Technical Newsletter

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The Secrets Behind Successful Sprinkler Spacing and Design

Knowing the types of sprinklers that are best for a job and determining where to place them for maximum efficiency and economy are decisions that begin early in the design process. They are choices based on all of the information gathered about the site as well as an understanding of basic hydraulics.

Selecting the Right Sprinklers

Irrigation designers today have a wide choice of sprinklers, ranging from shrub spray sprinklers and pop-up spray sprinklers to rotating impact and pop-up gear-driven designs.

There are a few general considerations to keep in mind when determining what type of sprinklers to use:

- the size and shape of areas to be watered
- type of plant material
- available water pressure and flow
- local environmental conditions such as wind and temperature
- soil type and the rate at which it can accept water

The challenge is to irrigate the area adequately while using the least number of sprinklers to keep the job economical. Each sprinkler has a performance range that must fit within the flow and pressure available to the site. Knowing the discharge requirements for a sprinkler is also important to ensure it does not exceed the soil absorption rate.

Each kind of sprinkler has specific strengths.

Spray, strip and stream sprinklers:

- are used for smaller landscaped areas
- are used for a mixed selection of plantings
- have a fixed arc of coverage that ranges from full-, half- and quarter-circles to variable arc nozzles (VAN)
- usually operate at 15-30 psi
- throw water from 4-22 feet
- are well suited for projects with lower water pressures

Impact, ball drive, and gear-driven rotors:

- are best for larger areas
- apply water more slowly than spray heads
- can operate at higher pressures (25-100 psi)
- throw from 15-80 feet
- offer full and part circle models

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Sprinkler performance charts from the manufacturer can summarize critical information to help designers make the best sprinkler decisions. *(see figure 1)*

SPRINKLER SPACING AND RANGES

12 SERIES (STANDARD 30° TRAJECTORY)

Nozzle	Pressure psi	Radius ft.	Flow GPM	■ Precip. in/h	▲ Precip. in/h
	15	9	1.80	2.14	2.47
	20	10	2.10	2.02	2.34
	25	11	2.40	1.91	2.21
12F	30	12	2.60	1.74	2.01
	15	9	0.90	2.14	2.47
	20	10	1.05	2.02	2.34
	25	11	1.20	1.91	2.21
12H	30	12	1.30	1.74	2.01
	15	9	0.45	2.14	2.47
	20	10	0.53	2.02	2.34
	25	11	0.60	1.91	2.21
12Q	30	12	0.65	1.74	2.01

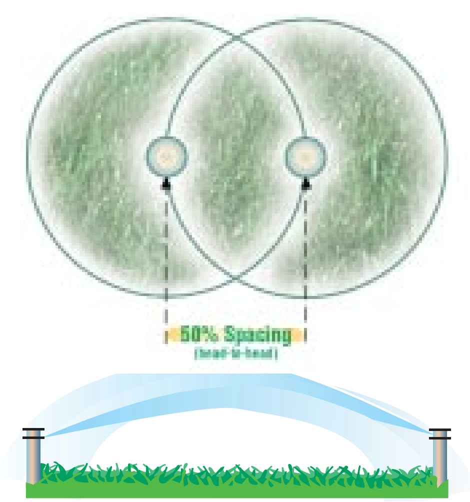
figure 1

Spray heads and rotors each have different requirements for zoning and spacing.

Spacing Sprinklers

Efficient spacing begins with an understanding of sprinkler water distribution. Sprinklers are designed for overlapping coverage. Proper overlap ensures even distribution of water and eliminates dry spots. When overlapped, the weak area of coverage from one sprinkler is supplemented by the surrounding sprinklers.

Head-to-head spacing, or sprinklers spaced at 50% of the sprinkler's diameter, is most common to ensure uniform coverage. *(see figure 2)*



Determining Sprinkler Precipitation Rates

The designer needs to know how much water is needed per week or per day to maintain the turf and how that compares to the amount of water the sprinklers in an area will apply. The ***precipitation rate (PR)*** is the calculated average amount of water that all of the sprinklers in a specific area apply in one hour. It is usually measured in inches per hour (metric=mm/h). This delivery rate is based on the type of nozzle, the arc and the spacing.

Calculating the PR early in the process helps the designer make sure that the sprinklers can apply enough water during the time available for watering (water window), without exceeding the soil intake rate.

