



# What is Smart Watering?

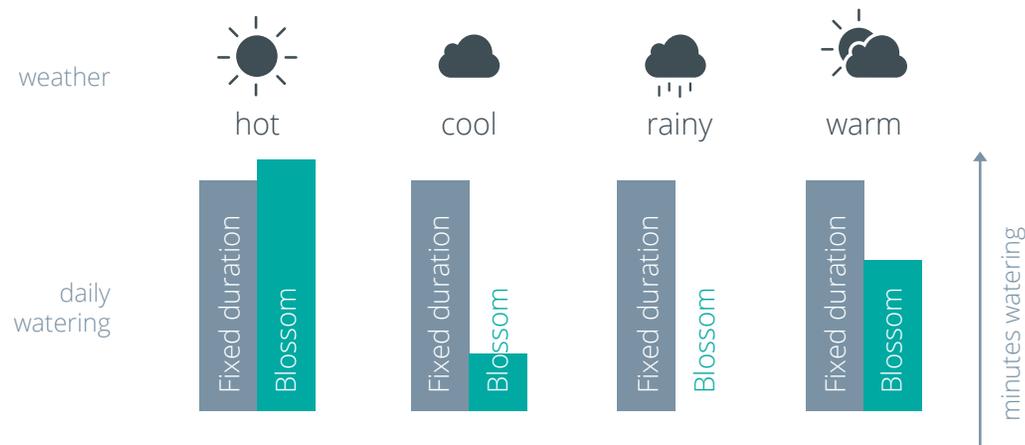
**blossom**





## What is Smart Watering?

Smart Watering provides plants the exact water they need, when they need it – without requiring continuous manual adjustment. Blossom’s Smart Watering algorithm gathers local weather data, plant information, and site-specific conditions to calculate exactly how much water a given zone needs and applies it according to your specified watering schedule. This means that on the sunniest, hottest, driest days, the Blossom Controller will apply extra irrigation to replenish what is lost. On cooler, less sunny days, less water is needed. Rain, if forecast, is subtracted from any irrigation requirements. The result is an automatically adjusted watering schedule tailored for your garden.





## How it Works?

### Evapotranspiration ET and ETo

ETo Variability

Customization

Leaky Water Buckets

Creating the Schedule

Error

Future Steps

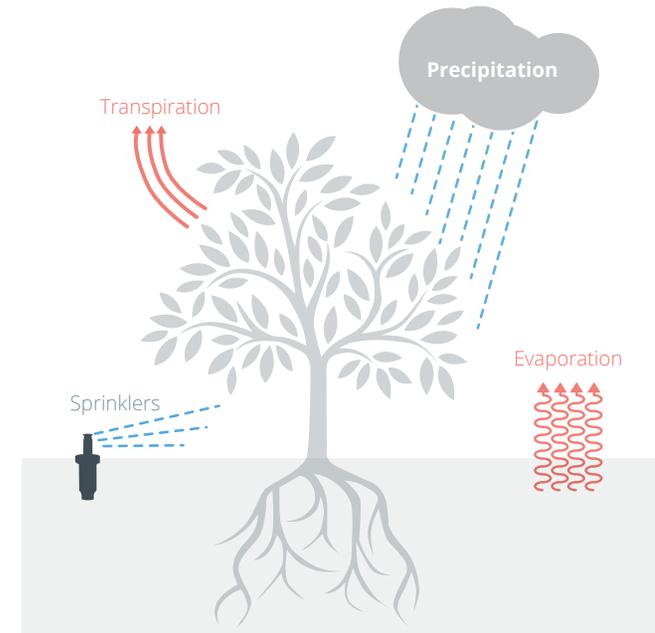
## Evapotranspiration

### What is Evapotranspiration?

Smart Watering is based on a well-studied concept used widely in commercial agriculture, called Evapotranspiration, or “ET.” Evapotranspiration is the process by which water is transferred from the soil to the atmosphere, by evaporation directly from the ground as well as through transpiration by plants. (Transpiration is evaporation through a plant’s leaves.) The total amount of evapotranspiration is determined by numerous factors, with the prevailing weather and plant type first among them. For example, evapotranspiration will be higher for plants with broad, leafy foliage as compared to a plant with small, waxy leaves. Similarly, evapotranspiration will be greater on dry, sunny days than on cloudy, cool days.

