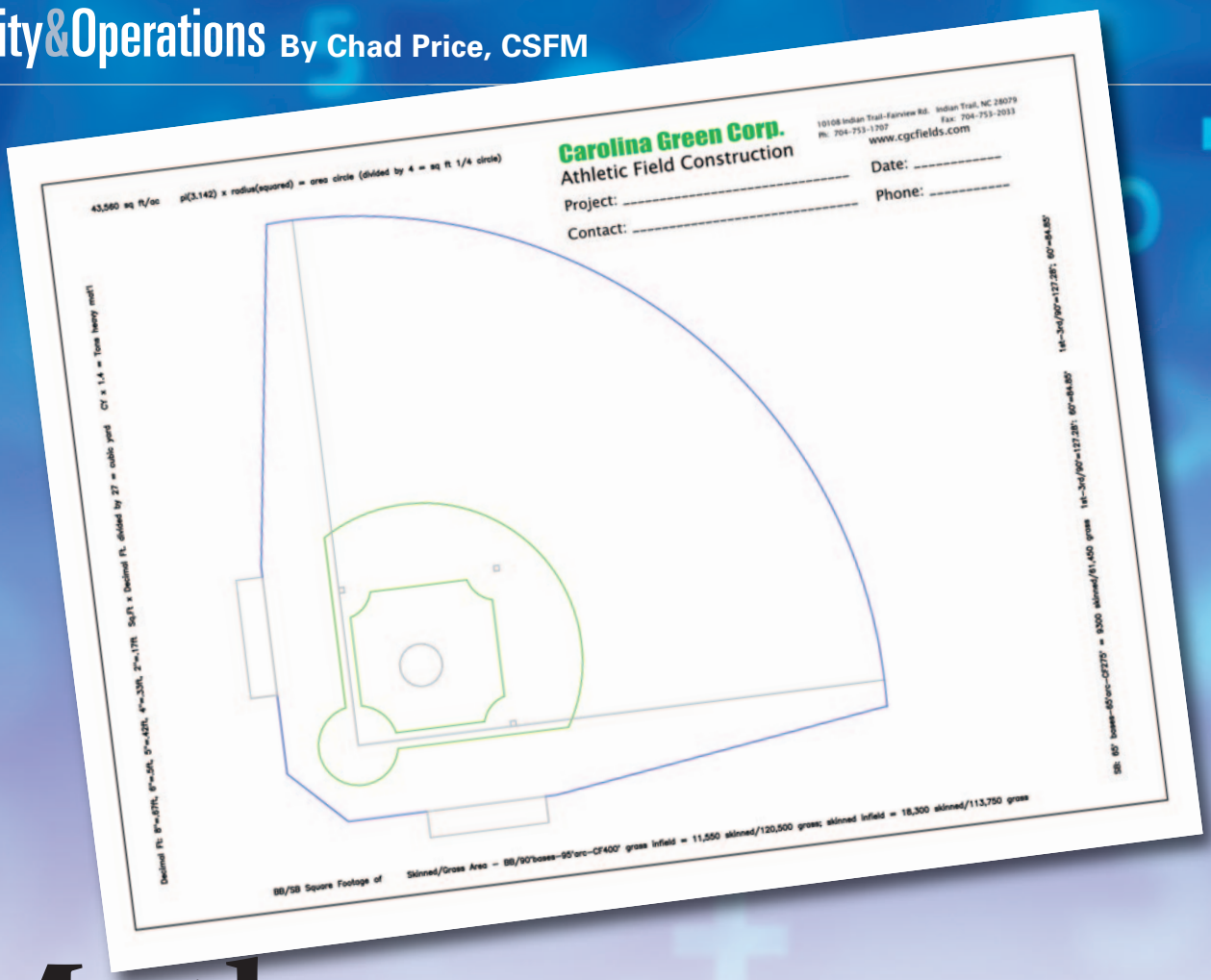


Math 101 for Sports Turf Managers

ARE YOU SMARTER THAN A 7th GRADER?

