

Turfgrass calibration and math workshop

Nebraska Turf Conference 2020

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Unit Conversions

Measures of length

Common units

Inch (in, “), Foot (ft, ‘), Yard (yd), Centimeter (cm), Meter (m), Mile

Conversions

1 ft = 12 in	1 in = 0.083 ft
1 yd = 3 ft	1 ft = 0.333 yd
1 m = 100 cm	1 cm = 0.01 m
1 in = 2.54 cm	1 cm = 0.394 in
1 mile = 5,280 ft	

Area measurements

Common units

Square Inches (sq. in; in²), Square Feet (sq. ft; ft²), 1,000 sq ft (M), Acre (A), Square Centimeters (cm²), Square Meters (m²), Square Yards (sq. yd; yd²), Hectare (H)

Conversions

1 ft ² = 144 in ²	1 in ² = 0.007 ft ²
1 yd ² = 9 ft ²	1 ft ² = 0.111 yd ²
1 yd ² = 1,296 in ²	1 in ² = 0.0008 yd ²
1 A = 0.405 H	1 H = 2.47 A
1 A = 43,560 ft ²	

Weight measurements - force of gravity on an object

Common units

Grams (g), Milligram (mg), Pounds (lb; #), Kilograms (kg), Ounce (oz), Ton (t, T)

Conversions

1 g = 0.0353 oz	1 oz = 28.35 g
1 g = 1,000 mg	1 kg = 1,000 g
1 kg = 2.2 lb	1 lb = 0.45 kg
1 lb = 16 oz	1 lb = 454 g
1 t = 2,000 lb	

Volume measurements

Common units

Cubic Inches (cu. in; in³), Cubic Feet (cu. ft; ft³), Cubic Yards (cu. yd; yd³), Fluid Ounce (fl. oz.), Quart (qt), Pint (pt), Gallons (g; gal), Cubic Centimeters (cu. cm; cm³), Cubic Meters (cu. m; m³), Liters (L)

Conversions

$$1 \text{ gal} = 0.1337 \text{ ft}^3$$

$$1 \text{ gal} = 3.785 \text{ L}$$

$$1 \text{ ft}^3 = 28.317 \text{ L}$$

$$1 \text{ ft}^3 = 1,728 \text{ in}^3$$

$$1 \text{ yd}^3 = 27 \text{ ft}^3$$

$$1 \text{ g} = 128 \text{ fl. oz}$$

$$1 \text{ g} = 4 \text{ qt}$$

$$1 \text{ qt} = 2 \text{ pt}$$

$$1 \text{ ft}^3 = 7.481 \text{ gal}$$

$$1 \text{ L} = 0.264 \text{ gal}$$

$$1 \text{ L} = 0.0353 \text{ ft}^3$$

$$1 \text{ in}^3 = 0.0006 \text{ ft}^3$$

$$1 \text{ fl. oz} = 0.0296 \text{ L}$$

$$1 \text{ fl. oz} = 0.0078 \text{ g}$$

$$1 \text{ qt} = 0.25 \text{ gal}$$

$$1 \text{ pt} = 0.5 \text{ qt}$$

Examples

Suppose you want to convert 2.5 gal to liters. There are essentially three methods to solve this problem.

1. Cross multiply and divide

$$\frac{X \text{ L}}{2.5 \text{ gal}} = \frac{1 \text{ L}}{0.264 \text{ gal}}$$

$$\frac{X \text{ L} * 2.5 \text{ gal}}{2.5 \text{ gal}} = \frac{1 \text{ L} * 2.5 \text{ gal}}{0.264 \text{ gal}}$$

X=9.47 liters

2. The line method

$$\frac{3.785 \text{ L}}{1 \text{ gal}} \times \frac{2.5 \text{ gal}}{\text{app}} = \frac{\text{L}}{\text{app}}$$

Note: multiply across the top and divide by each number in the denominator.

$$\frac{3.785 \text{ L}}{1 \text{ gal}} \times \frac{2.5 \text{ gal}}{\text{app}} = \frac{9.46 \text{ L}}{\text{app}}$$

3. Use technology

The screenshot shows a Google search interface. The search bar contains the text "convert 2.5 gallons to liters". Below the search bar, there are links for "All", "Shopping", "News", "Images", "Videos", "More", "Settings", and "Tools". The search results show "About 257,000 results (0.40 seconds)". A unit converter widget is displayed, showing "Volume" as the category. The input field shows "2.5" and the unit "US liquid gallon". The output field shows "9.46353" and the unit "Liter". Below the widget, there is a "Formula" section with the text "for an approximate result, multiply the volume value by 3.785".

Suppose you want to convert 1.2 t to kg. Start by gathering the needed information.

1. Cross multiply and divide

$$\frac{X \text{ kg}}{1.2 \text{ ton}} = \frac{2,000 \#}{1 \text{ ton}}$$

$$X \text{ kg} = 2,400 \#$$

$$\frac{X \text{ kg}}{2400 \#} = \frac{0.45 \text{ kg}}{1 \#}$$

$$X = 1,080$$

2. Using the line method

0.45 kg	2000 #	1.2 t	=	kg
1 #	1 t	app		app

Note: multiply across the top and divide by each number in the denominator.

0.45 kg	2000 #	1.2 t	=	1,080 kg
1 #	1 t	app		app

3. Using Google

convert 1.2 tons to kilograms

All
 Shopping
 News
 Images
 Videos
 More
Settings
Tools

About 17,700,000 results (0.44 seconds)

Mass

1.2

=

1088.62

US ton

Kilogram

Formula for an approximate result, multiply the mass value by 907

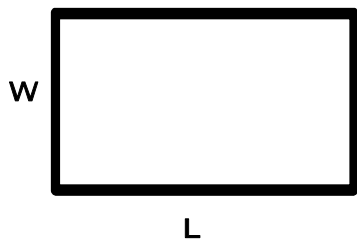
Calculating areas

Regular shape method

With this method, the turf site of interest is subdivided into the best possible fit of rectangles, trapezoids, triangles, circles, or ovals. The area of each figure is determined and added together. Before proceeding with this method, a brief review of calculating the area of geometric figures is provided.

Area of a rectangle

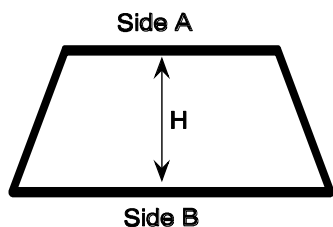
A rectangle is a four-sided figure in which the opposite sides are parallel and with four right angles. The area of a rectangle is calculated by multiplying the length (L) by the width (W).



$$\text{Area} = \text{length} \times \text{width}$$

Area of a trapezoid

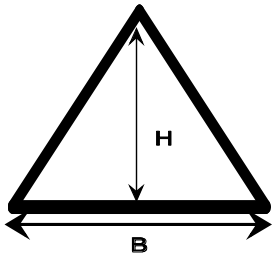
A trapezoid is a four-sided figure in which only two of the sides are parallel. The area of a trapezoid is found by averaging the length of the two parallel sides and multiplying by the height (H).



$$\text{Area} = \frac{A+B}{2} \times H$$

Area of a triangle

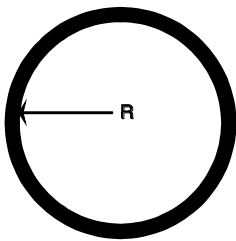
A triangle is a three-sided figure. The area of a triangle is the base (B) multiplied by the height (H), divided by two.



$$\text{Area} = 0.5 \times \text{base} \times \text{height}$$

Area of a circle

A circle is a closed figure in which every point on the curve is an equal distance from the center of the circle. The area of a circle is the radius squared (r^2) multiplied by 3.14 (pi). The radius is one-half the diameter of the circle.