In practice, the amount of evapotranspiration is calculated for a reference plant, typically, grass, under certain standard site conditions. This standardized reference value, which varies every day is called Reference Evapotranspiration, or “ETo”.

ETo is typically measured in millimeters. For example, over a given surface area of land, an ETo of 20mm means that 20mm of water would evaporate from that surface area.





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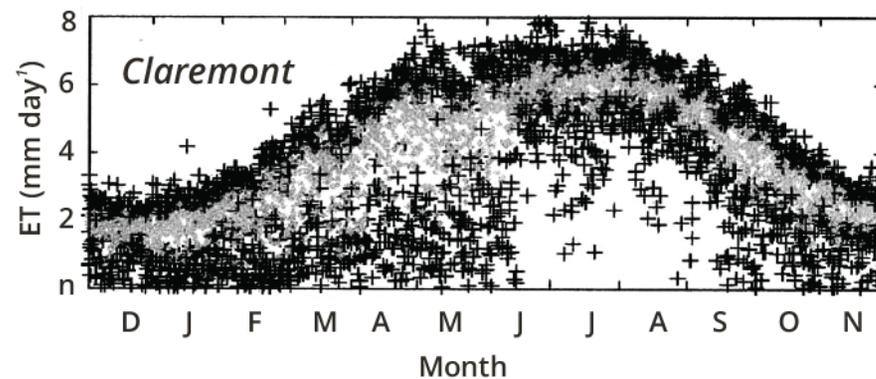
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## ETo Variability

ET is the fundamental driver of water loss in your garden, and the simple fact is that it varies every day. The primary drivers of daily variation are net solar radiation and relative humidity. Average temperature, wind speed, and wind direction are also important variables. (Hidalgo, et al.) Though there is a strong, predictable seasonal trend, there is significant daily variation as well, particularly in spring when the weather is the most unpredictable. (See Fig 1). This is important because automatic sprinkler systems are usually set to run long enough to water all your plants enough for the most demanding days. Smart Watering, by contrast, uses ET to determine what is needed on each day, saving water and also keeping plants more healthy by not overwatering them.



(Figure 1. Chart of daily ETo for a typical California city.  
From Hidalgo, et al.)



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## Customization

At Blossom, we calculate an ETo value for your exact location, synthesizing weather data from a variety of sources. But ETo is a standardized value — it applies only to a specific crop type. What if your garden has something other than the reference crop growing in it? That is where our **Xona Technology** comes into play. You tell our system what you are growing in each zone of your sprinkler system: shrubs here, flower beds there, grass over there. With that information, we can calculate an adjusted ET value for each zone of your garden.



- 1 Shrubs  
not exposed to rain
- 2 Flowers
- 3 Grass
- 4 Trees
- 5 Shrubs



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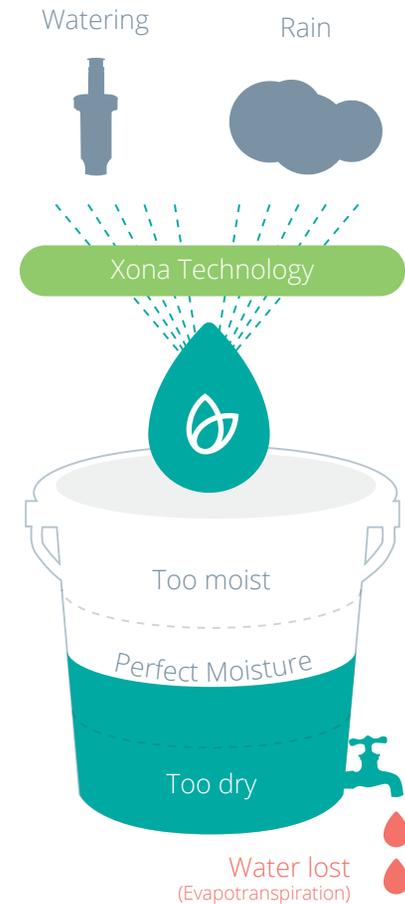
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## Leaky Water Buckets

ET tells us how much water is lost each day, but that alone is not enough to determine how much water to apply. For that, we use a “leaky bucket” algorithm. Imagine a bucket that represents the soil’s ability to hold water. ET is slowly emptying the bucket each day, and rain sometimes fills the bucket. Our goal is simply to keep the water level in the bucket centered between two levels: a minimum (where the soil becomes too dry) and maximum level (where the soil becomes too moist). Xona Technology, then, uses ET along with measured and predicted rainfall to determine how much water (in mm) a given garden zone requires.