Oh how I remember struggling through 7th grade math and complaining to my mom, "I will never use this stuff."

"Wait and see, one day you will," she said. By the way, 7th grade was when I realized there were people in this world smarter than me, many people in fact. I did not know what career I wanted to pursue back then, but I was sure it would be outside and far from a desk job requiring math skills.

Mom was right, I realized years later when a co-worker and I were repeatedly having difficulty estimating odd-shaped areas on plans. We knew there were formulas for these basic calculations, but they were lost in the past. This was before the Internet and before we had AutoCAD, so we resorted to desperate measures—we asked his 9th grade daughter for help.

She quickly realized we did not have a clue, and provided us with a cheat sheet of all types of geometry formulas, which still to this day is hanging on the office wall. In fact, we have included these formulas in memo pads our people use daily in the field.

Writing this article really made me realize how often I use math in sports fieldwork. Whether it is estimating and bidding a job, building a job, applying maintenance products, or completing job reports, there are basic recurring formulas and exercises I use daily and wish to share. You can download my cheat sheet at our website, www.cgcfields.com. Take it, use it, add to it, and make it your own.

Basically, there are three types of calculations that get it done for me: DISTANCE, AREA and VOLUME.

Distance

Most distance calculations we use involve right triangles or 90-degree corners such as the right angle at home plate or the corner of a soccer field. The most common distance calculation we use in the field is to determine the distance from first base to third base. It is easy to remember one distance, say for 90-foot bases, but when you have 45', 60', 65' bases and so on, you need a formula. That formula ($c^2 = a^2 + b^2$) for a right triangle. "c" is the hypotenuse, or the long

Math background courtesy of istockphoto.com.

side of the triangle, and "a" and "b" are the distance of each side forming the right angle. For example:

90' base path; ("a" and "b" are both 90, and 90 squared is 8100); squaring in math is multiplying any number times (x) itself, $90^2 = 90 \times 90$. The hypotenuse is "c" or the distance from first to third (or home to second)

$c^2 = a^2 + b^2$ or $c^2 = 8100 + 8100$ or $c = \sqrt{16{,}200}$ or $c = 127.27$ feet.

Distance from first to third base is 127.27 feet. You need a calculator with a square root key (√). It also helps to have a tape measure with feet measured in tenths so you do not have to convert .28 feet into inches. You can get these at most home and hardware stores. They usually have feet in inches on one side and feet in tenths on the other.

Just this summer, Bob Campbell, past president of STMA, sports turf manager at University of Tennessee, and former high school math teacher, laid on me an even more simple equation to solve the same problem. In a right triangle where both sides are equal, such as base paths on an infield, the hypotenuse is equal to $d\sqrt{2}$. For example:

"d" is distance of base path (90 feet) and $\sqrt{2} = 1.414$

Therefore, using the equation $d\sqrt{2}$ for the hypotenuse is: 90' x 1.414 = 127.26 feet from first to third.

This is an easy method since all you have to remember is 1.414, and know your distance of base path. You do not have to have your calculator to figure square root, you can just scratch it out in the dirt as long as you can remember 1.414.

One final right triangle method we often use when laying out a field is a 3/4/5 triangle. We use this to simply create a right angle, a true 90 degree corner. "3" is one side, "4" is the other, and "5" is the hypotenuse. You can measure it in feet, inches, or whatever, as long as you have a 3 and a 4 on each side, and a 5 on the hypotenuse. We commonly use 30 feet, 40 feet, and 50 feet to help in accuracy. If you get three pins in place at those distances, then you know you have a square corner, and can lay off a field from there.

Area

In determining area in sports fields, we are typically dealing with rectangles, circles, and triangles. The rectangles are easy, just length times width equals square feet. A football field would be 160' x 360' or 57,600 SF.

