

HYDROBULL No 3

A TECHNICAL BULLETIN from HYDROGOLD
INT'L WATER MANAGEMENT CONSULTANTS



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WATERING WINDOW

This is the last of the 3 basic irrigation parameters:

- ‡ Area of Coverage - The area watered by (in this case) the sprinklers
- ‡ Peak Application - The maximum application (precipitation) for the hottest period
- ‡ Watering Window - The time period during which the irrigation occurs

The watering window is the time taken to complete a full irrigation cycle. That is, the time to apply the Peak Application over the Area of Coverage.

This article ties all 3 basic irrigation parameters together.

1 FACTORS IN DETERMINING THE WATERING WINDOW

There are many factors to consider. Not all will apply in all cases and the relative importance of each will vary between projects. It is important to be aware of all influencing factors in making the optimum choice.

1.1 Budget

From a budget point of view, the longer the Watering Window, the better. The longer Watering Window means smaller pumps and mainlines - lower cost. See later in the article for the explanation.

1.2 Wind

Higher wind leads to lower irrigation efficiency - lower uniformity and higher water losses due to wind drift. Therefore we need to be aware of selecting our Watering Window so that we avoid high-wind parts of the day/night.

Typically the night time has much lower wind speeds. Often the wind (particularly during the peak irrigation season) has a regular pattern. However, there are notable exceptions and site-specific wind data is important (refer to Hydrobull No 1 on Sprinkler Coverage).

1.3 Power Tariffs

Many areas offer significant savings to operate pumps during off-peak hours.

Electricity grids are typically heavily loaded from 6 pm to 10 pm and (perhaps) from 7 am to 8 am. So reduced tariffs are often given overnight (between say) 10 pm to 6 am. These may represent as much as a 50% saving. With the pumps' power rating (typically) between 100 to 200 kW, this can translate to several thousands of dollars each year.

Operating during off-peak times normally means the power is better quality which helps everyone out.

In some areas where the power grid is already critically loaded, it could be a condition for getting the connection license.

Location conditions need to be considered for each project.

1.4 Impact on Operations - Use and Maintenance

While irrigating, the facility is not available for other uses. In particular, this impacts on sports field use and maintenance. While a shorter Watering Window will increase the cost, this may need to be balanced by increased revenue generated by the facility being open for longer hours.



The (3) Irrigation Pump Stations at the Singapore Turf Club (Kranji). The Watering Window for the main track is a tight 2 hours. The system (designed by Hydrogold in 1997) included watering for 5 different tracks as well as the extensive landscape irrigation of street verges for the surrounding complex.

1.5 Night Time Irrigation

With the occasional exception of agricultural irrigation, irrigation normally takes place at night. There are many reasons supporting this:

1.5.1 Reduced Water Loss

- a) Lower night temperatures have less evaporation losses
- b) Less wind provides a higher uniformity of coverage
- c) Less wind leads to lower drift loss.

1.5.2 Human Traffic

With golf, commercial and residential irrigation, there is normally a need to consider human traffic. We need to consider the hours when there will be human traffic. Typically these times are not available for irrigation.

1.5.3 Effluent/Recycled Water - Safety and Regulation

Where effluent/recycled water is in use, it is likely that regulations will specify that the irrigation must finish a certain time (say 2 hours) before human traffic is allowed.

1.5.4 Night Lighting

Particularly for golf courses, we need *special consideration for night lighting*. Typically this has a significant impact on the available Watering Window. Eg. Night golf to 11 pm may restrict us to a 6-hour Watering Window (eg, from 11 pm to 5 am).

But it may not be as simple as that. There may be only 9 holes lit. Or it may be only the finishing 4 holes of each nine holes that are lit. These situation require a more sophisticated approach incorporating the potential scheduling requirements into the irrigation design (primarily pump capacity and mainline sizing).

1.5.5 Breaking the Disease Cycle

Some agronomists believe that night irrigation helps break the disease cycle.

When there is night irrigation, the crop (typically turf) dries out during the day, slowing/preventing the spread of a disease.

With day irrigation, the crop (turf) is wet during the warm day. In the cool of the night, there is condensation on the crop that leaves the crop moist 24 hours a day. This promotes the spread of disease.