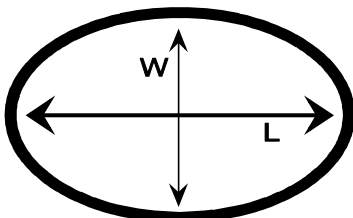


$$\text{Area} = \pi \times \text{radius}^2$$

$$\text{Area} = 3.142 \times \text{radius} \times \text{radius}$$

Area of an oval

An oval is a closed figure in which every point on the curve is not an equal distance from the center. A racing track and egg have an oval shape. The area of an oval is Pi multiplied by the length (L) multiplied by the width (W), divided by 2.

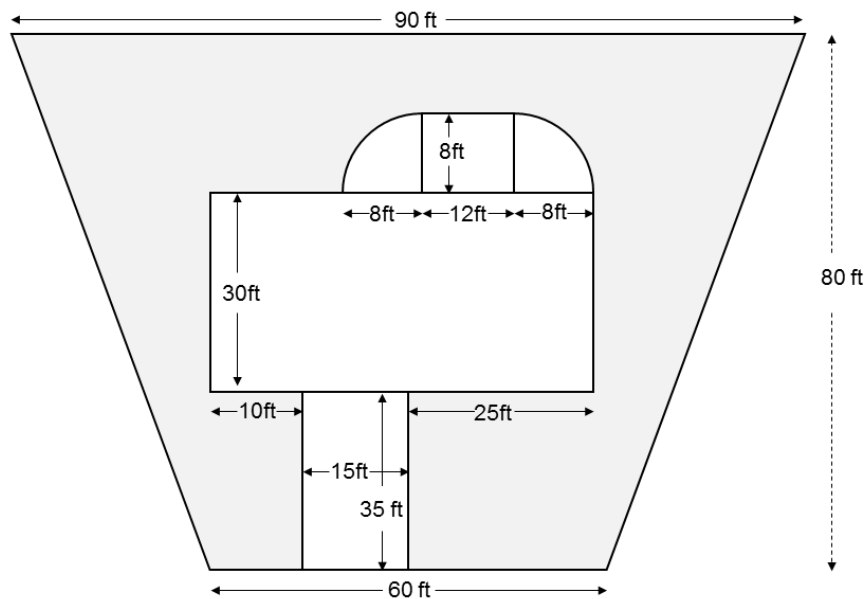


$$\text{Area} = \pi \times \text{width} \times \text{length} \times 0.5$$

Using regular shapes to determine an area

1. Use the following steps to determine the area of a turfgrass stand using geometric figures:
 1. Subdivide the area into the best possible fit of rectangles, trapezoids, triangles, circles, and ovals. A set of stakes or flags can be placed at the junctions to aid in sighting lines and measurement of area.
 2. Make a drawing of the turf area, including the geometric figures you plan to use.
 3. Measure the linear dimensions of each geometric figure and record them on your drawing.
 4. Compute the area of each geometric figure using the formulas on the previous pages.
 5. Calculate the area of the turf site by adding the square footage of each geometric figure together.

What is the total area of the turfgrass?



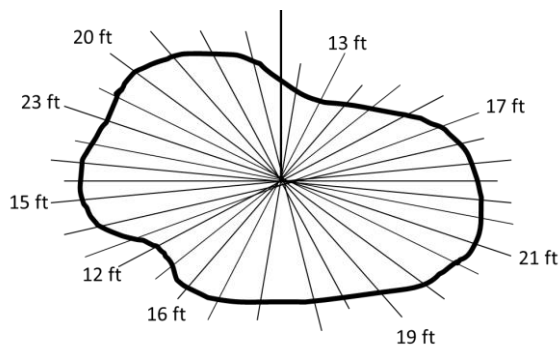
1. Calculate the area of the large trapezoid.
2. Calculate the area of the non-turf areas.
3. Subtract the individual smaller shapes from the trapezoid area.

Using the average radius method to calculate the area of circular objects

Use the following steps to measure the area of roughly circular putting greens, sand traps, or other similarly shaped objects:

1. Select and mark the approximate center point of the green.
2. Divide the irregularly shaped area into 10° or 20° increments. Use the 10° spacing when greater accuracy is desired or the green is irregularly shaped.
3. Measure the distances from the center to the perimeter of the green: 36 measurements for 10° increments and 18 measurements for 20° increments. Record the measurements at the appropriate intervals.
4. Determine the average radius by totaling the measured radii and dividing by the number of measurements.
5. Use the average radius with the formula $A = 3.14 \times (\text{radii}^2)$ to calculate the area of the putting green.

2. Determine the area of the putting green drawn below:



Record the measurements from either 10° or 20° increments in the appropriate box.

13 ft, 17 ft, 21 ft, 19 ft, 16 ft, 12 ft, 15 ft, 23 ft, 20 ft (9 measurements for example only)

Calculations

Average radii =

Area of green = $3.14 \times (\text{Average radii})^2$

= $3.14 \times$ _____

= _____ ft^2

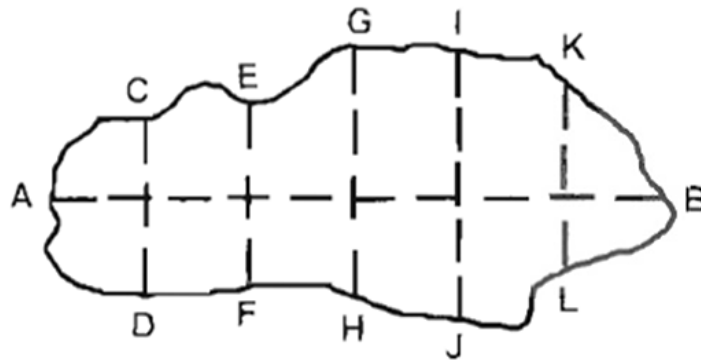
Use the offset line method to calculate the area of irregular shapes

The offset method is used to measure irregularly shaped areas such as bunkers or highly contoured fairways. This method divides large areas to a series of smaller equally spaced shapes along a measured line.

Use the following steps to measure irregularly shaped areas:

1. Determine the main line length. This line should be the longest straight axis of the area. Mark the endpoints and measure the length of the axis (line).
2. Mark offset lines at right angles to the length (axis) line. The number of offset lines and the interval between offset lines, called the *segment length*, should be chosen so that they divide the main length line axis into equal segments. The more uniform the area being measured, the fewer offset lines are needed. If you are measuring an irregularly shaped area, more offset lines should be used. If the area you are measuring is extremely long (over 300 feet) the interval between offset lines can be between 30 to 50 feet.
3. Measure the length of each offset line. Offset lines are measured from one edge of the area to the other.
4. Add up the length of all offset lines and multiply by the segment length. This calculation will yield the area of the feature of interest.

3. Calculate the area of the bunker drawn below using the offset method:

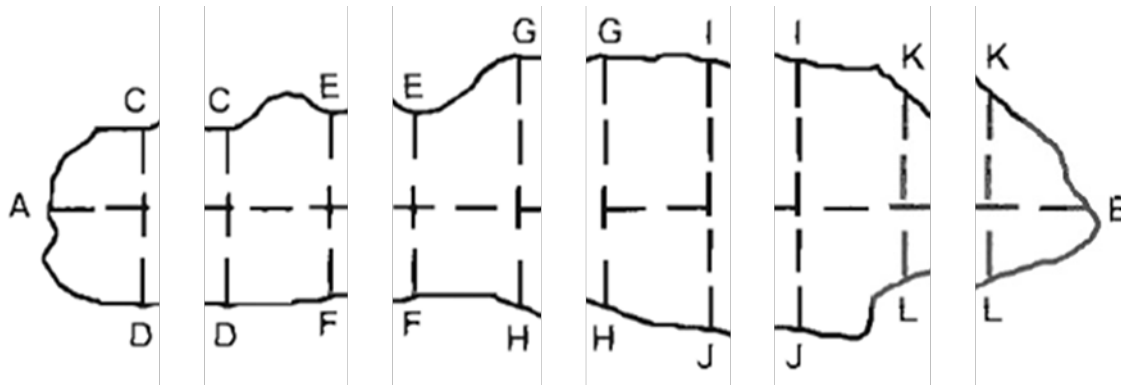


Length of the main line (line AB) = 174 ft

Segment length (S) = Length of main line (174 ft) / number of segments (6)

Segment length (S): _____

With this method, you are essentially breaking the area into smaller shapes estimated as rectangles.



