IRRIGATION OF GOLF GREENS

1 INTRODUCTION

1.1 The Importance of the Green

The green is the most important area of the golf course. How important?

- 50% of the shots for a par round of golf are either onto or on the green
- Tournaments are won and lost on greens
- Superintendents may keep or lose their jobs on the greens' quality
- Greens are the most expensive turf ($/m²) to construct and maintain
- Turf is cut short and it is more stressed than anywhere else

1.2 Achieving the Best Quality Green

To achieve the best quality green with the available resources, the Golf Course Superintendent needs to manage the:

- Water (the focus of this article)
- Root Zone
- Nutrients
- Surface

CONFIGURING IRRIGATION FOR GREENS

2.1 Configuration No. 1 - "Typical" - Only Full-Circle Sprinklers

Here we use all full-circle sprinklers to irrigate with an even (uniform) application of water to both the green and its surrounds.

The problem with this configuration is matching the different irrigation requirements of the green and its surrounds. Typically the green has a higher percolation rate and requires more water than its surrounds. So if we apply sufficient water for the green, the surrounds become waterlogged.

With Valve in Head irrigation systems, we can change the individual run times of the sprinklers to accommodate the different application needs of the green and its surrounds. But we are very limited in what we can do with this configuration.

Often, this difference in irrigation requirements is most noticed in the approach to the green. When the greens are elevated from the fairway, the low point created in the approach becomes easily water logged. Refer to Item 4 following for more information on this.
2.2 Configuration No. 2 - Supplementary Part-Circle Sprinklers

Here we add a set of part-circle sprinklers side by side with the full-circle sprinklers for targeted watering of the green. This allows us to add extra water to the green (eg, syringing) without wetting the surrounds which already have enough water.

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John Pryor operating the part-circle sprinklers on the green during the construction of the 3rd golf course at Kau Sai Chau Public Golf Course in Hong Kong. Hydrogold designed the irrigation system for this golf course which included 3 Flowtronex Pump Stations. The Golf Course Architect, Nelson-Haworth, designed with the large elevation variations to produce this spectacular golf course.
2.3 Configuration No. 3 - Back to Back Part-Circle Sprinklers

A common variation of the full / part-circle configuration (No. 2) is to use the "back to back part-circle configuration."

The inward facing part-circle sprinklers are used to independently irrigate the green...

The outward facing part-circle sprinklers and surround sprinklers irrigate the surrounds...
Some Golf Course Superintendents prefer this configuration since it is conceptually simpler. One set of part-circle sprinklers waters the green and the other set of part-circle sprinklers waters the surrounds. Simple! And that is about where the good news ends.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Configuration Nos. 2 &amp; 4 Hydrogold 's Recommendation</th>
<th>Configuration No. 3 A Common Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinklers</td>
<td>Full and Part-Circle Combination</td>
<td>Back to Back Part-Circle Sprinklers</td>
</tr>
<tr>
<td>Irrigation Uniformity</td>
<td>Most of the watering (say 80%) is applied by full-circle sprinklers that have high irrigation uniformity.</td>
<td>All the water is applied by part-circle sprinklers that have low irrigation uniformity. Part-circle sprinklers dump water at the end of their arcs (creating wet spots). Matching the arcs of back to back part-circle sprinklers is both problematic and a maintenance issue.</td>
</tr>
<tr>
<td>Programming</td>
<td>Full-circle sprinklers are the easiest to program - 360 degrees</td>
<td>Part-circle sprinklers need to have their arc of rotation measured, recorded and maintained.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Full-circle sprinklers have a longer life with fewer problems (no reversing mechanism).</td>
<td>Part-circle sprinklers need more maintenance.</td>
</tr>
<tr>
<td>Pinching In (see sketch below)</td>
<td>The inward facing part-circle sprinklers can be pinched in to the green with minimal impact on irrigation uniformity.</td>
<td>The inward facing part-circle sprinklers cannot be pinched in to the green since it leaves poorly irrigated areas behind the part-circle sprinklers.</td>
</tr>
</tbody>
</table>

**Pinching In with Back to Back Part-Circle Sprinklers Produces Dry Areas…**
2.4 Configuration No. 4 - The Optimum Solution

This is the same as Configuration No. 2 except the part-circle sprinklers are pinched in to the green (away from the full-circle sprinklers). This provides more targeted watering of the green.

First the bulk of the water (say 5 mm) is applied with the high uniformity full-circle sprinklers to both the green and its surrounds…

Then the Supplemental Water (say 1.5 mm) is applied using the Part-Circle Sprinklers to the Green only…

If you want a Drier Green, then the Part-Circle Sprinklers should face outward.
3 SPRINKLERS ON EMBANKMENTS

The placement (staking) of sprinklers on the ground is critical to the proper performance of the irrigation system. With the slopes commonly associated with greens (and tees), special care needs to be taken.

