Recommendations for Optimizing Use of Smart

Irrigation Controllers

Support provided by

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INTRODUCTION

Recent research on landscape irrigation has found that homeowners using in-ground, automatic irrigation systems—typical in Florida—apply 260% more water than homeowners without automatic irrigation systems (DeOreo et al., 2016). This is largely due to a "set it and forget it" mentality despite seasonal fluctuations in plant water needs (Mayer et al. 1999).

To reduce the waste of irrigation water (e.g., after a substantial rain) in 1991 Florida pass a law—the Florida Statute 373.662—that stated that: "Any person who purchases and installs an automatic lawn sprinkler system after May 1, 1991, shall install, and must maintain and operate, a **rain sensor device or switch** that will override the irrigation cycle of the sprinkler system when adequate rainfall has occurred". With the development of new technologies, the statute was changed in 2010 to: "Any person who operates an automatic landscape irrigation system shall properly install, maintain, and operate **technology that inhibits or interrupts operation** of the system during periods of sufficient moisture".

"Smart irrigation control" technologies for irrigation have been developed to apply only the required amount of water to the landscape, reducing irrigation waste. Therefore, they comply with Florida Statute 373.662 and can be used instead of rain sensors. The Irrigation Association (www.irrigation.org) defines smart irrigation controllers as "controllers that reduce outdoor water use by monitoring and using information about site conditions (such as soil moisture, rain, wind, slope, soil, plant type, and more), and applying the right amount of water based on those factors". Essentially, these irrigation controllers receive feedback from the irrigated area and schedule or adjust irrigation duration and/or frequency accordingly. For example, they would reduce watering in the cooler months compared to the hot and dry months. There are generally two types of smart controllers: soil moisture-based controllers and climatologically-based controllers, also known as evapotranspiration or ET controllers.

These controllers, however, cannot fix a poorly designed or poorly maintained irrigation system. Thus, it is important to have the irrigation system inspected regularly and to have necessary maintenance performed in a timely manner. Always check for proper operation of the automatic irrigation system before installing smart irrigation controllers. As a reference, an irrigation system evaluation form is included at the end of this guide as Appendix I. In addition, check lists for the installation of SMSs and ET controllers are provided in APPENDIX II and APPENDIX III, respectively.

SOIL MOISTURE SENSORS

Soil moisture sensors (SMSs) are add-on devices that connect to conventional irrigation system time clocks, or timers (Figures 1 and 2). The goal of adding a SMS is to skip unnecessary irrigation cycles already programmed in the timer. Limiting water or reduced watering, as done by a properly installed and maintained SMS, has not been found by UF to decrease turf quality, but to reduce overwatering.
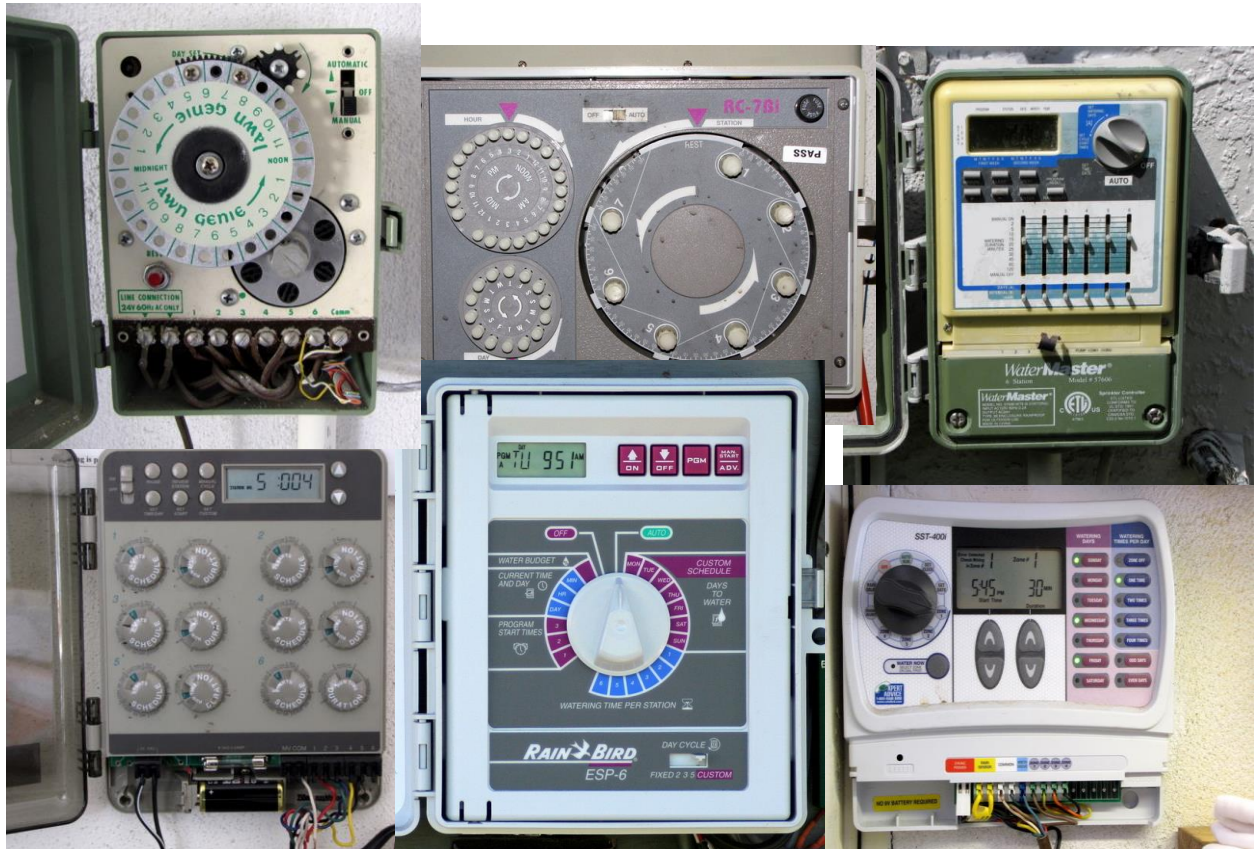
Figure 1. Electromechanical to electronic timers, commonly used in the Tampa Bay Area.
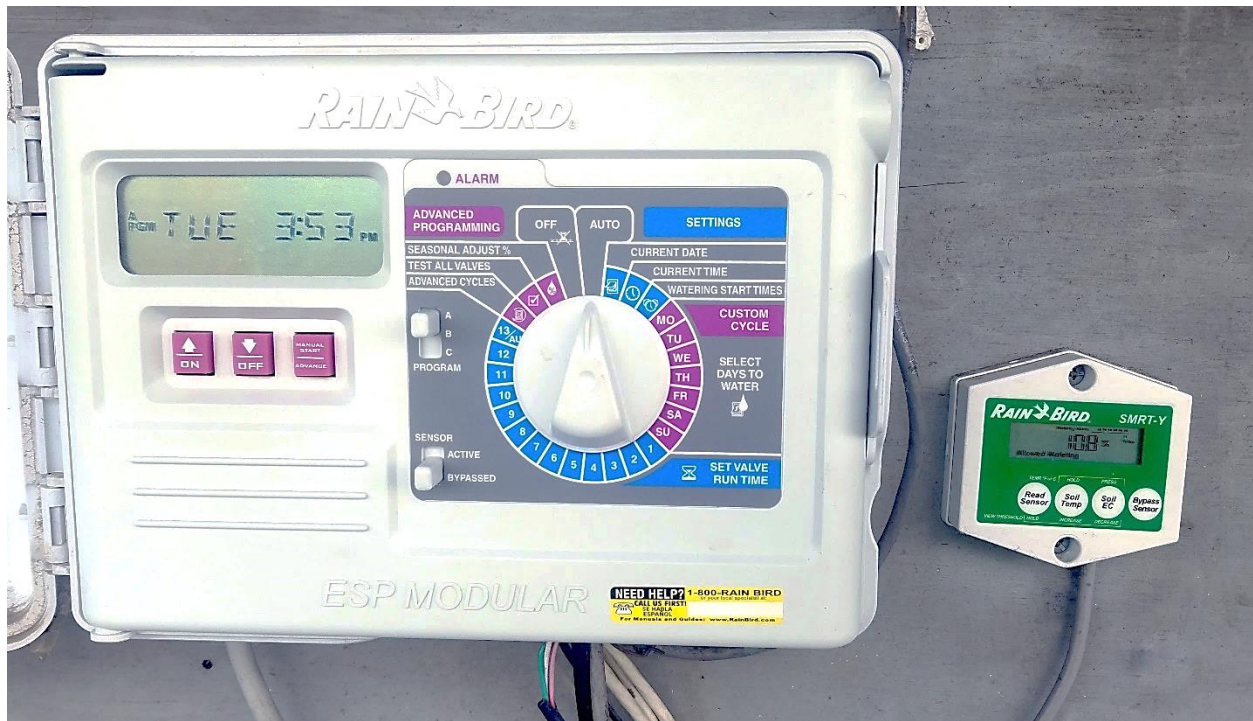
Figure 2. SMS controller connected to an irrigation timer