Length of offset lines:

CD = 30 ft

EF = 35 ft

GH = 60 ft

IJ = 71 ft

KL = 32 ft

Total length

of offset lines _____

3. Area of bunker = Total length of offset lines x Segment length

Area = _____ x _____

Area = _____

Modified Offset Method

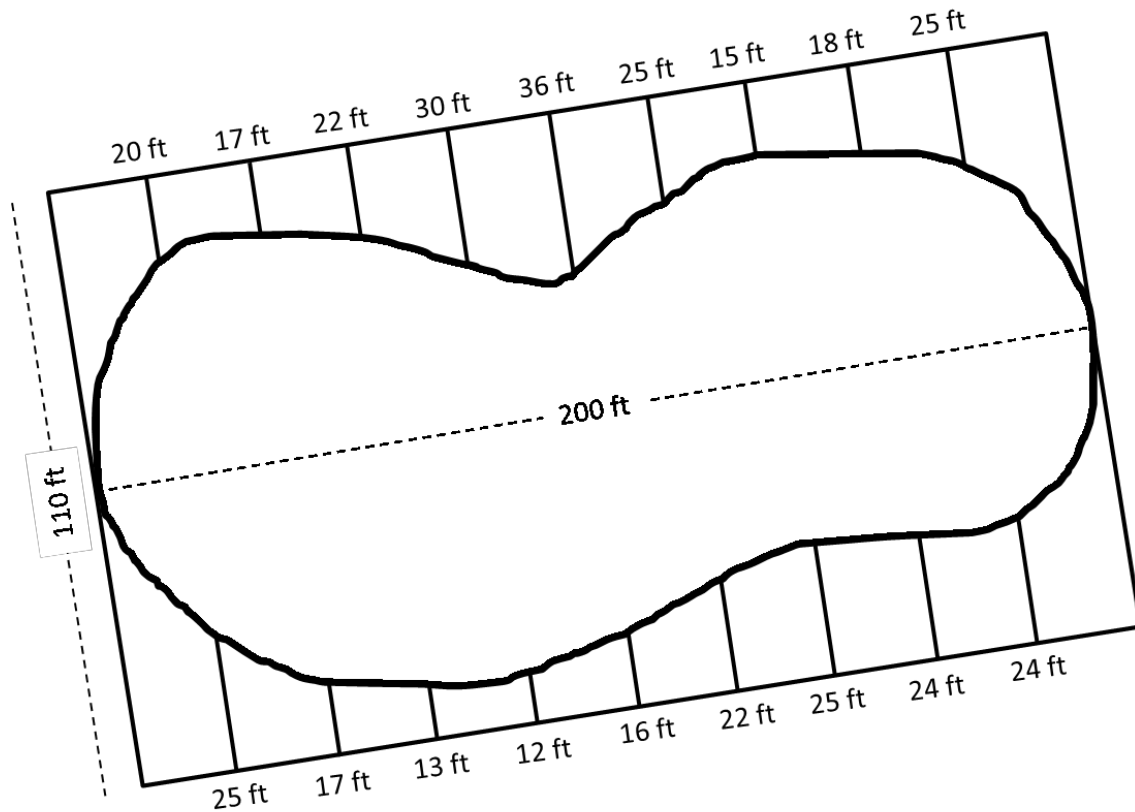
The modified offset method is a modified version of the offset method used to measure areas of irregularly shaped features where measurements of the feature itself are difficult to obtain, such as ponds or other hard-to-reach areas. This method employs the same calculations as the offset method but focuses on the *difference* in offset lengths.

Use the following steps to measure irregularly shaped areas:

1. Determine the main line length. This line should be the longest straight axis of the area. Mark the endpoints and measure the length of the axis (line).
2. Mark off a rectangle around the feature of interest. Be sure two of the rectangle's lines run parallel to the main line axis and the other lines are flush with the endpoints of the main axis line.
3. Determine the length of the secondary line, which runs perpendicular to the main line axis.
4. Mark offset lines at right angles from the rectangle sides running parallel to the main axis, to the feature of interest. The lines should extend from the opposite side of the feature to the opposite rectangle side. The segment lengths should be chosen so that they divide the main length line axis into equal segments. The more uniform the area being measured, the fewer offset lines are needed. When measuring an irregularly shaped area, the more offset lines the better.
5. Measure the length of each *modified* offset line. Modified Offset lines are measured from each edge of the feature outwardly to the rectangle. Each offset line is calculated as the difference between the secondary line and the sum of two corresponding lines.
6. Add up the length of all offset lines and multiply by the segment length. This calculation will yield the area of the feature of interest.

Example:

4. Calculate the area of the pond (gray) below using the modified offset method:



Length of the main line = 200 ft

Segment length: $200 / 10 = 20$

Length of the secondary line = 110 ft

Length of *modified* offset lines:

Line 1	$= 110 \text{ ft} - (20 \text{ ft} + 25 \text{ ft}) = 65 \text{ ft}$
Line 2	$= 110 \text{ ft} - (17 \text{ ft} + 17 \text{ ft}) = 76 \text{ ft}$
Line 3	$= 110 \text{ ft} - (22 \text{ ft} + 13 \text{ ft}) = 75 \text{ ft}$
Line 4	$= 110 \text{ ft} - (30 \text{ ft} + 12 \text{ ft}) = 68 \text{ ft}$
Line 5	$= 110 \text{ ft} - (36 \text{ ft} + 16 \text{ ft}) = 58 \text{ ft}$
Line 6	$= 110 \text{ ft} - (25 \text{ ft} + 22 \text{ ft}) = 63 \text{ ft}$
Line 7	$= 110 \text{ ft} - (15 \text{ ft} + 25 \text{ ft}) = 70 \text{ ft}$
Line 8	$= 110 \text{ ft} - (18 \text{ ft} + 24 \text{ ft}) = 68 \text{ ft}$
Line 9	$= 110 \text{ ft} - (25 \text{ ft} + 24 \text{ ft}) = 61 \text{ ft}$

Total length of modified offset lines = _____

Area of pond = Total length of modified offset lines x Segment length

Area = _____ x _____

Area = _____

Area of turfgrass between the rectangle and pond?

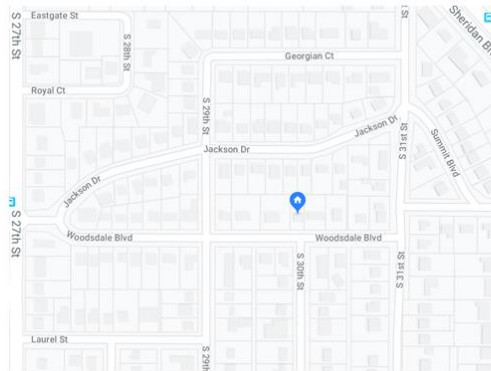
Area of grass = Area of rectangle – area of pond

Area = _____ - _____

Area = _____

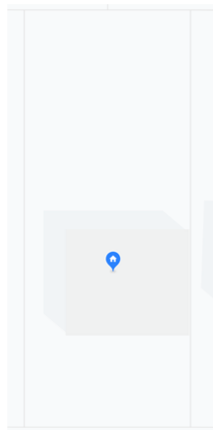
Areas using Google Maps

- <https://maps.google.com/maps>
- Enter address in search box or zoom to desired property



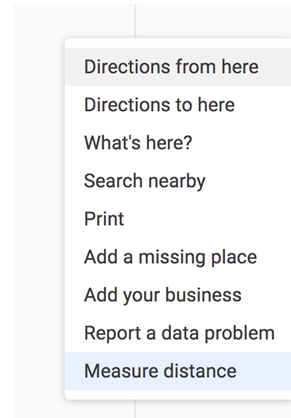
Using Google Maps

- Zoom in as close as possible while maintaining property boundaries (might need to split larger properties)