Area of a circle is often used to calculate odd shaped fields like baseball and softball. The fair territory area of a field can be calculated using the area of a circle formula, ($A=\pi r^2$), then dividing by 4,

because baseball and softball fields are essentially ¼ of a circle. The radius is the distance from home plate to the fence. You have to calculate foul territory separately, usually using rectangle and triangle calculations depending on the shape, and add to the total. For example:

Distance from home plate to fence is 320' (radius = 320), radius squared (r^2 = 320' x 320') = 102,400

Pi or ∏ = 3.142 Area of circle = ∏ r^2 or
3.142 x 102,400 = 322,048 SF

The fair territory of the baseball field is ¼ of this big circle area so 322,048 divided by 4 = 80,512 SF (square feet).

Add the remaining apron and foul territory using rectangle or triangle calculations, depending on the layout. Triangle calculations work well for foul territory areas where the foul line dies into the corner. The triangle area calculation is ½(height x base), or half of a rectangle. For example:

Base is 30' and height is 120', so:
30' x 120' ÷ 2 = 1800 SF

These calculations for baseball and softball are not exact, but are usually very close. Another way is to break up the field into smaller parts, rectangles and triangles, and compare the totals to get an average. When calculating turf area, I will calculate total area first, then calculate and deduct skinned and non-turf areas to get total square footage for turf.

To calculate the total square footage inside a track, calculate the "D" rings as a circle, and the straight run of the track as a rectangle. For example:

Straight run of track = 300'
Width of field track to track = 240'
Rectangle area is 240 x 300 = 72,000 SF

Radius of D ring = 120'
Area of D ring is ∏r^2 or A = 3.142 x 120^2
or 3.142 x 14,400 = 45,245 SF

Total Area inside track is: 45,245 + 72,000 = 117,245 SF.

Volume

Say you want to know how much infield mix you need to add 2 inches depth over your 9000 square feet of skinned area. This is a typical volume calculation, and sounds easy enough, but there are some stumbling blocks. The first one is dealing in inches. The first I do in any volume calculation is convert inches to tenths of a foot, or to a decimal. Simply divide 1 by 12 to convert 1" to .083 feet and so on for the other inches up to 11. The conversion table is as follows:

1" = .08'	4" = .33'	7" = .58'	10" = .83'
2" = .17'	5" = .42'	8" = .66'	11" = .92'
3" = .25'	6" = .5'	9" = .75'	

We now know that 2 inches equals .17 feet, so the equation becomes:

9000 SF x .17' = 1530 cubic feet
27 cubic feet = 1 cubic yard
1530 cf ÷ 27 cf/cyd = 56.6 cy material required.

If your supplier delivers in cubic yards, then you are good to go. If they deliver in tons, then you need to convert from cubic yards to tons. All materials are different depending on moisture content and bulk density, but a good standard conversion is 1.4, that is 1 cubic yard equals 1.4 tons. This works very well for sand and stone, and for most infield mixes. Some infield and warning track materials are lighter per volume and have more of a 1/1 or 1/1.2 ratio. Experience will tell, but using 1.4 is always the sure thing.

So converting 56.6 cy to tons would be:
56.6 cy x 1.4 = 79.2 tons material required.

Another common sports field volume calculation is topdressing. Say you want to topdress ¼ inch of sand over your 80,000 SF soccer field. How much material is required?

Cheat Sheet

Inches to Decimal Feet Conversions

1" = 0.0833'	4" = 0.3333'	7" = 0.5833'	10" = 0.8333'
2" = 0.1667'	5" = 0.4167'	8" = 0.6667'	11"= 0.9167'
3" = 0.2500'	6" = 0.5000'	9" = 0.7500'	12" = 1.0000'

Calculating Area of a Circle

Pi (3.142) x r2 (radius squared) = sf area
EXAMPLE: 18' Diameter Circle
3.142 (pi) x 81 (9x9=81, radius is equal to ½ of diameter) = 255 square feet