Commercially Available Systems

A SMS system includes a probe to be inserted in the soil and a controller where a user-adjustable soil water content threshold is set. Four current commercially available SMS systems that have been evaluated at the University of Florida are shown in Figure 3. Advantages and disadvantages of each are presented in Table 1.

Table 1. Currently available SMS systems evaluated at the University of Florida; advantages and disadvantages of each one.

Brand	Model	Advantages	Disadvantages
Baseline	WaterTec S100	2-wire sensor Easy connection to any valve	Wired
Rain Bird	SMRT-Y	3-wire sensor Easy connection to any valve	Wired Transform a 2 wire connection to a 3 wire connection
Toro	PSS	Wireless sensor More options for installing the sensor	Batteries last approximately 2 years Difficult to find it after 2 years
Hunter	Soil-Clik	Availability	Condition the sensor for 30 minutes before burying it Make a slurry to bury the sensor Wired Always install the sensor in the last zone No wiring to a valve option Wire must run from the sensor to the controller

Figure 3. Examples of SMS systems evaluated at the University of Florida.

Note: During the preparation of this guide, the Environmental Protection Agency (EPA) WaterSense program, is finalizing a protocol to test SMSs. If a commercially available SMS passes the test, EPA will grant that model a WaterSense label, meaning that it meets the criteria as a water-efficient product and as a resource to help save water. At that point, TBW will only endorse SMSs with a WaterSense label.

Irrigation Control

Two types of control strategies are employed with SMS controllers, "bypass" and "on-demand". The bypass configuration will be explained in this document, since it is the most common for small sites such as residential and light commercial.

Typically, a bypass SMS controller has a soil moisture threshold adjustment from "dry" to "wet", which can be adjusted by the user to suit specific plant, soil, and microclimate needs. The soil moisture content is routinely checked by the sensor and compared to the threshold setpoint. When the timer sends the electric signal to initiate irrigation, if the measured soil moisture is above the setpoint (too wet), irrigation is not allowed. The typical mechanism used by SMS systems to bypass an irrigation cycle is by electronically breaking the common wire.

These SMS controllers do not interrupt irrigation events once they are allowed to begin. To do this, they are either connected to the last irrigation zone or have a time delay so that, once irrigation begins, all irrigation zones will receive water.

Number of Sensors

Many of the SMS systems only include one probe to be buried in the soil. For properties with 8 irrigation zones or less, a single sensor is adequate to control the entire automatic irrigation system, in which case the sensor should be buried in the irrigation zone requiring most frequent irrigation and the runtimes for the other zones should be adjusted to limit over-watering. The zone requiring most frequent irrigation is normally full sun turfgrass.

Location of the Probe; do's and don'ts

The SMS probe(s) should be:

- located in the root zone of full sun turfgrass (Figure 4),
- in undisturbed soil,
- with the center of their sensing section approximately 3 inches deep,

Areas to avoid – general

When establishing the SMS location, certain areas and site conditions should be avoided (see Table 2 and Figure 5).

Table 2. Probe locations to be avoided

Install the sensor at least 5 feet away from	To avoid
A property line	Irrigation overspray from a neighbor's yard
An impervious surface	Runoff from impervious surfaces and compacted soil around impervious surfaces
A structure (e.g., house, porch, shed, etc.)	Compacted soil, shade, and runoff
A depression/swale	Naturally high soil moisture content areas
On-site treatment and disposal systems (e.g., septic tanks, drain fields)	High moisture areas
A plant bed	Higher runoff, shade, and unrepresentative plant roots
A shaded north side of the home (if possible)	Areas with a lower ET rate and higher moisture content
A downspout	Areas with higher amounts of inflowing water relative to the rest of the landscape
An overhang	
A hose bib	
An air-conditioner system condensate line	

Figure 4. Good location for installing the SMS probe

Figure 5. Not a good location for installing a SMS probe

A newly developed landscape will have fill material that must be considered during SMS installation. On other occasions it will be difficult to tell if the soil has been, or will be, compacted. Installers should use their best knowledge of the landscape history and projected use to determine the SMS location. If it is known that the soil has been, or will be, compacted in one area, the SMS should be installed elsewhere. Therefore, the sensor should be installed away from:

- A construction road
- An area with plant debris (e.g., tree stump)
- An area with fill dirt (if fill dirt is unrepresentative of the entire landscape)
- Buried material (e.g., cable, water, or sewer line)

Probe installation

Different types of probes require different installation procedures. However, common to all is the sensor mechanism should be placed within the root zone, with the center of its sensing section at approximately 3 inches deep, in undisturbed soil. Good contact between the probe and the soil (preventing void spaces) is fundamental for proper functionality of any SMS system.

Sensor types

Three types of residential sensor probes are now typically available in Florida: (1) flat, (2) node, and (3) rod. Installation procedures vary by type.

Flat Sensor Probes:

- Encased wave guides: The Baseline WaterTec S100 sensor probe is long, flat, and has a solid surface encasing the wave guides. It should be installed horizontally and with the thin side facing up (Figure 6).

- Exposed wave guides: The Rain Bird SMRT-Y sensor probe is long, flat, and has exposed rounded wave guides (steel rods). It should be installed horizontally and with the wide side facing up (Figure 7).