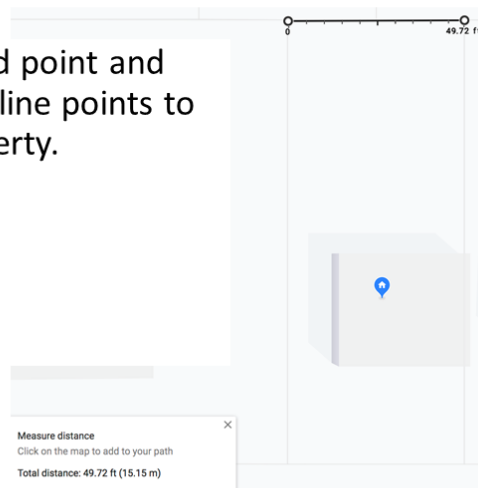
Using Google Maps

- Right click (PC) or control-click (Mac) for popup menu and choose Measure distance
- Next steps are easiest if the property is positioned so you can easily see boundaries



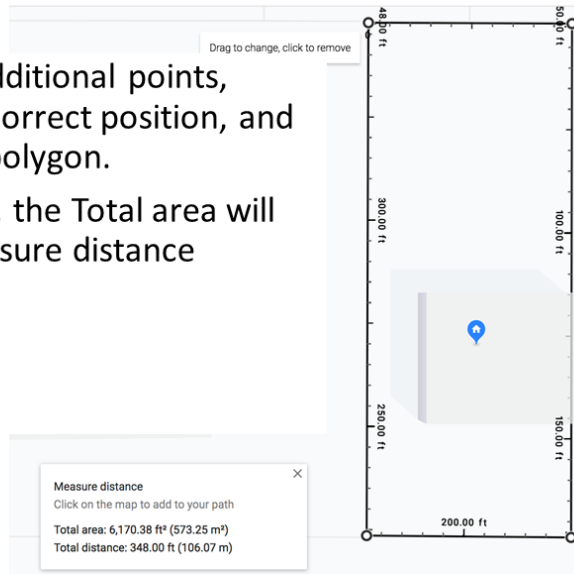
Using Google Maps

- Click to create a second point and click and drag the two line points to the corner of the property.



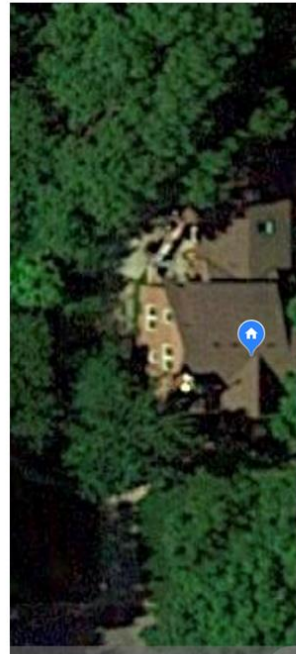
Using Google Maps

- Click to create additional points, dragging to the correct position, and completing the polygon.
- Once completed, the Total area will show in the Measure distance dialogue box.
- 6,170.38 sq ft
- What's missing?



Using Google Maps

- Try satellite view



Using Google Maps

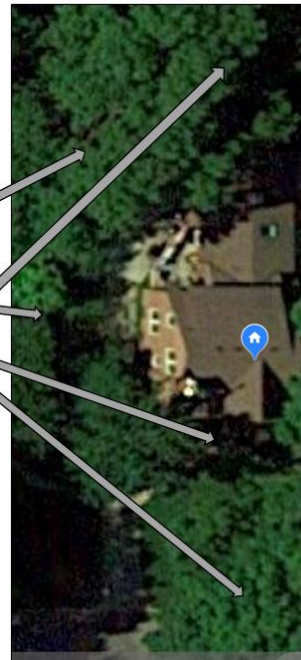
- Try satellite view

Detached garage

Driveway

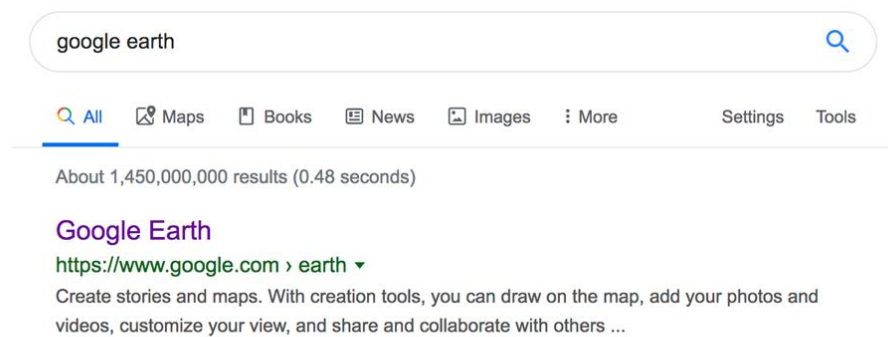
Landscape beds

Tees (everywhere)



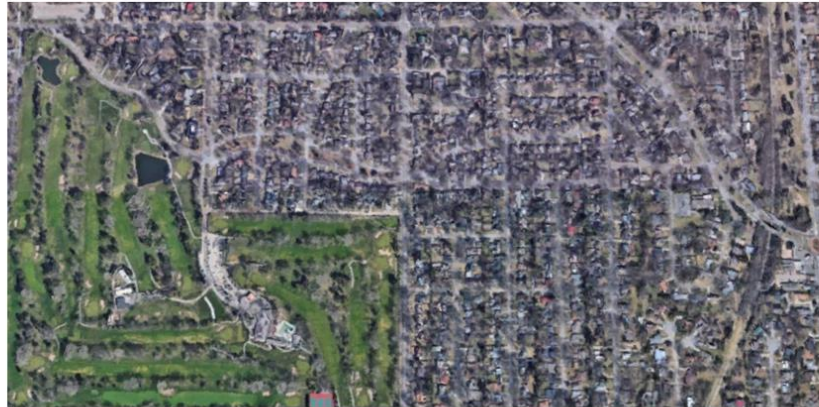
- What about fall/winter images?

Using Google Earth



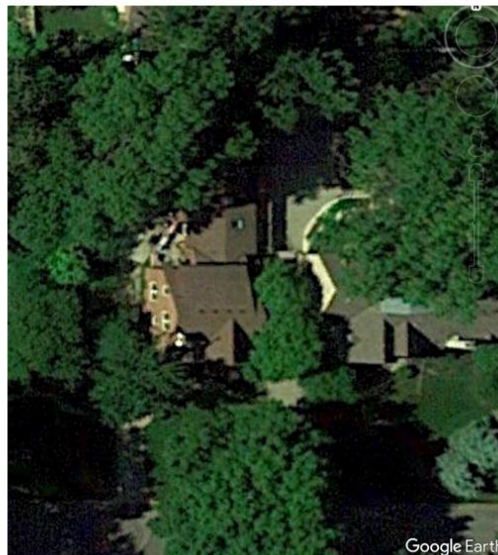
Using Google Earth

- Access historical satellite images (not Chrome version)