2 WHY IS AN 8-HOUR WATERING WINDOW SO COMMON FOR GOLF?

This allows the irrigation cycle (for example) to:

- ‡ Start at 10 pm (after the peak power load of the power grid)
- ‡ End by 6 am (allows 1 hour of maintenance and a 7 am opening to public)

Obviously this has not considered each of the factors listed above, but it is a default standard for golf (when there is no night golf).

3 TYING THE 3 BASIC IRRIGATION PARAMETERS TOGETHER

Basic Irrigation Parameters

- ‡ Area of Coverage
- ‡ Peak Application (Depth)
- ‡ Watering Window

Irrigation Volume = Area * Peak Application (Depth)

$$\text{Pumping Rate} = \frac{\text{Irrigation Volume}}{\text{Watering Window}} = \frac{\text{Area} * \text{Application}}{\text{Watering Window}}$$

For Example:

Area = 40 Ha = 400,000 m²

Peak Application = 6 mm = 0.006 m

Watering Window = 8 hours

The *theoretical* formula is:

$$\text{Pumping Rate} = \frac{400000 \text{ m}^2 * 0.006 \text{ m}}{8 \text{ h}} = 300 \text{ m}^3/\text{h}$$

4 IMPACT OF WATERING WINDOW ON BUDGET

From the equation above, we can see that if the watering window was halved to 4 hours, the pumping rate would be doubled to (a huge) 600 m³/h. Doubling the pump station capacity (and the carrying capacity of the mainlines) would have a large impact on the budget.

More typically the decisions are being made between a 10 hour or 8 hour Watering Window in which case the impact is still significant (say 5% to 10% of the irrigation budget).

5 REFINING THE EQUATION

The above equation needs to be modified:

$$\text{Pumping Rate} = \frac{\text{Area} * \text{Application}}{\text{Watering Window}} / \text{Scheduling Efficiency}$$

The Scheduling Efficiency (not to be confused with Scheduling Coefficient for sprinklers) is the efficiency of the control system to schedule the irrigation (programming).

For example. A large system for a golf course with a Computerised Central Controller:

$$\text{Pumping Rate} = \frac{400000 \text{ m}^2 * 0.006 \text{ m}}{8 \text{ h}} / 0.9 = 333 \text{ m}^3/\text{h}$$

With stand-alone controllers, the Scheduling efficiency may be around 0.7 and with a manually operated system around 0.45. *That is, a manually controlled system would need twice the pumping capacity of a centrally controlled system.*

With small landscape systems, the scheduling efficiency is typically 0.5 to 0.7 depending on the flow of individual zones and the manual programming of the controller(s).

IN SUMMARY...

We see that the 3 basic irrigation parameters,

- ‡ Area of Coverage
- ‡ Peak Application
- ‡ Watering Window

all significantly impact the performance and cost of the irrigation system. The importance of each is (generally) in the order listed above.

A Most Important Point, let me repeat, A MOST IMPORTANT POINT...

Once an irrigation system has been designed for these 3 irrigation parameters, you have defined the maximum capacity of the system. You cannot make changes without impacting one of the other parameters. For example.

- ‡ If we add more sprinklers to the system, then we will increase the Watering Window.
- ‡ If we want to increase the Peak Application, the Watering Window will be increased. This is likely to cut into golf course operating hours. Eg. Increasing the Peak Application from to 5 mm to 6 mm will increase an 10-hour Watering Window to 12 hours.
- ‡ We cannot shorten the Watering Window by just increasing the pump station flow. If we increase the pump flow, then the mainline capacity (sizes) would need to be increased - a prohibitively expensive exercise. There may be possible changes needed for the Irrigation Control System as well.

Remember: *Define all your 3 basic irrigation parameters at the time of the design because that is what you will live with for the life of the system.*

Consider potential changes in the future. Eg. Additional areas of coverage (sprinklers) or shorter Watering Window (for night golf) or higher application (replanting with new plant species or a change in turf management practices).

Employ the services of a professional water management consultancy like Hydrogold to help decide on these critical parameters.



This "Wall to Wall" irrigation system for Luxe Hills Golf & Country Club in Chengdu (China) was designed by Hydrogold with 1,654 sprinklers (Nominal Area of 63 Ha or 155 acres) a Peak Application of 5 mm/day (1.38 inches/week) and a Watering Window of 8.5 hours.

The Golf Course Architect is Mark Hollinger of JMP Golf Design, a long-time Hydrogold Client Luxe Hills was voted by China Golf in 2007 as the Best New Golf Course Design.