Figure 6. Sensor probe with encased wave guides been inserted within the root zone
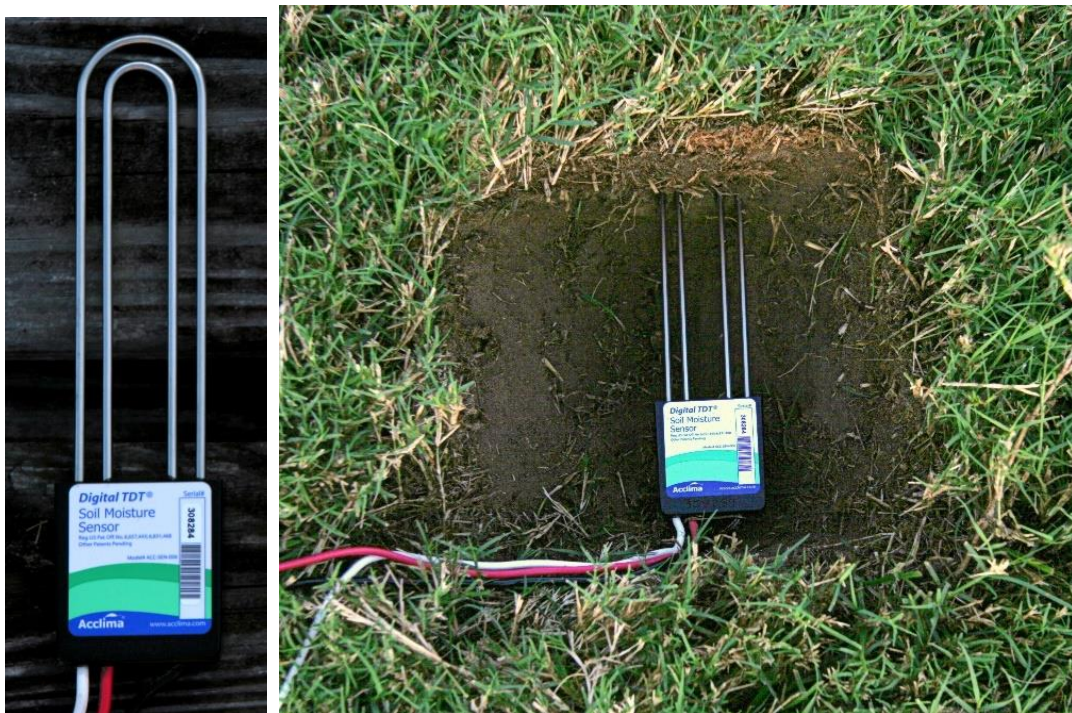
Figure 7. Sensor probe with exposed wave guides been inserted within the root zone

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For flat sensor installation in existing turfgrass, an area of sod must be removed to accommodate the probe and a trench must be dug to run the SMS wiring. A square-point shovel is required for proper SMS installation (Figure 8).

Figure 8. Square-point ditching shovel required for SMS installation

Procedure:
1. With the recommended shovel, dig a square hole to a depth of 8 to 10 inches, ideally creating a sod plug that can be pulled out whole, while creating a wall of undisturbed soil where the probe will be inserted (Figures 9 and 10).
2. In established turfgrass, and for an easier insertion of the probe, cut the turfgrass roots to fit the sensor into the wall of the hole, at 3 inches deep, by using a "metal slicing tool" (thinner than the probe) and mallet (Figures 11 and 12).

In new landscapes, the SMS will often be installed prior to installation of the sod. Typically, the sod comes with 1 – 3 inches of soil. Therefore, for these cases, the probe should be installed with the center of its sensing section at 2 inches deep, waiting for the sod to be laid on top.

3. Slide the wave guides of the probe completely into the wall of the hole (Figure 13).

4. Gently compact the soil above the sensor to ensure that there is adequate contact between the sensor probe and the soil (Figure 14).

5. Replace the cut square of turfgrass and soil to completely cover the sensor probe. Gently compact the cut square of turfgrass sod, making sure that there are no channels that will allow water to seep in and pool around the SMS probe. Additional soil may be required around the edges of the soil plug to fill in any remaining gaps (Figure 15).

6. Dig the trench to run the wiring, make the connections according to the manufacturer's specifications, and check for proper SMS controller functioning. *Note:* Inadvertent cutting of the wiring is one of the greatest threats to SMS operation. It is highly recommended that all in-ground wiring be encased in conduit to protect it from being severed.

Figure 9. Cutting a square plug of turfgrass

Figure 10. Removing a square plug of grass. Around 80% of the fine/active roots are located above the red line, which is around 3 inches from the surface of the soil

Figure 11. Root cutting procedure preparing soil for SMS installation

Figure 12. Depth recommended to insert the probes (3 inches deep)

Figure 13. Wave guides of the probe completely inserted into the undisturbed wall of the hole

Figure 14. Compaction of soil around sensor to reduce void space and ensure adequate contact between SMS probe and soil

Figure 15. Soil and turfgrass plug replaced, covering SMS probe prior to burying wire

Node Probes

Two models of node probes are currently available: The Hunter Soil-Clik (with one probe) and the Irrometer Watermark (with a pair of probes). These node probes are known as Granular Matrix Sensors (GMS). The installation method for node probes differs from the flat probes.

Procedure:

1. Soak lower two-thirds of probe for 30 minutes before installing. Do not allow water to cover the top cap where wires are connected (Figure 16).
2. With the help of a mallet, insert a ½" PVC pipe to make a vertical hole to the desired depth in the soil (outside diameter 7/8") (Figure 17).
3. In a container, mix a slurry of native soil and water, and pour into the hole (Figure 18 and 19).
4. Place the sensor in a vertical position at bottom of the hole (Figure 20).
5. Pack native soil tightly around probe. Soil must be in full contact with probe (Figure 21).
6. Allow the probe to acclimate for 2 to 3 days and water normally, before proceeding to sensor-based irrigation.

7. Particular attention should be taken when installing Granular Matrix Sensors (Figure 16). Due to their design, the probes of GMSs need to be connected to the last zone to run, so the sensor is not wetted before all valves have been already allowed to irrigate. Sometimes this means the irrigation zones on the controller should be re-sequenced, so the area where the sensor has been installed is the last to run.

Figure 16. Soaking the GMS probes

Figure 17. Making a vertical hole to insert the probe

Figure 18. Mixing a slurry of native soil and water

Figure 19. Pouring the slurry into the hole

Figure 20. Placing the sensor into the soil

Figure 21. Packing native soil around the probe

Rod Probes

Currently, the only model with rods is the Toro Precision Soil Sensor System (Figure 22). This SMS system is currently the only wireless system and requires three size AA alkaline batteries for operation.

Procedure:

1. With the batteries installed, move the sensor probe to the proposed installation site. Signal strength is indicated by the LED color on top of the sensor as follows: green = excellent, yellow = acceptable, red = not acceptable - relocate sensor

2. With a suitable installation site selected, thoroughly irrigate the sensor location and surrounding landscape area.

3. Trim the grass close to ground level where the sensor will be placed. Caution: For close-cut turf varieties, such as Hybrid Bermuda, the top of the sensor must be installed at grade level to prevent damage by mowing equipment.

4. Applying even, downward pressure on top of the sensor, insert the sensor probes and retention spikes completely into the soil.

Figure 22. Sequence of installing a wireless probe with rods

Marking and Measuring the Sensor Location

Documentation of the sensor location can make future maintenance easier. For this, the SMS installer should mark the sensor location. Next, the installer should measure and record the distance from the SMS to two permanent points in the landscape (triangulation). Then, a diagram with the distances and location of these elements should be drawn and displayed adjacent to the irrigation timer. If an as-built irrigation plan exists, the location of the sensor should be marked on it.

In new landscapes, mark the sensor location with a flag to prevent damage during the sod installation.

Connecting the Sensor

A wired SMS requires digging a trench for wire connection. Depending on the circumstances, either mechanical or manual means can be used to dig the trench.

Wiring provided in the installation kit is not always long enough to span the distance between the SMS probe and the irrigation valve or SMS controller. Moreover, additional wiring should be added to allow for SMS probe installation in an optimal location, if necessary.