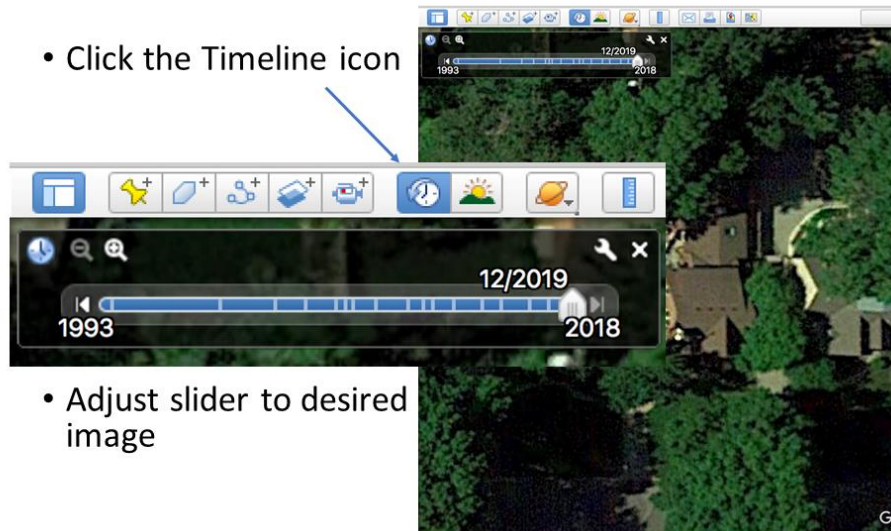
Using Google Earth

- Same property



Using Google Earth

- Click the Timeline icon



- Adjust slider to desired image

Using Google Earth

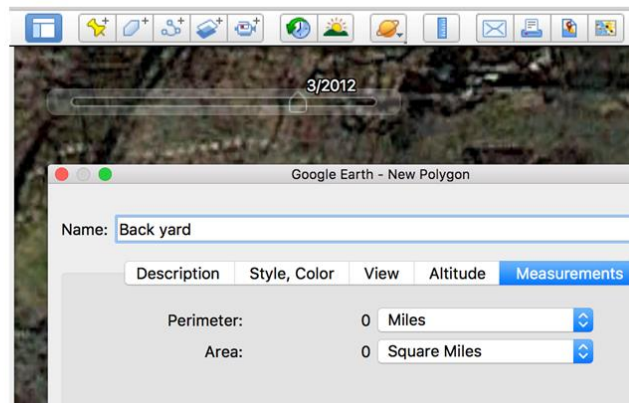
- Potential problems with evergreens



Using Google Earth

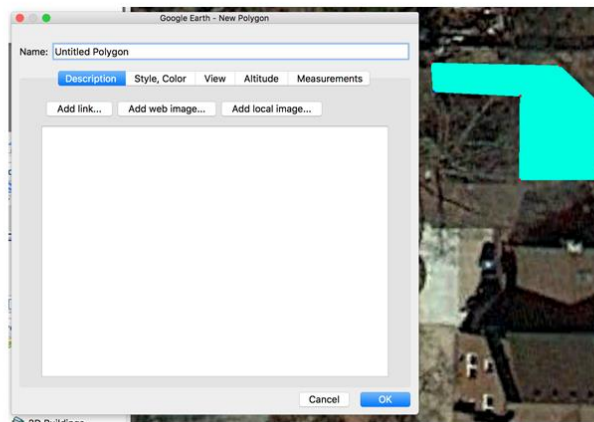
- New polygon icon

↓ (specify colors and measurements)

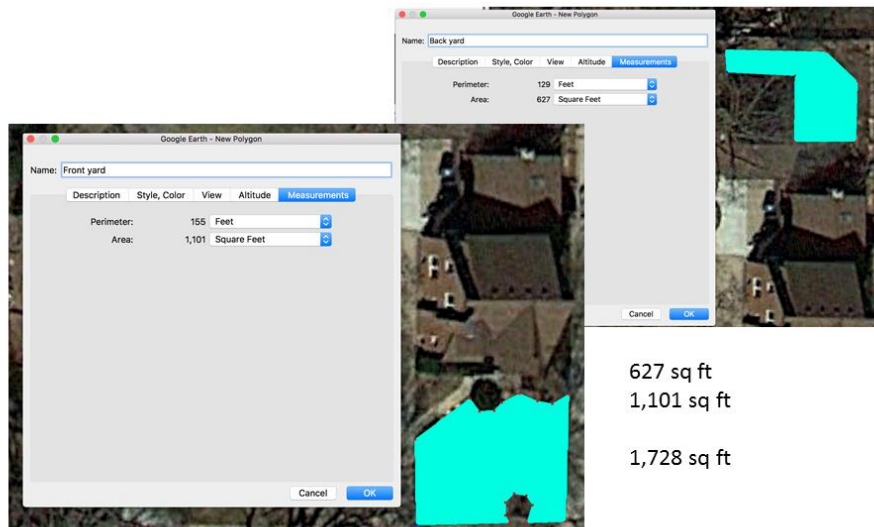


Using Google Earth

- Do Not Click OK
- Move polygon dialogue box away from image
- Click and drag points
- Record area



Using Google Earth



Other points

- Must visit property
- Tape/wheel
- Handheld GPS
- Steps

For example, **GPS**-enabled smartphones are typically **accurate** to within a 4.9 m (16 ft.) ... However, their **accuracy** worsens near buildings, bridges, and trees. High-end users boost **GPS accuracy** with dual-frequency receivers and/or augmentation systems.

Dec 5, 2017

[GPS Accuracy - GPS.gov](https://www.gps.gov)

<https://www.gps.gov> › systems › gps › performance › accuracy



Other points

- Handheld GPS

Commercial grade **handheld GPS units** are able to obtain coordinates with a horizontal **accuracy** of approximately 3 meters if the unit can receive a wide area augmentation system (WAAS) signal; otherwise, the **accuracy** is approximately 10 meters. Apr 6, 2017



GPS - USGS

<https://water.usgs.gov/osw/gps>

Is it important?

	Satellite	Phone Low	Phone Hi	GPS Low	GPS Hi
Width	30 ft	14 ft	46 ft	21 ft	39 ft
Length	57.6 ft	51.6 ft	73.6 ft	48.6 ft	66.6 ft
Area	1728 sq ft	722.4 sq ft	3385.6 sq ft	1020.6 sq ft	2597.4 sq ft
How much 46-0-0 to achieve a 1# N/1,000 sq ft application rate?					
# Urea	3.8# Urea	1.6# Urea	7.36# Urea	2.2# Urea	5.6# Urea
Actual N rate	1# N/M	0.4# N/M	2# N/M	0.6# N/M	1.5# N/M

It was also suggested to use county level GIS tools that are often publicly available. It might be worth checking those resources out in your area.

We would like to treat the 1,700 sq ft lawn with an over-the-counter Scott's product for crabgrass control and apply 1# per 1,000 sq ft, what is the application cost and which is the best buy?

Product	Cost	Coverage sq ft	Analysis	AI	Weight
Scotts® Halts® Crabgrass & Grassy Weed Preventer	\$17.99	5000		1.71% Pendimethalin	10.06 lb
Scotts® Turf Builder® Lawn Food	\$16.99	5000	32-0-4		12.5 lb
Scotts® Turf Builder® Triple Action				0.81% Pendimethalin 0.69% 2,4-D 0.345% MCP	
	\$26.49	4000	16-0-1		20 lb
Scotts® Turf Builder® Halts Crabgrass Preventer with Lawn Food	\$26.49	5000	30-0-4	1.29% Pendimethalin	13.35 lb

A.

$$\frac{\$17.99}{5 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$6.12}{\text{weed ctrl app}}$$

$$\frac{\$16.99}{12.5 \text{ \# fert}} \mid \frac{1 \text{ \# fert}}{0.32 \text{ \# N}} \mid \frac{1 \text{ \# N}}{1 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$7.22}{\text{fert app}}$$

Total \$13.34

B.

What was our N rate?

$$\frac{\$26.49}{4 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$11.26}{\text{combo app}}$$

$$\frac{0.16 \text{ \# N}}{1 \text{ \# fert}} \mid \frac{20 \text{ \# fert}}{4 \text{ M}} = \frac{0.8 \text{ \# N}}{\text{M}} \text{ still need } 0.2 \text{ \#}$$

$$\frac{\$16.99}{12.5 \text{ \# fert}} \mid \frac{1 \text{ \# fert}}{0.32 \text{ \# N}} \mid \frac{0.2 \text{ \# N}}{1 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$1.44}{\text{app}}$$

Total \$12.70

C.