Here is the formula:

PR Formula

$$PR = \frac{96.3 \times \text{gpm (applied to the area)}}{S \times L \text{ (or area in ft}^2\text{ of each zone)}} = IN/HR$$

96.3 – is a constant

GPM – applied to target area by all sprinklers in pattern

S – distance in feet of sprinklers on a row

L – distance in feet between sprinkler rows

IN/HR – average inches per hour

Matched Precipitation Rates

Matched precipitation rate (MPR) refers to sprinklers that apply water at the same rate per hour no matter the arc of coverage or part of a circle they cover. For instance, a full-circle sprinkler discharges twice the flow of a half-circle sprinkler and a quarter-circle sprinkler discharges half of what the half-circle unit does.

MPR allows the same type of sprinklers, no matter what their arc, to be circuited on the same valve and to deliver the same PR rate. Spray heads have fixed arcs and are matched by the manufacturer, while rotors offer a choice of nozzles to match the designed arc pattern. *(See figure 3)*

Example of MPR sprinklers.

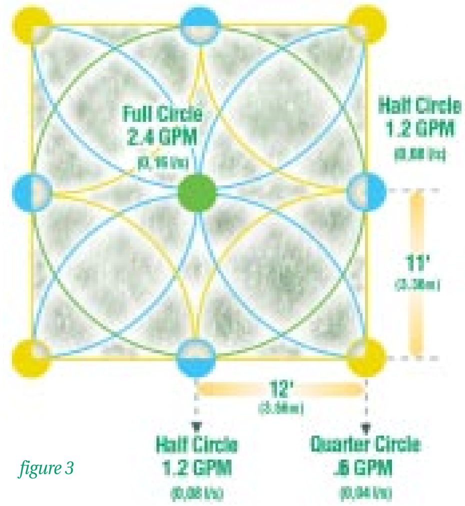


figure 3

Practice calculating the PR for this area.

The spacing, length and gpm discharge for the full-, half- and quarter-circle sprinklers are shown on the layout. The operating pressure is 25 psi (2 bars) and radius of throw is 11 feet (3.3528 m).

The total number of gallons applied by these MPR sprinklers is:

- 1 - Full-circle sprinkler = 2.40 gpm (0,16 l/s)
- 4 - Half-circle sprinklers = 4.80 gpm (0,32 l/s)
- 4 - Quarter-circle sprinklers = 2.40 gpm (0,16 l/s)

A total of 9.6 gpm is applied to the area.

To calculate the PR for this area:

$$PR = \frac{96.3 \times 9.6 \text{ gpm}}{22 \times 24} = \frac{924.48}{528} = \boxed{1.75 \text{ in/hr}}$$

The PR is 1.75 inches per hour (44.5 mm/hr).

Zoning and Rotor Spacing

To avoid overwatering, designers should never combine sprinklers in the same valve group if the sprinkler precipitation rates are not matched (or have more than a 10% difference). Also avoid grouping sprinklers that are at different elevations.

For a rough estimate of the number of valve zones needed, add the gpms (liters/sec) for all sprinklers and divide the total by the maximum gpms (liters/sec) available from the water source.

Keeping the Rotor Ratio Correct

If spray heads are spaced correctly, whether half-, quarter- or full-circle heads are used, the designer can achieve MPR.

The same can be accomplished with rotors, but the designer must choose nozzles to keep the quarter-circles, half-circles and full-circles at a ratio of one to two to four. *(see figure 4)*

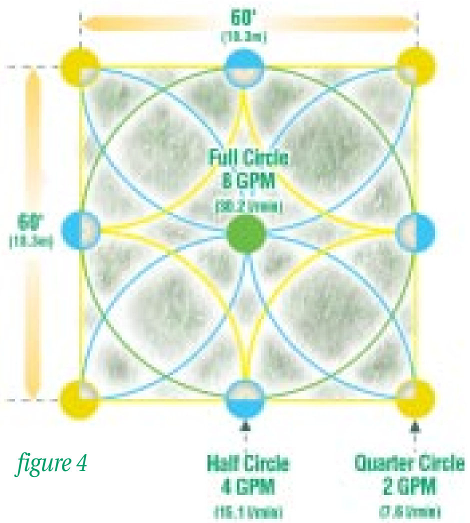


figure 4

Here is an example of the 1 to 2 to 4 ratio. All half circles are at 4 GPM and all quarter circles are at 2 GPM.