When connecting the wires from the sensor to the wires coming from the controller or valve, installers should add a small valve-box where the wire connections must have waterproof grease cap wire connectors (Figure 23). If this type of connector is not used during the installation, communication with the sensor will soon fail. In addition to confine the wire connections, the small valve-box will also help finding the sensor location and testing its response, if necessary.
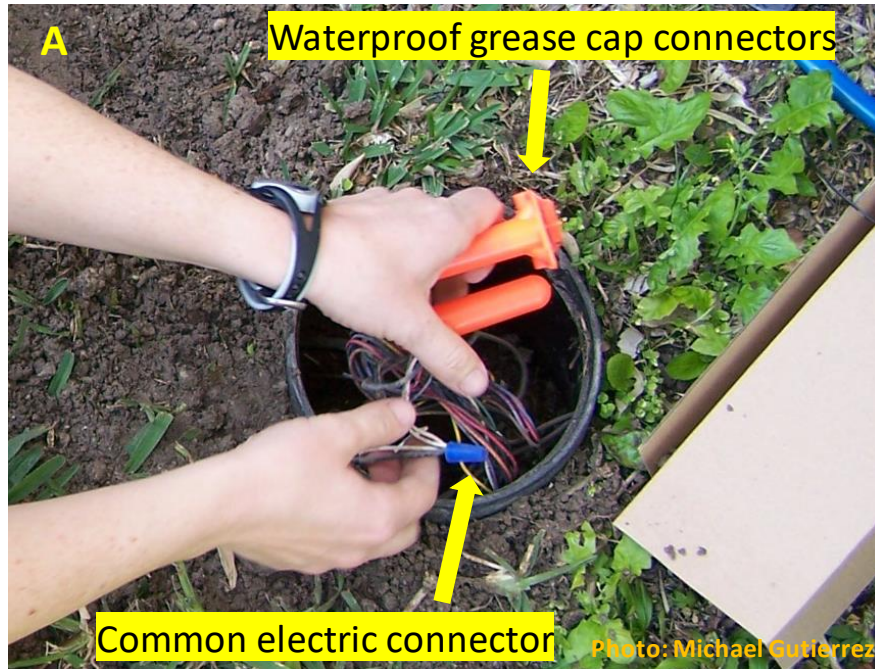
Figure 23. Picture A shows a wire connection, capped with a common electric connector, before inserting it into the waterproof grease cap connector. The waterproof grease caps are used to protect the connection between the probe wires and the extension wires coming from the controller or valve, encased in a valve-box. Picture B shows waterproof grease cap connectors completely submerged in water.

Connecting the Wires

Each brand, with a wired probe, has its own way to connect the probe to a zone valve or to its controller. The same occurs with the sensor controller when connecting it to the timer. Refer to the user's manual for wiring details.

The SMS controller should be installed on an interior wall (i.e. garage) next to the irrigation timer, unless otherwise prepared for through a waterproof/outdoor housing. Each SMS brand contains different color-coded wires to connect the controller to the irrigation timer. User should follow the manufacturer instructions described in the manual.

Calibration

The SMS manufacturers refers to calibration as the process to determine the irrigation threshold—or setpoint—in the controller. This process could be done manually or automatically. The University of Florida recommends the automatic method, since the resulting setpoint would be site-specific. This setpoint can be fine-tuned by the user, afterward.

The first step for the automatic calibration is to saturate the soil with water where the probe was installed. The purpose of this is to establish the field capacity of the soil (i.e., no further water drainage below the root zone). To saturate the soil, pour at least 5 gallons of water directly over the installed and connected SMS. The best way to do this is with a hose or a bucket (Figures 24 and 25).

Note: The soil surrounding the sensor should not receive any water during the 24-hour post-saturation period for all methods identified. If irrigation or rainfall occurs during this period, then the soil will not be at field capacity at the end of 24 hours and the procedure must be repeated once the soil dries.

Figure 24. Hose method
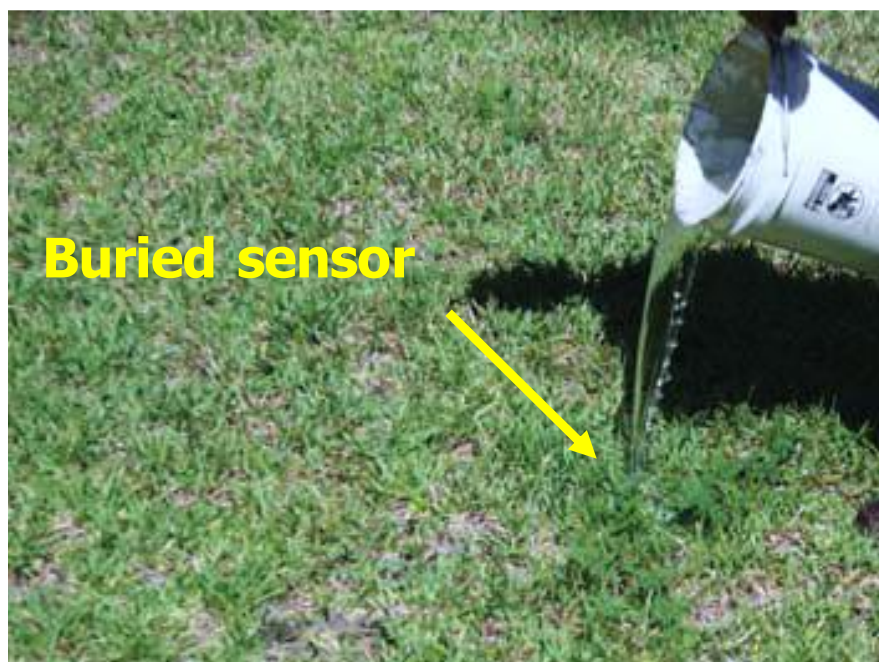
Figure 25. Bucket method

After the saturation is completed, the installer should perform the calibration on the SMS controller. Calibration instructions are brand-specific and, therefore, the user should follow manufacturer's instructions. After 24 hours, the SMS controller will read the soil moisture content, which should be close to field capacity. At that point, the controller will automatically establish the setpoint, which will range between 50% and 75% of the field capacity, depending on the SMS brand.

Note: Timing related to landscape establishment is an important component of proper calibration. Establishment periods typically range from 30-60 days. The controller and sensor should be calibrated post-establishment, because root depth and soil conditions vary from pre- to post-establishment.

Programming the Irrigation Timer

The irrigation timer, not the SMS controller, initiates scheduled irrigation events. It is extremely important that the irrigation controller be set for an irrigation schedule appropriate for the irrigation system, location, plant need, season, and the local watering restrictions.

Generally, a sunny turfgrass area will have the most frequent irrigation need relative to other landscape plants. If the turfgrass requirements are met, other plant water requirements should also be met.