When we are installing sprinklers, we have two primary objectives:

- Keep the sprinkler top parallel to grade (ground) to avoid mower damage
- Keep the sprinkler top parallel to the area to be irrigated for irrigation uniformity

When staking the sprinklers, it is important to find an area where both these conditions are met. It would be nice for the sprinkler to be at the same level as the irrigated area but this is often not possible with undulating golf courses.

A light wind prevents any water falling on the green

The spray is at 41 degrees to the irrigated green instead of the standard golf sprinkler trajectory of 23 degrees.

A better location

Sprinkler incorrectly positioned on green embankment

This sprinkler is parallel with the ground but not the irrigated area. The solution here is to bring the sprinkler up the embankment. This will shorten the spacing to the adjacent green sprinklers but there will be minimal impact on irrigation uniformity from that. In fact, bringing the sprinkler top parallel to the irrigated area (the green) will in this case significantly improve irrigation uniformity. Also, some relocation of the surround sprinklers will be needed.

General Note: Shortening spacing between sprinklers (by say up to 25%) has a minimal impact on irrigation uniformity. However, stretching sprinkler spacing beyond specifications (by say as little as 5% but certainly 10%) has a large detrimental impact on irrigation uniformity.
HIGH SPRAY EASILY AFFECTED BY WIND

SPRAY FALLS SHORT,
NOT "HEAD TO HEAD" COVERAGE

DRY AREA LEFT
BY SPRINKLER ON SLOPE

TEE BOX (CRITICAL AREA FOR IRRIGATION)

BUDDY PATH

PREFERRED SPRINKLER LOCATION - VERTICAL ALIGNMENT OF SPRINKLER
- PROVIDES EVEN WATERING OF TEE (UNIFORM IRRIGATION)

SPRINKLER CORRECTLY INSTALLED (PARALLEL TO GRADE)
BUT SPRINKLER SPRAY IS TOO HIGH ON ONE SIDE AND TOO LOW ON THE OTHER
- RESULT IS DRY/WET AREAS, ON AND OFF THE TEE (NON-UNIFORM IRRIGATION)

SPRINKLER INCORRECTLY INSTALLED VERTICALLY AND ABOVE GROUND
- WILL BE DAMAGED BY MOWER

SPRINKLER INCORRECTLY INSTALLED VERTICALLY AND BELOW GROUND
- SPRAY WILL NOT CLEAR GROUND ON RIGHT HAND SIDE

SUITABLE ALTERNATIVE LOCATION FOR SPRINKLER

ENLARGEMENT

SPRINKLERS ON EMBANKMENTS (PARTICULARLY TEES, ALSO GREENS)
4 AVOIDING WATERLOGGED APPROACHES TO THE GREEN

4.1 The Problem

This thunderstorm at the Macau Golf and Country Club graphically shows the typical topography associated with waterlogged approaches to greens. Note the green elevated above the fairway. Also the slope of the green directs surface water to the green approach. Photo courtesy of Andrew Clacy (2005 Macau Open)

The Waterlogged approach to the green is an all-too-common problem. This situation commonly arises when the green is elevated above the fairway which (typically) creates a low point in the green approach.

The problem can be compounded by the back of the green being higher (to provide the golfer with a view of the green). This creates a surface water flow into the low point (the green approach). This is more a problem for intense rainfall. It will not arise with proper irrigation since there should be no run-off.

4.2 The Role of the Irrigation Designer

Often the irrigation designer is unfairly blamed for over irrigating this area. Our view is that the irrigation designer is to provide an irrigation system that applies water uniformly (efficiently) over the playing surfaces.

The Superintendent then modifies the actual application using the Irrigation Control System. This is where flexibility offered by Valve in Head sprinklers (as opposed to Block Sprinklers) is most appreciated.
One suggestion proposed (and which Hydrogold rejects) is to stretch the sprinkler spacing so the approach receives less water.

We strongly recommend not stretching the spacing to maintain irrigation uniformity...

Stretching the spacing creates drier areas near the sprinklers but leaves the area between them fully irrigated. That is, the wet area is still there...
4.3 Poor Drainage in the Green Approach

**Most often, poor drainage is the primary cause of waterlogged approaches to the green.** Since it is the most expensive to rectify, it is often overlooked. Some considerations are:

4.3.1 Budget Constraints, Golf Course Design and Construction
Sad to say, but this problem often exists from the very day the golf course is constructed. A combination of budget constraints, poor golf design and construction do not properly address the following issues.

As such, the Golf Course Superintendent has to undertake expensive rectification works for cost cutting during construction. Or maybe just live with the problem (and complaints from golfers).

4.3.2 Soil Structure
The soil structure in the approach is critical. A heavy soil will retain moisture and remain water logged no matter what. Even, with a sub-soil drainage system, the water will not move from a heavy soil to the sub-soil drainage pipe (tiles).

A proper soil structure should be put in place during construction.