Hypotenuse of a Right Triangle

To find the hypotenuse of a right triangle, the square root of the sum of the squares of the shorter legs must be used. This is the formula used to find the value of c.
$c^2 = a^2 + b^2$ Find the value of "c" when a = 90 and b=90
$c^2 = a^2 + b^2$ $c^2 = 8100 + 8100$ $c = \sqrt{16,200}$ $c = 127.27$
or the quick method where both sides are equal, such as base paths on an infield; d√2.
"d" is distance of base path (90 ft) and √2 = 1.414 90'x 1.414 = 127.26 feet

Calculating Volume

To determine the amount of material needed for your application, use the following formula and add any required compaction factor necessary:

$$\frac{\text{Area (sq ft)} \times \text{Depth of Material Needed (ft)}}{\text{27 cubic feet per cubic yard}} = \text{Cubic Yards}$$

EXAMPLE: $\frac{(90{,}000 \text{ sq ft} \times 0.6667' \text{ ft})}{\text{27 cu ft}} = 2{,}222 \text{ cy} + \text{compaction factor}$

The sooner we stop dealing in inches the better. We need to convert ¼" to a decimal. We know from the table above that 1" equals .08', and we know ¼ equals .25, so we convert as follows:

.08' x .25 = .02' or ¼" = .02'

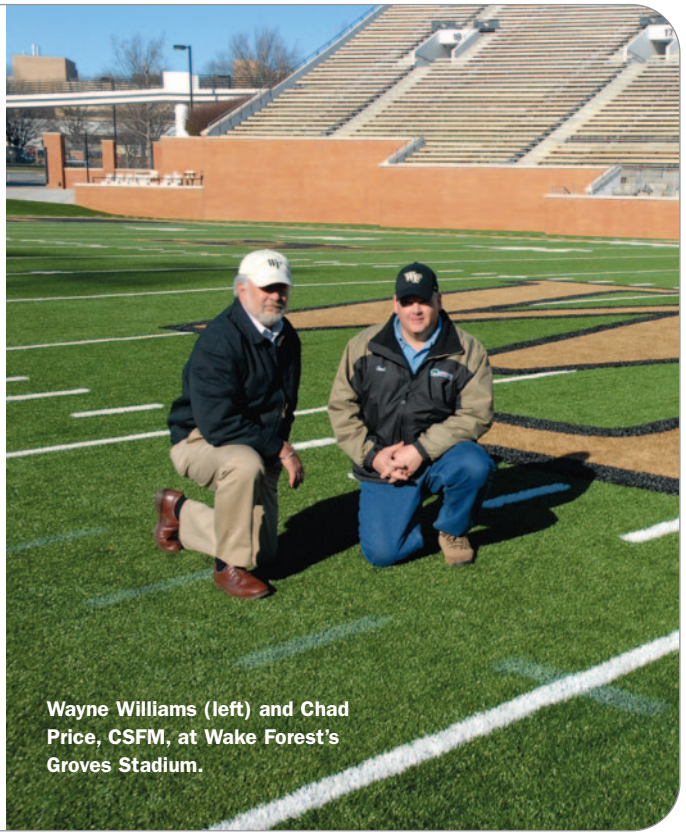
From there: .02' x 80,000 SF = 1600 cubic feet
(27 cubic feet per cubic yard)
1600 cf ÷ 27 cf/cyd = 59.26 cy
59.26 cy x 1.4 cy/ton = 83 tons sand required for ¼" topdress.

The process to remember in volume calculations is: inches to feet (decimal), feet to cubic feet, cubic feet to cubic yards, and cubic yards to tons.

These are the most basic exercises, but also the most common we face as sports turf managers. In the world of shrinking budgets and rising costs, having the correct calculation on quantities is critical.

I am now faced with my greatest challenge, helping my 7th grader get through math. He complains every night, claiming he will never use this stuff. He too is in for a revelation. ■

Chad Price, CSFM, owns Carolina Green Corp., a sports field contractor in Indian Trail, NC.



Wayne Williams (left) and Chad Price, CSFM, at Wake Forest's Groves Stadium.