Watering restrictions

As of the printing date of this document, year-round watering schedule and rules have been decreed (Figure 26) in the area of jurisdiction of the Southwest Florida Water Management District's (SWFWMD, 2019).
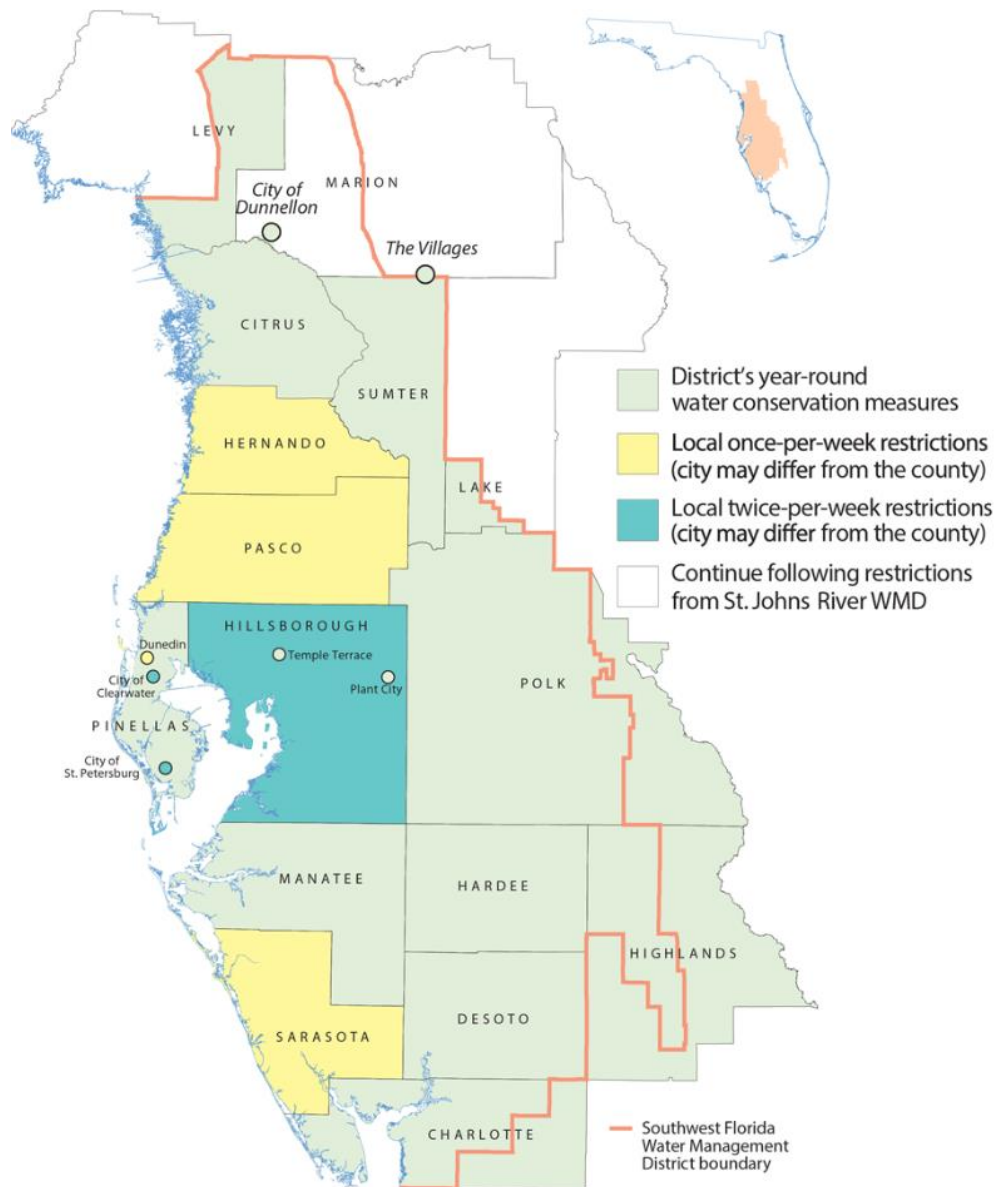
Figure 26. Map displaying the watering restrictions in the SWFWMD area

Effective Date and Areas

- The District's year-round water conservation measures are in effect except where stricter measures have been imposed by local governments.

- The measures shown below currently apply to all of Charlotte, Citrus, DeSoto, Hardee, Highlands, Manatee, Pinellas, Polk, Sumter, Lake and Levy counties; the City of Dunnellon and The Villages in Marion County; and the cities of Temple Terrace, Plant City and North Port.

- Some local governments such as unincorporated Hillsborough County and the cities of Clearwater, St. Petersburg and Tampa have local ordinances with differing twice-per-week schedules.

- Some local governments such as unincorporated Hernando, Pasco and Sarasota counties, and the cities of Dunedin, Longboat Key, Sarasota and Venice, have local ordinances that remain on one-day-per-week schedules.

Lawn Watering Days and Times

- Lawn watering is limited to no more than twice per week.

- Lawn watering days and times are as follows unless your city or county has a different schedule or stricter hours in effect:

  o Even addresses may water on Thursday and/or Sunday before 10 a.m. or after 4 p.m.

  o Odd addresses may water on Wednesday and/or Saturday before 10 a.m. or after 4 p.m.

  o Locations without a discernable address, such as rights-of-way and common areas inside a subdivision, may water on Tuesday and/or Friday before 10 a.m. or after 4 p.m.

- Hand watering and micro-irrigation of plants (other than lawns) can be done on any day and any time.

New Lawns and Plants

- New lawns and plants have a "30-30" establishment period.

- On the day of installation, watering is allowed on any day at any time.

- During the first 30 days, watering is allowed on any day during the allowable hours.

- During the second 30 days, watering is allowed three days per week: even-numbered addresses may water on Tuesday, Thursday and Sunday; odd-numbered addresses may water Monday, Wednesday and Saturday; and locations without a discernable address may water on Tuesday, Friday and Sunday.

Reclaimed Water

- Reclaimed water is only subject to voluntary watering hours, unless restricted by the local government or utility.

Fountains, Car Washing and Pressure Washing

- There are no specific restrictions on fountains, car washing and pressure washing.

- These and other water uses should be conducted as efficiently as possible, such as using a shutoff nozzle on each hose to adhere to the general restriction prohibiting wasteful water use.

Additional watering restrictions may be imposed by local governments if conditions warrant it. Always refer to your city or county regulations first. For the SWFWMD area, a Water Restrictions Hotline is currently available: 1-800-848-0499 (FL only).

A petition for variance from year-round water conservation measures or water shortage restrictions is available if an alternative irrigation plan is proposed. Petitions should be directed to SWFWMD: during normal business hours at 1-800-848-0499 (FL only) or email Water.Restrictions@WaterMatters.org.

Runtimes

When an in-ground irrigation system is provided with a smart irrigation controller (SMS or ET controller), the runtime of each zone should be scheduled to fulfil the maximum irrigation requirement during the year (normally between May and August). After the runtime is established, the smart irrigation controller would adjust this schedule, depending on the agroclimatic conditions of the site.

Different methods could be used for establishing the maximum runtime of each zone.

From online tables:

Different online tables are available for setting the runtime of each irrigation zone, for turfgrass in Florida. A simplified summary of the recommended irrigation runtimes—based on the irrigation scheduling developed by Dukes and Haman (2016)—is presented in Table 3. This table assumes application rates for residential sprinklers are ~0.5 inch/hour for rotors and ~1.5 inches/hour for spray heads. (For details on how to estimate the actual application rate, see the "Application rate" subheading.)

For example, from Table 3, for an irrigation zone located in the Tampa Bay Area (Central Florida), the maximum requirement is during the summer season. If the zone has spray heads, the runtime would be 30 minutes for full replacement of the historical evapotranspiration. These runtimes, in minutes, are for each of two irrigation events programmed per week. If irrigation is allowed only at one day per week, then increase the runtime in Table 3 30%. Longer runtimes will result in wasted water.

Table 3. Irrigation scheduling (minutes) per irrigation event for Florida turfgrasses, considering two irrigation cycles per week. If irrigation is allowed only at one day per week, then first cycle should be programmed to run early in the morning (before 6 AM) and the other cycle to run in the night of the same day (between 6 PM and 11 PM).