4.3.3 Sub-Soil Drainage
When the green approach is a low point, sub-soil drainage becomes a necessity in almost all situations.

4.3.4 Surface Drainage from the Green Approach
Surface drainage is a result of the original design from the Golf Course Architect and how it is shaped during construction. Surface drainage is more applicable to intense rainfall. With proper irrigation, there will be no surface run-off.

4.4 Golf Course Maintenance and Operation

4.4.1 Compaction, Aerification and Top Dressing
The permeability of the soil will reduce with compaction. So it is critical to keep buggy traffic away from the green approach and minimise movement of other machinery through this area.

A program of aerification and top dressing with sand will maintain and even improve the soil permeability in this critical area.

4.4.2 Irrigation Operation
The run times of the sprinklers should be adjusted to the individual requirements of the areas they irrigate. You got to love Valve in Head systems for this.

**Use the cycle and soak feature of the Irrigation Control System to prevent surface run-off during irrigation.** Surface run-off produces both non-uniform irrigation and waterlogged areas.
Catch cup test to test Distribution Uniformity on this green at Melville Glades Golf Club in Perth, Western Australia. Hydrogold is designing the irrigation system as the Club progressively renovates its course.

Pipe and wiring for dual heads on the green

Note the catch basin in the approach to the green

Planning + Design + Product + Installation + Maintenance come together to produce this beautiful green and surrounds at the Angkor Golf Resort in Cambodia. Hydrogold designed the irrigation system for this Nick Faldo designed golf course.
5 HIGH PERCOLATION SURROUNDS - DRY GREENS
This article is based on the green requiring more water than its surrounds. While this is by far the most common requirement, there are occasions where:

✦ The native soils in the surrounds have higher percolation rates than the greens
✦ The native soils in the surrounds do not retain water in the profile unlike greens which normally use a perched water table
✦ The greens may want to be run drier than the surrounds (e.g. algae)

In these situations, the surrounds will require more water than the greens. This requires a simple inversion of the foregoing, e.g. Using configuration Nos. 2 or 4, the part-circle sprinklers would be facing outward from the green rather than inward.

6 SUMMARY
The green is the most critical area of the golf course. The career of many Golf Course Superintendents is often determined by the quality of the greens they maintain.

As usual, the "secret" to good greens is attention to Hydrogold's Quality Chain. Planning + Design + Product + Installation + Maintenance = SUCCESS

For more information, Refer to Hydroview No. 1 on the Hydrogold Education Centre. http://www.hydrogold.com/education.html#hydroview

Planning - Provide sufficient budget - Appoint a good design team
Design - Construct the green and surrounds properly. Flexible irrigation system
Product - Select product that has stood the test of time - 20+ years
Installation - Adhere to design and specifications - Don't bury mistakes
Maintenance - Aerate, top dress with sand, control irrigation

Tamarina Golf Club in Mauritius. The green for the magnificent 13th hole is nestled amongst the bushes at the river's edge. Hydrogold designed the irrigation for this Rodney Wright designed golf course.

Hydrobull No 204 - Irrigation of Golf Greens - 2012-09-27 (Revised 2017-07-16) - Page 13
7 DESIGN CASE STUDY - El Macero Country Club (Added 2013-01-01)

We have just completed the irrigation design for the new practice greens at El Macero Country Club in Davis, California (designed by GolfPlan).

The 4 sheets following show Hydrogold's preferred layout of green sprinklers. That is Configuration No 4 outlined in Item No 2.4 of this article. That is:

- Applying water to both the green and surrounds using high uniformity, triangularly spaced full-circle sprinklers
- Targeted watering of the green with independently-spaced (supplementary) part-circle sprinklers.

This is the optimum solutions since the bulk of the water is applied using the efficient irrigation of the full-circle sprinklers. The part-circle sprinklers are used for targeted irrigation of the greens (e.g. syringing, apply extra water to green only).

7.1 Sheet 1 - General Information - Legend and Title Block
7.2 Sheet 2 - Overall Layout - Showing the sprinkler, pipe and valve layout
7.3 Sheet 3 - Full-Circle Sprinkler Operation - Uniform Coverage
7.4 Sheet 4 - Part-Circle Operation - Targeted Coverage of the Green
AIR VALVE IS TO BE LOCATED ON SITE AT THE LOCAL HIGHPOINT OF THIS SUB-MAIN.

TREES / LANDSCAPING

PG

PG

Ø100 (4"")

Ø150 (6"")

Ø250 (10"")

Ø250 (10"")

APPROXIMATE LOCATION OF EXISTING 10" IRRIGATION MAINLINE WITH 90 PSI. CONNECT MAINLINE AND LOCATE NEW CONTROLLER HERE. PRECISE LOCATIONS TO BE DETERMINED ON SITE WITH THE OWNER.

THIS CONTROLLER IS TO BE CONNECTED TO THE POWER SOURCE AND THE COMMUNICATION LINE.