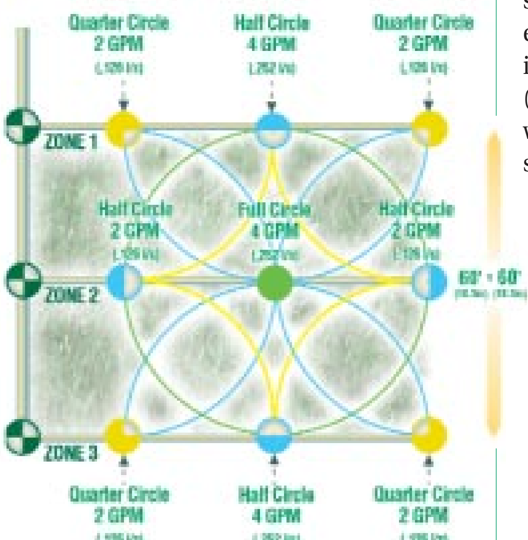


figure 5

By changing the nozzle sizes on zone 2, we can obtain proper coverage and complete this design using only 3 circuits, or zones. Here is an example of the 1 to 2 to 4 ratio zoned and nozzled to handle existing flow conditions.

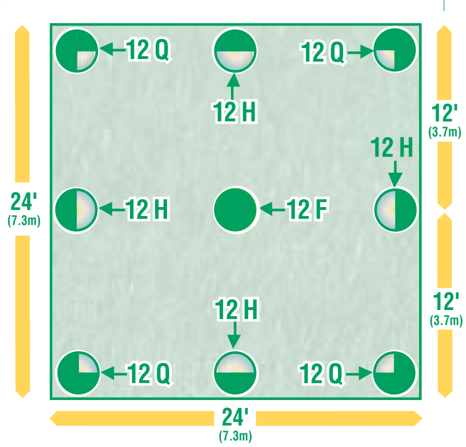
Just remember, designers may have to make adjustments to deal with real-world situations. To keep the application rate matched with rotors, the designer has to look at the nozzles and spacing. For instance, in figure 4, if the available flow is 10 gpm, the top row of sprinklers could form one zone at 8 gpm, as could the bottom row. But the middle row would exceed the flow available. The designer could renozzle the half-circles to 2 gpm and the full-circle to 4 gpm in the middle row, which would still keep the 1-2-4 ratio within that zone. However, the run time must then be ***doubled*** for zone 2 compared to zones 1 and 3 because it is covering twice the area with the same flow rate. *(see figure 5)*

Caution! Check to make sure going to the smaller nozzle will still provide the desired radius and coverage.

Checking Total System Operating Time to Ensure Success

In addition to following the appropriate spacing and zoning principles, designers should be sure to stop on a regular basis throughout the design to check the total system operating time. This should not exceed the daily time period available for irrigation known as the *water window* (i.e. 10 p.m. - 6 a.m.). To meet the water window requirements, the available system flow may need to be increased.

figure 6



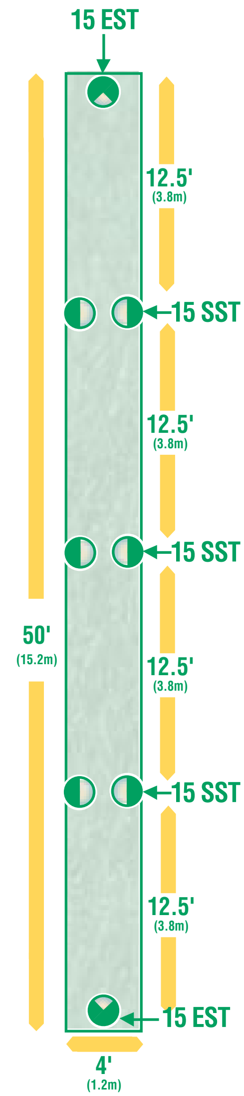
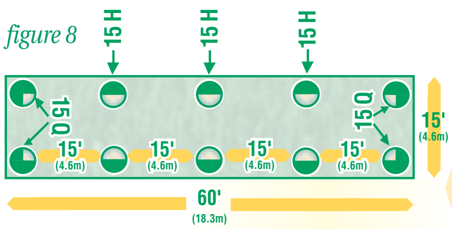


figure 7

Here are some possible solutions of sprinkler head layouts.