		North Florida			Central Florida			South Florida		
		Replacement of evapotranspiration								
		Reduced	Medium	Full	Reduced	Medium	Full	Reduced	Medium	Full
ROTORS	Winter	5	5	5	5	15	20	30	40	50
	Spring	25	35	45	40	55	65	45	55	70
	Summer	40	55	70	55	70	90	55	70	90
	Fall	35	45	55	40	55	70	30	40	50
SPRAYS	Winter	5	5	5	5	5	5	5	15	20
	Spring	5	10	15	10	15	20	15	20	25
	Summer	15	20	25	20	25	30	20	25	30
	Fall	10	15	20	15	20	25	10	10	15

Adapted from: Dukes, M.D. and Haman, D.Z. 2016. Runtimes calculated from historical evapotranspiration and effective rainfall, estimating 60% system efficiency. Numbers were rounded for convenience.

Note: This table is based on historical evapotranspiration, and might not represent necessary runtimes under atypical conditions (e.g., drought, wet conditions). Current conditions should be considered when setting the timer.

From a specific depth of water:

Sometimes a specific irrigation depth is recommended or desired. To transform a specific depth of water to runtime in the timer, first, is necessary to know the application rate of the zone (see the "Application rate" subheading), and then apply the formula below:

$$Runtime\ [minutes] = \frac{Irrigation\ depth\ [inches]\ x\ 60\ [minutes]}{Application\ rate\ [inches/hour]}$$

For example, a typical recommendation is applying ¾" (or 0.75") of water to the turfgrass per irrigation cycle, and let's say that the irrigation zone has an application rate of 1.5 inches/hour. Then the formula will be:

$$Runtime\ [minutes] = \frac{0.75\ [inches]\ x\ 60\ [minutes]}{1.5\ [inches/hour]}$$

$$Runtime \ = \ 30 \ minutes$$

Once the runtimes are determined, program the specific runtime into the irrigation timer for each zone.

Maintenance

Most of the Rain Bird and Baseline SMSs tested at UF have worked properly for many years, without any maintenance. The wireless Toro SMSs operate around two years, until the batteries expire and need to be replaced. If a note of where the probe was located was not done—or not done properly—it would be very difficult to find. In that case, the whole system (controller and probe) would need to be replaced. Long term duration/maintenance of the Hunter SMSs has not been assessed by UF.

ET CONTROLLERS

Climatologically based controllers are also known as evapotranspiration controllers, ET controllers, or "WBICs" (acronym for weather-based irrigation controllers). In this document we will refer to them as ET controllers (Figure 27).

The United States Environmental Protection Agency (EPA), through its WaterSense program, has labeled some ET controllers which are certified to use at least 20 percent less water, save energy, and perform as well as or better than regular models (EPA, 2019). A list of WaterSense-labeled ET controllers can be found at: https://www.epa.gov/watersense/product-search

Note: If an ET controller is installed on a property that was not previously over-irrigating its landscape, studies have demonstrated that their historical irrigation water use might increase. Therefore, ET controllers are only recommended for water users using more than required.

Types of ET controllers

There are generally three types of ET controllers:

a. **Signal based**: Meteorological data are either collected from publicly available sources or from agreements with weather station networks. The ET value is calculated for a hypothetical grass surface for that site. Then, ET data are sent to surrounding controllers via wireless communication. In some cases, the ET values are adjusted to account for controllers that are not near the weather data collection site. The ET controller adjusts the irrigation runtimes or watering days according to climate throughout the year.

b. **Historical ET**: This approach for ET controllers uses a pre-programmed crop water use curve for different regions. The curve may be modified by a sensor such as a temperature or solar radiation sensor that measures on-site weather conditions.

c. **On-site weather measurement**: This approach uses measured weather data at the controller to calculate ET continuously and adjust the irrigation times according to weather conditions.
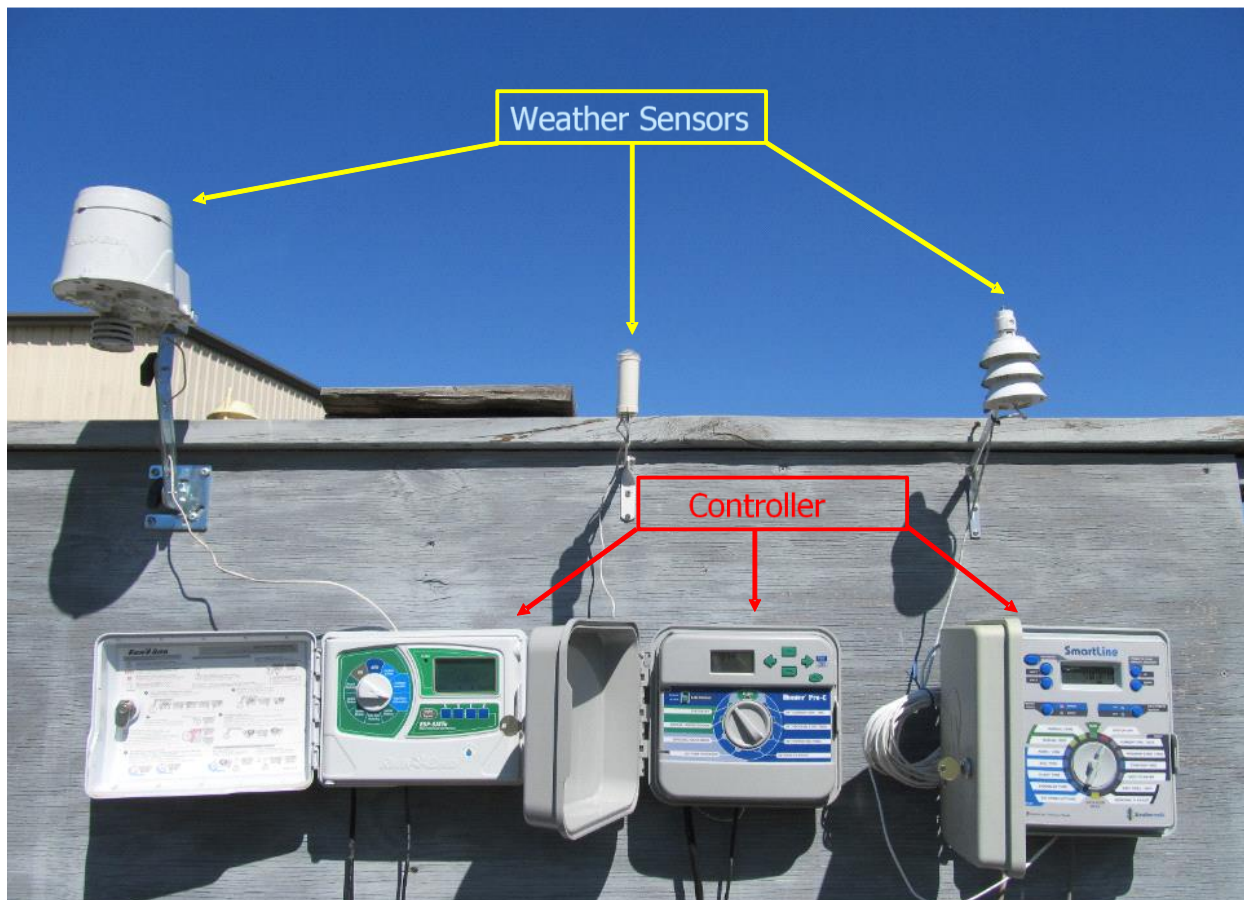
Figure 27. Different ET controllers with wired weather sensors

Sensors

Most current ET controller kits include one or more sensors for gathering local weather conditions.