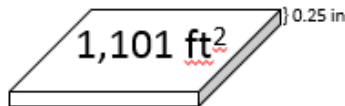
$$\frac{\$26.49}{5 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$9.01}{\text{combo app}}$$

N rate is calculated at 0.8#N/M as above

$$\frac{\$16.99}{12.5 \text{ \# fert}} \mid \frac{1 \text{ \# fert}}{0.32 \text{ \# N}} \mid \frac{0.2 \text{ \# N}}{1 \text{ M}} \mid \frac{1.7 \text{ M}}{\text{app}} = \frac{\$1.44}{\text{app}}$$

Total \$10.45

The front yard (1,101 sq ft) and back yard (627 sq ft) are on separate irrigation zones. The home irrigation system output is 12.5 gallons per minute per zone. In order to deliver 0.25” of water, how long does the system need to run in each zone?



Convert 0.25 in to feet

$$\frac{0.25 \text{ in}}{12 \text{ in}} = 0.0208 \text{ ft}$$

Calculate volume

$$V1 = 1,101 \text{ ft}^2 \times 0.0208 \text{ ft}$$

$$V1 = 22.94 \text{ ft}^3$$

Follow same approach for back yard

$$V2 = 13.06 \text{ ft}^3$$

1 min	7.48 gal	22.94 cu ft	=	13.7 min
12.5 gal	1 cu ft	app		app

1 min	7.48 gal	13.06 cu ft	=	7.8 min
12.5 gal	1 cu ft	app		app

Assuming the irrigation system is programmed to deliver 0.25” of water, three times per week and runs from mid-May through mid-September (20 weeks). What are the annual irrigation costs (\$1.482/748 gallons)?

Calculate gallons used per irrigation event

12.5 gal	21.5 min	=	268.75 gal
1 min	event		event

Calculate annual costs

\$1.482	268.75 gal	3 events	20 wks	=	\$31.95
748 gal	1 event	1 wk	1 year		year

Sprayer Calibration

The proper calibration of a boom sprayer is essential to ensure that the desired amount of a pesticide or fertilizer is applied to the turfgrass site. Although there are several methods of calibrating a sprayer, there is no substitute for calibration. Improper calibration may cause poor pest control, environmental contamination, injury to the desired turf, and unnecessary expenditures for pesticides or fertilizers.

A sprayer should be calibrated at the start of every growing season and the calibration should be checked during the growing season. Nozzles should be checked for wear, and correct spray pattern each time the sprayer is used. All screens should be cleaned throughout the season to ensure proper application.

Steps to Calibrate a Boom Sprayer

1. Determine the boom width by multiplying the number of nozzles by the spacing between nozzles. (Convert to feet.)
2. Measure a calibration course of 1000 ft² over terrain that is similar to terrain where the sprayer will be operating.
3. Determine the amount of time required to cover the 1000-ft² calibration course when operating the sprayer at the desired spraying speed. Be sure the sprayer is at the desired spraying speed when passing the start and end points of the calibration course. It is best to make two separate passes over the calibration course and use the average time for calibration calculations. The spray tank should be half full when making the calibration runs. Be sure to record the gear, rpm or mph, and pressure at which the calibration runs were made.
4. Measure the nozzle output of the sprayer by placing a collection vessel under each nozzle and operating the sprayer for the same number of seconds it took to cover the calibration course (Step 2). Record the output in ounces (fl.oz) of each nozzle and sum to determine the output of the sprayer.
5. Calculate the number of gallons output per ft² of calibration course (128oz = 1 gallon).
6. Convert from gallons/ft² to gallons per 1,000 ft² and to gallons per acre. (43,560 sq. ft. = 1 acre)

Boom Sprayer Calibration

A. Width of boom (ft) =
$$\frac{\text{Spacing between nozzles (in)} \times \text{number of nozzles}}{12 \text{ (in)}}$$

=
$$\frac{\text{_____ in} \times \text{_____ nozzles}}{12 \text{ (in)}}$$

=
$$\text{_____ ft}$$

- B. Measure a lineal distance equal to 1000 ft² and determine the amount of time needed to travel the calibration course.

	Direction A	Direction B	Mean
Seconds to travel calibration course	_____	_____	_____

(Gear: _____ RPM or MPH _____ Pressure _____)

- C. Measure the sprayer output for the same number of seconds it took to complete the calibration course.

Nozzle 1.	_____	oz
2.	_____	oz
3.	_____	oz
4.	_____	oz
5.	_____	oz
6.	_____	oz
7.	_____	oz
8.	_____	oz
9.	_____	oz
10.	_____	oz
11.	_____	oz
12.	_____	oz
Total	_____	oz

In summary:

Total _____ oz collected in _____ seconds or per 1000 sq. ft.

- D. Calculate the output per 1000 sq. ft. of the calibration course.

Output in oz: _____ (from C)

$$\frac{\text{_____}}{1000 \text{ sq. ft.}} \times \frac{1 \text{ gal}}{128 \text{ oz}} = \frac{\text{_____}}{1000 \text{ sq ft}} \text{ gals}$$

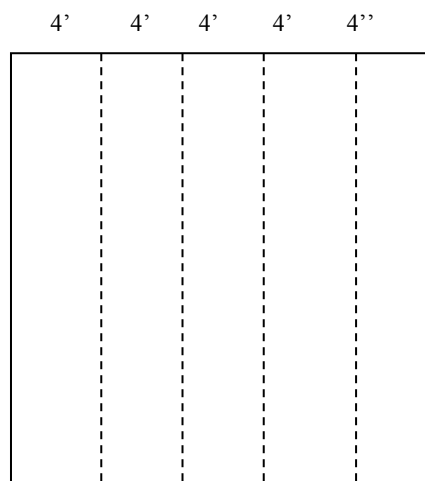
Checking for Worn Nozzle Tips

1. Measure the output of each nozzle in comparison to one brand new nozzle placed in the boom. Output can be measured by a collection vessel placed under each nozzle and operating the sprayer for one minute.
2. Record the output from each nozzle. If the output from any nozzle is 10% or greater than the output from the new nozzle the old nozzle should be replaced. If two or more nozzles have an output 10% or greater than the new nozzle, all nozzles on the boom should be replaced. It is important to have uniform output from all nozzles.

Calibrating a Lawn Gun

Setup and practice:

Measure off a rectangular area at least 50-ft long by 20 ft wide (1000 ft²) on pavement. Pavement should be used so you can easily see spray patterns. Divide this rectangle into five rectangles 4 ft X 50 ft. The optimum spray pattern for a lawn gun is to spray an arc 8 feet wide and then overlap 50% on your next pass to insure optimum coverage. Therefore, practice walking down each line spraying an 8-foot arc. As the pavement dries, you will see the accuracy of your pattern. Since the effective spray width is only 4 feet (1/2 of your 8-foot arc), you should make five passes over this calibration course to cover 1000 ft² evenly. Though all walking speeds are different, the target speed is about 2.8 MPH, which will deliver 2 gallons/1000 ft² at 2 gallons/min flow rate. Continue practicing until you are comfortable and accurate.



Steps to Calibrating a Lawn Gun

1. Record the amount of time it takes for an applicator to uniformly apply clean water to this area, making 5 passes on 4' centers.
2. Spray into a five gallon bucket for the amount of time recorded in Step 1. Measure the amount of water collected in the bucket in fluid ounces.
3. Divide the water collected in step 2 by 128 (1 gallon = 128 fluid ounces) to calculate spray volume in gallons/1000 ft².
4. Divide the gallons in the spray tank by the answer in Step 3 to calculate the area that can be covered with one tankful.

A. Amount of time to accurately apply water to 1000 ft².
_____ sec.

B. Volume collected in 5 gallon bucket in the amount of time from A.
_____ fl. oz.

C. Convert spray volume collected in bucket from fluid ounces to gallons:
_____ oz. ÷ 128 oz/gallon = _____gallon/1000 ft²

D. Area covered with one tank:
_____ gallons in spray tank ÷ _____gallons/1000 ft² = _____ft²/tank

Spreader Distribution and Calibration

A properly maintained and calibrated spreader is an essential piece of equipment for professional turfgrass managers. It is important that fertilizers pesticides and seed are applied at their recommended rate. Over-application of a product is an unnecessary expense that may injure turf and is potentially injurious to the environment. Under-application may be more costly because of poor turf response and the need to retreat or reseed because of reduced product performance.

