Irrigation Design for Efficiency

by Robert Bodi

I often tell my students that we live in a round world, but we are required to design and install irrigation systems that are manufactured to water a square one. With this in mind, how can we expect to ever have an efficiently designed irrigation system?

There are two major elements in being able to obtain an efficient irrigation system: They are the design of the system and the actual installation of it. You cannot achieve an efficient system without both of these two elements done properly. A poor irrigation design will frustrate a good installer and will result in system problems for years to come. Hiring an unqualified installer will waste a good design. To prevent this from becoming a reality, we will investigate just what it takes to design for efficiency.

There are many decisions that have to be made before a proper design process can begin. Some of the key components of the system will need to be decided upon before starting.

Water Window for Irrigation

Your point of connection (POC) is where the system starts. It is imperative for it to be sized correctly before the project begins. This is one of the most important aspects of designing a system. The POC could be the pump that pulls the water out of a lake or well or could be the connection to the city water main. The water demand for your entire system will need to be known to size this component. Some things to consider in sizing these are the total areas needed to be irrigated. Will there be one field or a complex? Will you sprinkle just the fields or common areas such as around concession stands, playgrounds, between fields and even parking areas? If these decisions cannot be nailed down prior to the initial design process, it would be wise to size the POC slightly larger for future additions.

Your water window will need to be addressed to determine the size of the POC. The water window is considered to be the amount of time it takes to exhaust the water from the system onto the area where it is needed. In other words, let's say you have a complex with four fields that have heavy play on them. You need to be able to sprinkle them in six hours and can only water five nights a week because of maintenance and play time (5 nights x 6 hours a night = 30 hours per week water window). For an example, the POC is sized to handle only one 2-inch zone running at any given time. You need 1 1/2 inches of water per week on your turf. You have 20 large rotor zones that are 2-inch valves and can deliver 3/4 inches per hour precipitation rate (PR). Therefore you will have to run each zone for two hours per week to achieve a PR of 1 1/2 inches for the week. This will give you a water

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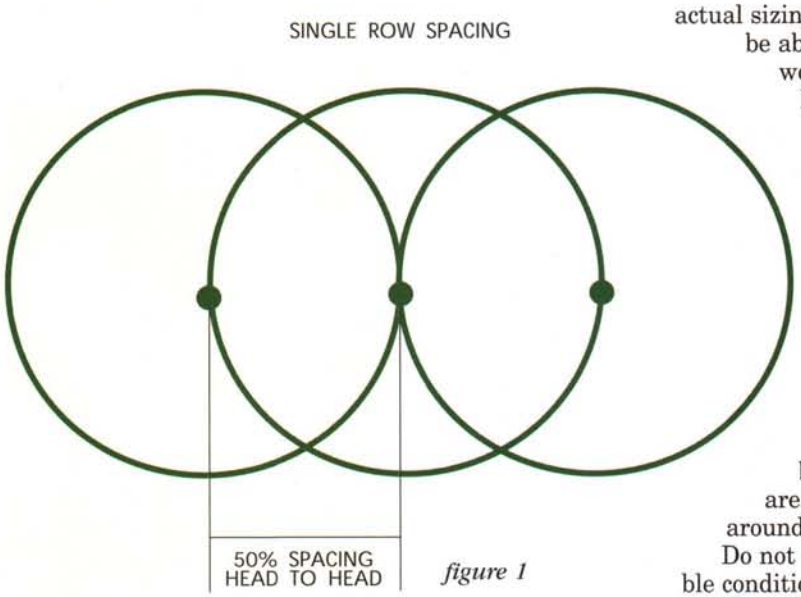

figure 1

window of 40 hours per week (20 zones x 2 hours run time per week). Remember that you can only run one zone individually at a time because of the size of the POC. So we have a problem: Our turf requires we run our system 40 hours per week, but we are only able to run 30 hours per week because of time limitations. What are our options? Hopefully we did our homework before the actual sizing of the POC and decided that we needed to be able to run two zones at a time. If so, then we would only have to size the POC and the main line to be able to handle the water demand within our water window.

The efficiency of the irrigation system is a factor to consider when sizing the POC and the main line. This will effect the run times greatly. The efficiency of a system will depend directly on such factors as wind, spacing of heads and psi of a system and its components. If a system has an efficiency rate of say 85 percent, then you would have to plan on watering approximately 15 percent longer to get the actual amount of water on the turf back to 100 percent of its needs. In most large area applications a good effciency rating will be around 70 to 80 percent.

Do not forget to size the system for the worst possible conditions. That is, design your system for the worst week of the year, with the highest ET rate for your area. If your system can keep up with that type of demand, then it will do what you will ask of it in the future.