Rain sensor

A rain sensor is the most common sensor included by the different ET controller brands. Rain sensors bypass irrigation events when a specific amount of rainfall has occurred. Some ET controllers will refill the soil to field capacity after a rain event is sensed, whereas other controllers will only pause irrigation until the rain sensor is dry. Unless a controller measures rainfall on site, a supplemental rain sensor should be added due to frequent and site-specific rainfall experienced in Florida. It is important that the rain sensor be connected to a "sensor" port if available on the ET controller so that irrigation bypass events are accounted for properly in the controller. If the rain sensor has optional setting points, the sensor should be set to ¼ inch (Figure 28).

Figure 28. Rain sensors with optional set points, set at ¼" or 6 mm

Other sensors

Some ET controllers might include other sensors for measuring weather data. These data are used by their algorithms for calculating the amount of water that will be delivered to the different irrigation zones. These sensors usually measure temperature, solar radiation, and/or wind speed (Figure 29).
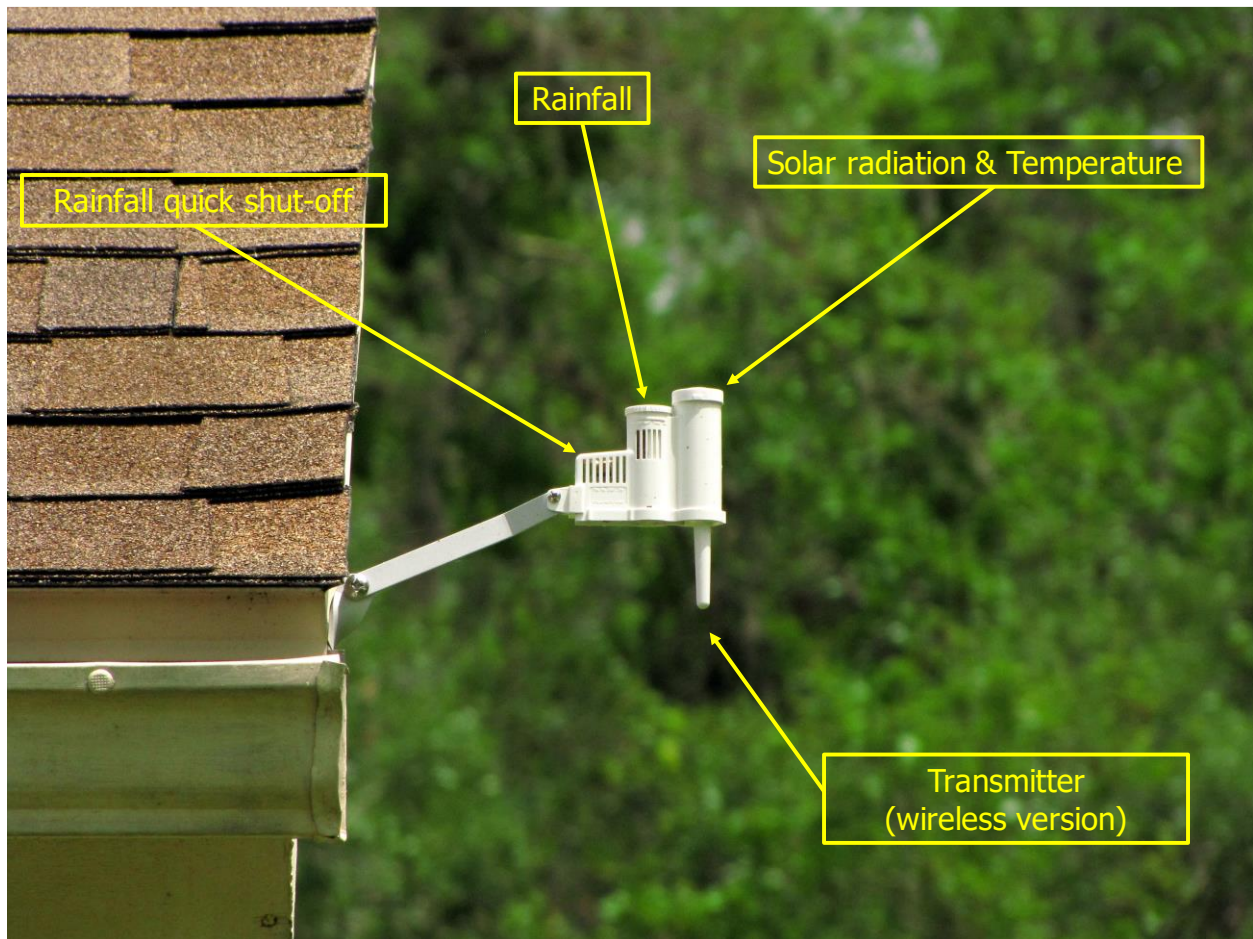
Figure 29. Wireless weather sensors for an ET controller

Location of sensors

Sensors should be installed in a place open to the sky, away from obstructions. A good location is the roofline of the house. Sensors should not be under a tree or other structure (Figures 30 and 31).

Figure 30. Adequate placement of sensors

Figure 31. Inadequate placement of sensors

Programming

Confusion may arise with these controllers when dealing with the programming aspect. The various commercially available ET controllers have different programming terms, inputs, and procedures; there is no standardized model. Table 4 shows common settings that should be programed in the ET controller. Manufacturers design the controllers to be installed by knowledgeable contractors who understand the various inputs. Programming the controller correctly for each unique landscape is critical to the ability of the controller to reduce water use and maintain good landscape aesthetics.

Table 4. Common settings that are programmable in ET controllers to properly schedule irrigation

Category	Common Settings	Parameter Affected by Setting	Common Florida Inputs
Irrigation Type	Spray head	Application Rate	Spray
	Rotor	Uniformity/	
	Impact		
	Bubblers	Efficiency	Rotor
	Drip emitters		
Soil Type	Sandy	Infiltration Rate	Sandy
	Sandy Loam		
	Loam	Water Holding Capacity	Sandy Loam
	Clay Loam		
	Clay		
Plant Type	Warm Season Grass	Crop Coefficient (Kc)	Warm Season Grass
	Cool Season Grass		
	Combined Grass		
	Flowers		Grass
	Trees		
	Shrubs		Mixed
	Mixed		
	Trees		Shrubs
	Native Grasses		
Microclimate	Sunny all day	ET Adjustments	Site Specific
	Sunny most of the day		
	Shady most of the day		
	Shady all day		
Slope	0-5%	Cycle/Soak	Site Specific
	6-8%		
	9-12%		
	13-20%		
	>20%		

Application rate

One of the settings for some ET controllers is the application rate. Rates of water application vary depending on the brand, type, and installation details of sprinklers. Typically, the application rates of rotors are lower than spray nozzles. This rate has units of depth per time (such as inches/hour) and can be used to calculate the irrigation runtime.

The application rate can be obtained by different ways. The easiest is to find the manufacturer's specifications of the sprinklers of each zone (typical application rates for residential sprinklers are ~0.5 inches/hour for rotors and ~1.5 inches/hour for spray heads). Another way is to calculate it through the depth using a soil water balance (see Dukes et al., 2019). A third way of obtaining the application rate is by performing a distribution uniformity test (see Trenholm et al., 2009).