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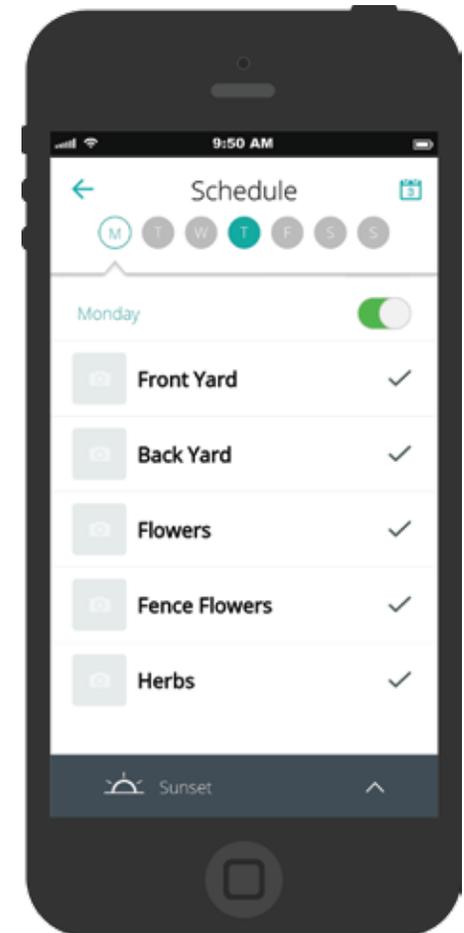
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## Creating the Schedule

There is still another piece of the puzzle. How do we convert from mm of water to irrigation duration? For that calculation, Blossom uses a few more pieces of information. One piece we need is your desired schedule. Can you water every day? Only once or three times a week? Obviously, if you water less frequently, individual cycles must be proportionally longer. Additionally, Xona uses knowledge of the type of emitters (sprinkler heads, drippers, etc) used in your garden. Emitters have calibrated flow rates, so we can establish a reasonable estimate of how much water flows per minute, from a given emitter. The final step is to make some standard assumptions about the coverage of your emitters (the number of emitters per area of garden) and we can calculate customized run-times for each zone of the your system each day.





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### Error - Fixed Sources

You may have noticed that there are a few sources of uncertainty in this puzzle. Sources of error generally fall into two categories: fixed and variable. All the fixed errors are things specific to your garden that we might not know. For example, what if your garden is partially shaded, or planted on a slope? What if your drip emitters are far apart or closely spaced? These variables are specific to your situation but they don't generally vary with time. That is why the Xona modeling in our App allows you to make an overall adjustment to each zone of your garden. You can increase or decrease, on a relative basis, the amount of water going to a given zone. We will make a good starting estimate, but you can fine tune the adjustment over time by observing your garden. Once you set it, we'll remember and learn so we can always give your garden the right quantity of water.



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## Error - Variable Sources

Remaining error comes primarily from things like inaccurate weather forecasts. For example rain might have been predicted but it never actually occurs. In this case, the Smart Watering technology would indeed get a given day's schedule wrong. However, before it is time to calculate the following day's schedule our system will have the actual weather from the previous day. As a result, we can adjust the following day's schedule to deal with any error in the previous day's forecast. The crucial element here is that in this system of constant feedback, error from forecast does not accumulate. Instead, errors from one watering schedule are constantly being zeroed out with adjustments to later schedules.

By the way, an important thing to note about weather variability is that fundamentally, the more variable the weather the more valuable becomes Smart Watering. Imagine a world in which the weather was the same every day. In that world, you could set your sprinklers on a fixed schedule for the exact amount of required water, and you'd never need to adjust it again. It is in the context of the variability of real weather that Smart Watering truly shines. And even though the application of water in one given day may be slightly incorrect due to the forecast error, the difference will be made up in the next cycle. Over the course of a week or a month, a Smart Watering schedule can be very close to optimal.



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Blossom believes our Smart Watering system is the most effective and efficient in the world for residential gardening. But, of course, we are perfectionists, and will continue to evolve our technology. For example, we may incorporate more information, such as sun exposure, site grading, and orientation. We may even incorporate local rain sensors, soil sensors, or your very own amateur weather station so you can have hyper-local weather data to use in the calculations. Each step takes us closer to the optimal irrigation for your garden!

If you have any questions, comments or suggestions regarding this document, please contact:

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## References

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