Uniformity of Sprinkler Systems

An irrigation system with poor uniformity will be the main reason for wet and/or dry spots in the turf. One of the most important factors of good uniformity is sprinkler head placement. For good uniformity the industry stan-

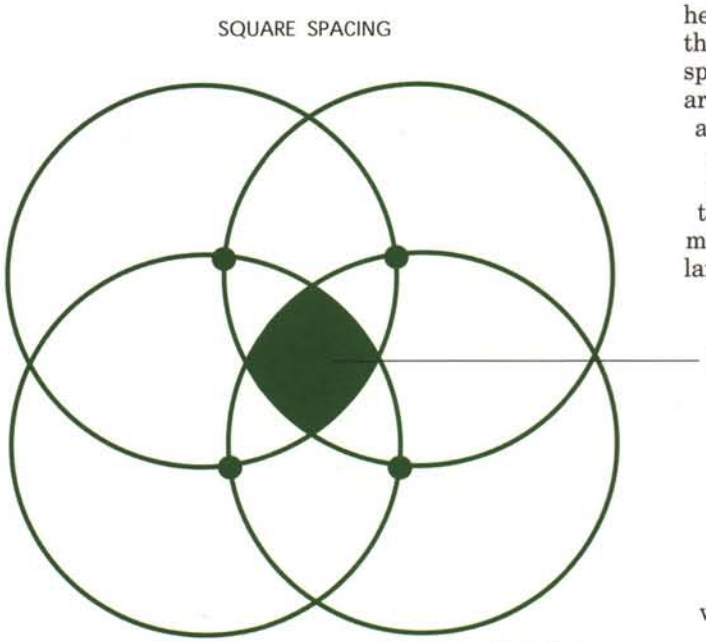

figure 2

dard is to place heads at 50 percent of their diameter. A common term for this is head-to-head coverage. On large turf applications such as golf and sports fields it is common to use 55 to 60 percent of the diameter. If you are irrigating an area with unusually high winds during the time of watering you should go to 50 percent of diameter or closer. Low angle nozzles are best for high wind situations also. They are less affected by the wind because of their low trajectory.

There are three types of spacing for heads: Single row, square and triangular spacing. Single row spacing provides the least uniformity, square offers higher uniformity, while triangular is the most effective.

In single row spacing (Figure 1) you will have a single row of heads in the center of the area to be covered. This is most common in golf applications. Single row spacing has poor uniformity and is not recommended.

The next type is square spacing (figure 2). This is where heads are placed in a square pattern grid on the area to be watered. The main problem with square spacing is that there is an area in the center of the square that does not get the same amount of water as the other areas.

The last type is triangular spacing (figure 3). It has the highest PR rate, best coverage and is easiest to manipulate the heads around irregular boundaries, such as infields, with the fewest effects on uniformity. The weak spot in square spacing is absent from triangular spacing. Typically you are required to use fewer heads in a large area with triangular spacing than with square spacing because of the efficiency of the watering grid. Therefore it is safe to say that the triangular system is the superior spacing technique to use for all of these reasons. There is a formula that is used for the placement of heads in a triangular system: Instead of spacing each row equally, use a multiplier of .866 for opposing rows. In other words, if you have a row of rotors spaced at 60 feet going from east to west, then the row spacing to the north will be .866 of 60 feet, or 52 feet.

Matched Precipitation Rates

The precipitation rate of a sprinkler system is a measure of the effective water that reaches the turf or area that you are trying to water. I have already mentioned that if you have poor spacing you will have uneven precipitation rates.

One other major factor in achieving good uniformity in your system is to match the heads to the area being covered to the other heads in that same area.

In any given area the water exhausted by irrigation heads must be matched to each other. In an area with heads that cover different amounts of ground, the heads or nozzles must be sized properly to deliver an amount of water that matches the other heads.

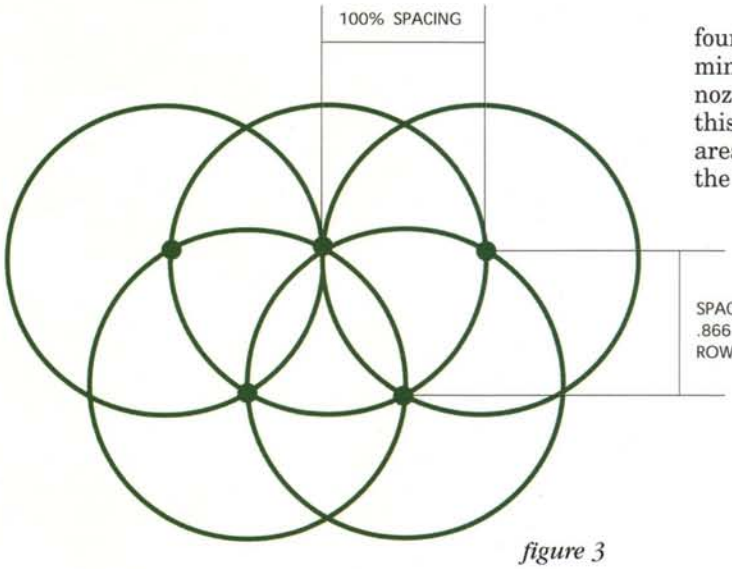

figure 3

TRIANGULAR SPACING

For example, let's say you have a zone with six heads each with a 60-foot radius. Four of them are 90-degree throws and two of them are 180-degree throws. The four heads have a nozzle that will deliver 10 gallons per minute. That would mean the two heads would need nozzles that deliver 20 gpm each. The principle behind this is that the 90-degree head is covering only half the area that the 180-degree head does. Therefore, if twice the area is being covered, then the head needs to deliver twice the water. This keeps the water distribution as equal as possible. Zones that do not have matched precipitation rates will not be able to perform properly.

We have looked at several of the main attributes needed to have an efficiently designed system. There is no doubt that your turf will suffer if any of these elements are not addressed when designing and installing your system.

Robert Bodi is certified through the Irrigation Association and teaches irrigation in a college degree program. He served on the STMA Certification Committee and was a member of the TNLA board for two years.