figure 8



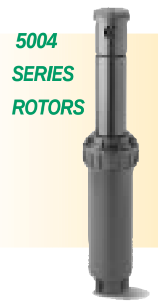


figure 10

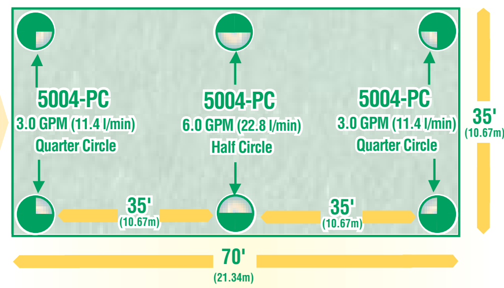
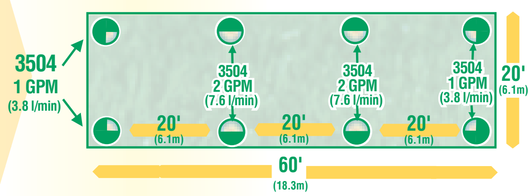
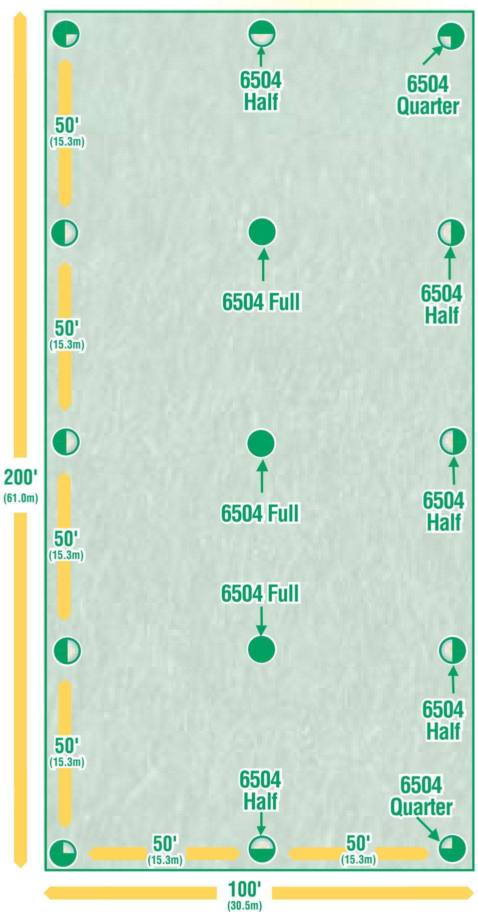


figure 9





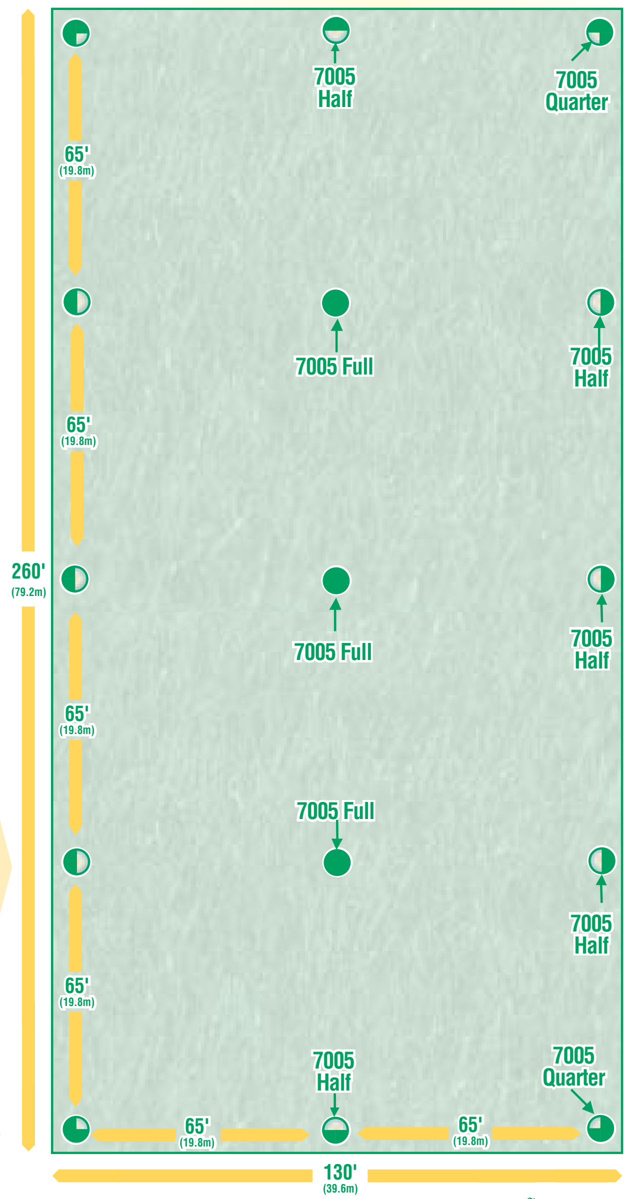


figure 11

figure 12