A rotary spreader should be calibrated at least weekly if used frequently or monthly if used less frequent. The spreader must be calibrated for each material used and speed (gear) at which it is used. Before calibrating, a spreader should be checked to verify proper working order. Items to check include:

- Tires inflated
- Axles greased and tires turn freely
- Spreader hopper and impeller clean
- Screen inside the hopper
- Agitation bar inside the hopper
- Adjustment knob will hold its position
- Rain cap present
- Gears greased (if recommended) and all teeth on gears present
- Pattern adjustment set

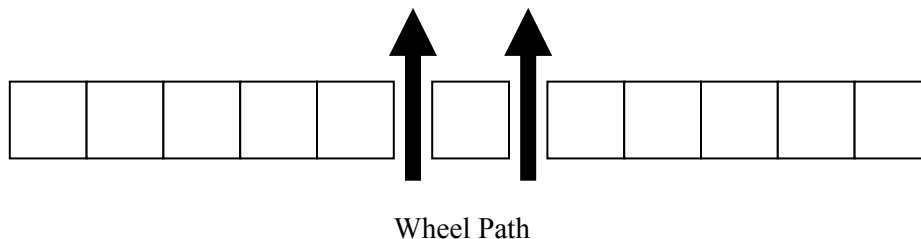
Calibrating Rotary Spreaders

Calibration of a rotary spreader includes three aspects; uniform distribution across the pattern, determining effective pattern width, and rate of application.

Uniform Distribution Across Pattern

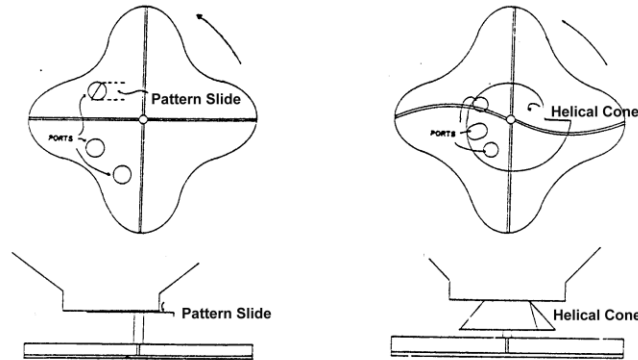
The purpose of this procedure is to insure that equal amounts of the material are being thrown to the right and left of the spreader.

Step 1 Place shallow boxes or pans side by side in a line perpendicular to the direction the spreader will be pushed. One box should be placed directly beneath the spot where the spreader will pass, leaving space for the spreader wheels to pass on either side of the box. Below is a diagram showing placement of the boxes.



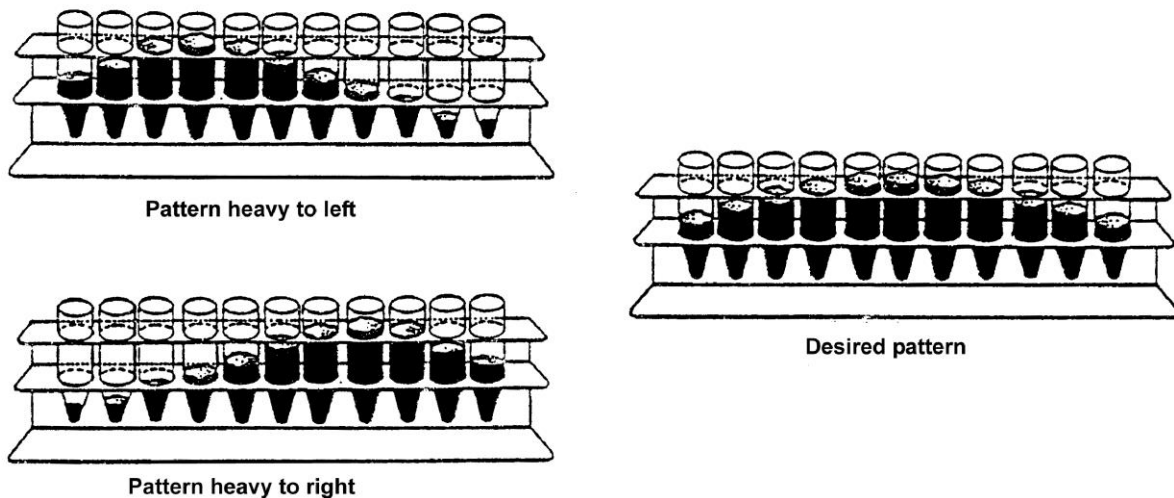
Step 2 Set the spreader at the opening that is suggested for the material.

Step 3 Set the pattern adjustment so it is completely open. The diagram below indicates the location of the pattern adjustment for two types of spreaders.



Step 4 Fill the spreader half full and make 8 to 10 passes over the boxes pushing the spreader in the same direction each time. Be sure the spreader impeller is parallel to the ground and a constant walking speed is used for each pass. Full walking speed should be achieved before turning on the spreader.

Step 5 The contents of each box should be weighed separately or poured into a small bottle or cylinder. The bottles should then be placed side by side in order. This will allow you to see the spreader pattern variation. The diagram below illustrates possible spreader patterns.



Step 6 Weigh the material collected in the boxes on the right and then weigh the material collected in the boxes on the left. The weight of material collected on each side should be within 15% of each other. If not, change the pattern adjustment setting.

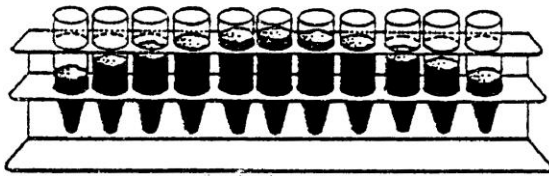
Step 7 Repeat the test until the distribution pattern is uniform.

Determining Effective Pattern Width

When a uniform pattern is achieved, the effective pattern width can then be determined.

Step 1 Read the volumetric measurements on the side of the vials. Determine at what distance from the center of the pattern the distribution rate decreases to one half the amount contained in the center vial.

Step 2 The effective pattern width is the distance between the tray on the left and the tray on the right at which the distribution rate is one-half the amount contained by the tray in the center.



Step 3 This distance is the effective pattern width and is the distance between spreader passes necessary to obtain uniform distribution.

Rate of Application

Step 1 The proper effective swath width and distribution pattern must be known for the material.

Step 2 Measure a lineal distance to equal 1,000 sq. ft.

$$\text{Lineal distance} = \frac{1,000 \text{ sq. ft.}}{\text{effective swath width (ft.)}}$$

Step 3 Calculate the required weight of fertilizer per 1,000 sq. ft. needed to apply the desired amount of nitrogen. Example: If you want to apply 1.0 lbs. actual nitrogen per 1,000 sq. ft. using urea you should apply 2.17 lbs. of urea per 1,000 sq. ft.

General formula

Rate	1 lb fertilizer	Area to be treated
1,000 ft ²	Analysis	

Example 1. How much 46-0-0 is needed to apply 1.0 lbs N/1000ft² to a 5,000 ft² lawn?

1.0 lbs N	1 lb fertilizer	5,000 ft ²
1,000 ft ²	0.46 lbs N	

Answer = 10.85 lbs 46-0-0 fertilizer

Step 4 Weigh 20 lbs. of the product and place it in the spreader hopper and spread it over the distance required to equal 1,000 sq. ft. Two or more passes will improve accuracy of the calibration. If you make two or more passes with the spreader be certain to make the appropriate adjustments for the extra square feet covered.

Step 5 Weigh the product remaining in the hopper and subtract this amount from the amount with which you started.

Step 6 The result is the application rate for this product in lbs. per 1,000 sq. ft. Adjust the spreader opening either up or down to achieve the desired setting.

Step 7 Repeat steps 4 through 6 until correct application rate is achieved.

Calibrating Drop Spreaders

Step 1 Measure the spreader pattern width in inches and convert to feet

Step 2 On a level area, measure a practical length for the calibration course

Step 3 Weigh the product before putting in the spreader/or catch the product in catch pan

Step 4 Make a pass with the spreader over a specified distance.

Step 5 Determine application rate by subtraction/or weigh the product caught in catch pan

Step 6 Readjust spreader and repeat steps 3 -5 until correct application rate is achieved.

Spreader Calibration Worksheet

Rotary Spreader Rate of Application Calibration Worksheet

Rotary Spreader Name: _____

Width of effective pattern width in ft : _____

Length of calibration course : _____ X _____ (width) = 1000 sq ft calibration course

Desired rate = _____ lbs/1000 sq ft

Calibration Run #1

Spreader setting _____

_____ lbs. fertilizer -	_____ lbs. fertilizer =	_____ lbs. fertilizer
in spreader	remaining in	applied/1000 sq ft
initially	spreader	

Calibration Run #2 (if necessary)

Spreader setting _____

_____ lbs. fertilizer -	_____ lbs. fertilizer =	_____ lbs. fertilizer
in spreader	remaining in	applied/1000 sq ft
initially	spreader	

Calibration Run #3 (if necessary)

Spreader setting _____

_____ lbs. fertilizer -	_____ lbs. fertilizer =	_____ lbs. fertilizer
in spreader	remaining in	applied/1000 sq ft
initially	spreader	

Drop Spreader Rate of Application Calibration Worksheet

Drop Spreader Name: _____

Width of the spreader in inches _____ $\div$ 12 inches = _____ ft wide

Length of calibration course _____ X _____ (width) = _____ sq ft calibration course

Desired rate = _____ lbs/1000 sq ft = _____ lbs/_____ sq ft calibration course

Calibration Run #1

Spreader setting _____

_____ lbs. product in catch pan

Calibration Run #2 (if necessary)

Spreader setting _____

_____ lbs. product in catch pan

Calibration Run #3 (if necessary)

Spreader setting _____

_____ lbs. product in catch pan

Using the setting from run #3 have each group member walk the calibration course and determine the amount of fertilizer applied

Calibrator 1: Name: _____ Amount applied: _____

Calibrator 2: Name: _____ Amount applied: _____

Calibrator 3: Name: _____ Amount applied: _____

Calibrator 4: Name: _____ Amount applied: _____

Estimate the setting on the spreader that would apply half of the rate just determined

Spreader setting _____

Now determine the actual amount applied using the estimated setting.

_____ lbs. product in catch pan

What might be the advantage of applying half the rate of product in 2 directions instead of applying the full rate in 1 direction?

Calibrating Hand-Held Sprayers

Reprinted from *The Nebline*, June 2008

[26]

Tom Dorn

UNL Extension Educator

Do you need to spot spray weedy patches in the lawn or pasture with a hand-held sprayer? We will discuss a simple step-by-step calibration procedure that ensures you apply the correct amount of pesticide to comply with the product label and so you will achieve satisfactory results.

In order to apply the recommended amount of chemical through a sprayer, you need to know two things:

1. The quantity of total spray output you will be applying per unit of area, e.g., gallons per acre (GPA); and,
2. The recommended amount of product to apply per acre.

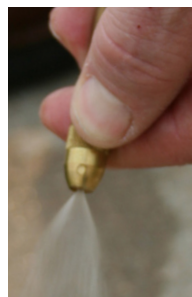
I recently came across a simplified method of calibrating hand-held sprayers. This methodology works for calibrating either compressed air (pump up) sprayers or sprayers with a motor driven pump to create pressure (hand guns). The following procedure illustrates the steps required to properly calibrate hand-held sprayers. Most of the procedure is the same whether you are using a compressed air or powered sprayer. *Italicized text applies only to compressed air sprayers.*

Measure Spray Output

- 1) Note the “full” mark on the spray tank. *There will be space above the mark for compressed air.*
- 2) Determine the useful volume of the spray tank by measuring the volume of water needed to fill an empty tank to the full mark.
- 3) Using only water, fill the container to the full mark. Start the motorized pump or pressurize the tank, then test the spray pattern. Add pressure and/or adjust the spray tip until you are satisfied with the spray pattern.
- 4) Measure and mark a test area 18.5 feet x 18.5 feet square



This spray tank holds 2 gallons when full.



Test spray pattern and adjust tip.

- 5) Spray the test area in the manner you would normally do when controlling the target pest and record the time in seconds to treat the test area.
- 6) *Pump up the pressure again and spray* into a container for the same number of seconds it took to “treat” the test area (step 5) and measure the fluid ounces (fl.-oz.) caught in the container. The number of fl.-oz. caught in the container will be equal to the gallons of spray you would have applied had you sprayed a full acre (GPA).



Spray in a container for the same number of seconds.

Determine the Amount of Chemical to Add to the Tank

- 7) Divide the useful capacity of the tank (step 2) by the spray output, GPA (step 6) to determine the decimal fraction of an acre covered by each tank of spray solution.

Continued on next page



Measure a test area 18.5 feet x 18.5 feet square. Then spray in the manner you would normally do and record the time in seconds to “treat” the test area.

- 8) Read the label to determine the volume of product recommended per acre.
- 9) Multiply the volume of product per acre (step 8) by the fractional acre covered per tank (step 7) to determine the amount of product to add per tank of spray.

Example

- Note the full mark. (Step 1)
- Tom measured the useful volume of the spray tank and found it to be two gallons. (Step 2)
- Test spray pattern. (Step 3)
- He measured and marked a test area 18.5 x 18.5 feet. (Step 4)
- He sprayed the test area and found it took 32 seconds. (Step 5)
- He caught the output in a container for 32 seconds and measured 34 fluid ounces of water caught. This shows Tom was putting out the equivalent of 34 gallons per acre. (Step 6)
- Each tank will cover 2 gallons / 34 gallons / acre = 0.059 acre (Step 7)
- The product label recommends 1 quart (32 fl.-oz.) of herbicide per acre. (Step 8)
- The amount of product to add to a full spray tank is: 32 fl.-oz. per acre x 0.059 acres per tank = 1.9 fl.-oz. per spray tank. (Step 9)

This methodology works because the test area (18.5 feet square) is 1/128 of an acre. A U.S. gallon is 128 fluid-ounces. The fluid ounces of spray required to treat the test area therefore is equivalent to the gallons of spray output that would be applied to a full acre, provided the operator maintains a consistent pattern of spray output and spray coverage.

How to Measure Small Quantities of Pesticide

You could measure small quantities of pesticides using a number of different measuring devices. Three common examples are:

- A measuring cup (Dedicate a measuring cup for garage use only. Never use the same cup that is used for cooking.)
- A tablespoon (Tbsp) (If you will be using an old tablespoon from the silverware drawer, check volume by pouring water from a measuring spoon into the spoon designated for pesticides to check the actual volume.)
- A disposable syringe calibrated in milliliters (These are sold at veterinary supply and farm supply stores). This is my personal favorite because you suck chemical into the syringe instead of pouring chemical from the bottle into an open measure which can spill on your hands or clothes. A syringe accurately measures any volume up to its full capacity.



Disposable syringe

The calculations below demonstrate how to compute the chemical needed for our example using these three fluid volume measuring devices.

- 1.9 fl.-oz. / 8 fl.-oz./Cup = 0.24 Cup per tank. Add just under 1/4 cup of product per tank.
- 1.9 fl.-oz. x 2 Tbsp per ounce = 3.8 Tbsp. Add just under 4 Tbsp per tank.
- 1.9 fl.-oz. x 29.6 milliliters (ml)/fl.-oz. = 56.2 ml. Add just over 56 ml per tank.