The recommended way to obtain the application rate is: Run each zone for 2 minutes, take a reading of the flowmeter before and after running each zone, and measure the area of each irrigation zone. After this is done, apply the calculations as shown in the following example:

A	Run time (minutes)	= 2
B	Meter reading before (Gal)	= 1000
C	Meter reading after (Gal)	= 1020
D = C - B	Gallons applied	= 1020 – 1000 = 20
E = D / A	Application rate (gpm)	= 20/2 = 10
F	Irrigation zone area (ft^2)	= 1000
G = (E/ F) * 96.3	Application rate (in/hr)	= (10/1000) * 96.3 = 0.01 * 96.3 = 0.96

Note: the factor 96.3 is used to convert gpm/ft^2 to in/hr

Efficiency

Many landscape sprinkler systems are inefficient. For scheduling purposes in the ET controller instead of using low quarter distribution uniformity (DUlq), it is recommended that the low half distribution uniformity (DUlh) be used. In absence of uniformity testing information, the following efficiencies may be used as an estimate: rotary or impact sprinklers: 70-80%; spray heads: 60-80%; drip or other microirrigation emitters: 80-90%. The lower the efficiency number input to the controller, the more water that will be applied because the controller will compensate for lower efficiency (i.e. more losses) by applying more water. It is best to use as high an efficiency value as possible to limit over-watering.

Landscape Inputs

Landscape conditions typically included as inputs to the controllers are soil type, plant type, slope, sun, and shade. The controllers generally have options available for each condition, which are self-explanatory.

Runtime setting

Set station runtimes for peak summer watering with seasonal adjustment set at 100%. For specific runtimes, see "Runtimes" heading, under soil moisture sensors

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IRRIGATION SYSTEM EVALUATION
Smart Controller Edition

Address: _____

Date: _____

Controller Location: Garage ☐   Outside wall ☐

Common Issues				
Leaks	Heads ☐ Pipes ☐	Valves ☐	Meter box ☐	Other ☐
Heads	Clogged ☐ Broken ☐ Sunken ☐		Misaligned ☐ Low pressure ☐	
	High pressure ☐ Blocked by vegetation ☐		Unmatched precipitation rate ☐	

Problems Detected/Solved:

Zone	Description

Flow Test / Zone number		1	2	3	4	5	6	7	8
A	Run Time (min)	___	___	___	___	___	___	___	___
B	Meter Reading Before	___	___	___	___	___	___	___	___
C	Meter Reading After	___	___	___	___	___	___	___	___
D = C-B	Water Applied (gal)	___	___	___	___	___	___	___	___
E = D/A	Application Rate (gpm)	___	___	___	___	___	___	___	___
F	Irrigated Area (ft^2)	___	___	___	___	___	___	___	___
G=(E/F)*96.3	Precipitation Rate (in/hr)	___	___	___	___	___	___	___	___

Soil Moisture Sensor									
Zone Number		1	2	3	4	5	6	7	8
Pgm A	Schedule	Sun ☐	Mon ☐	Tue ☐	Wed ☐	Thu ☐	Fri ☐	Sat ☐	___AM ___PM
Pgm A	Run Time	___	___	___	___	___	___	___	___
Pgm B	Schedule	Sun ☐	Mon ☐	Tue ☐	Wed ☐	Thu ☐	Fri ☐	Sat ☐	___AM ___PM
Pgm B	Run Time	___	___	___	___	___	___	___	___

Threshold: _____   Current Reading: _____

Sensor Location (zone) ___ ___ ___ ___ ___ ___ ___ ___

Sensor Location Notes _____

Valve Box Notes _____

ET Controller								
Setting	1	2	3	4	5	6	7	8
Sprinkler Type	___	___	___	___	___	___	___	___
Plant Type	___	___	___	___	___	___	___	___
Sun/Microclimate	___	___	___	___	___	___	___	___
Soil Type	___	___	___	___	___	___	___	___
Slope	___	___	___	___	___	___	___	___
Weather Sensor	Location: _____							

Evaluator: _____

APPENDIX II

CHECK LIST FOR SOIL MOISTURE SENSORS (SMS)

IRRIGATION SYSTEM EVALUATION:
- ☐ No leaks detected
- ☐ Irrigation heads working properly based on evaluation
- ☐ Irrigation system in good condition for SMS installation

SITE SELECTION FOR PROBE:
- ☐ In the location needing most frequent irrigation
- ☐ 5 feet away from (check all):
  - ☐ A property line
  - ☐ An impervious surface
  - ☐ A structure (e.g., house, porch, shed, etc.)
  - ☐ A depression/swale
  - ☐ On-site treatment and disposal systems (e.g., septic tanks, drain fields)
  - ☐ A plant bed
  - ☐ A shaded north side of the home (if possible)
  - ☐ A downspout
  - ☐ An overhang
  - ☐ A hose bib
  - ☐ An air-conditioner system condensate line
  - ☐ A construction road
  - ☐ An area with plant debris (e.g., tree stump)
  - ☐ An area with fill dirt (if fill dirt is unrepresentative of the entire landscape)
  - ☐ Buried material (e.g., cable, water, or sewer line)

INSTALATION OF THE PROBE:
- ☐ In the root zone of turfgrass
- ☐ In undisturbed soil
- ☐ With the center of their sensing section approximately 3 inches deep
- ☐ If probe has (choose one):
  - ☐ Exposed wave guides: installed horizontally, with the wide side facing up
  - ☐ Encased wave guides: installed horizontally, with the thin side facing up
  - ☐ Rods: installed vertically, with the top leveled with the ground
  - ☐ Node probe/s: installed vertically in a slurry of soil and water
- ☐ A picture was taken, showing probe installation depth and orientation

MAP OF THE PROBE'S LOCATION:

- ☐ Measured distance between the probe and two permanent points in the landscape
- ☐ Map drawn with the distance between the probe and two permanent points in the landscape
- ☐ Map with the probe location adhered to or beside the irrigation timer

WIRING:

- ☐ Outdoor wire connections protected with waterproof grease caps

CONNECTION TO THE TIMER:

- ☐ SMS controller installed next to the irrigation timer (choose one):
  - ☐ On an interior wall
  - ☐ Outdoor with a waterproof housing
- ☐ If probe is not a GMS type: SMS wired to the zone needing most frequent irrigation
- ☐ If probe is a GMS type:
  - ☐ SMS wired to the zone needing most frequent irrigation
  - ☐ Zone wired to SMS (choose one):
    - ☐ Was the last zone in the irrigation timer
    - ☐ Swapped zones, such that the SMS is now wired to the last zone

CALIBRATION:

- ☐ Saturated soil around the probe
- ☐ Initiated automatic calibration
- ☐ No rain for 24 hours after initiated automatic calibration

TIMER:

- ☐ Programed following local watering restrictions (day/s of the week, start time/s)
- ☐ Runtimes scheduled to fulfil the maximum irrigation requirement during the year

APPENDIX III

CHECK LIST FOR ET CONTROLLERS

IRRIGATION SYSTEM EVALUATION:
- ☐ No leaks detected
- ☐ Irrigation heads working properly based on evaluation
- ☐ Irrigation system in good condition for ET controller installation

SENSORS:
- ☐ Located on a place open to the sky, away from obstructions
- ☐ If the ET Controller did not include a rain sensor, a rain sensor was added and connected to the sensor port
- ☐ If the rain sensor had optional setting points, set it to ¼"

PROGRAMING:
- ☐ Programed following local watering restrictions (day/s of the week, start time/s)
- ☐ Application rate of each zone measured on-site
- ☐ Runtimes scheduled to fulfil the maximum irrigation requirement during the year
- ☐ If the model has predictive watering, selected not watering when 80%+ chance of rain
- ☐ Programed all the settings according to the model installed

CHECK LIST FOR SOIL MOISTURE SENSOR (SMS) INSTALLATION
(Evaluator will receive copy of installation check list along with all documents required for submittal by installers)

Property Owner Name:_____

Property Address:_____

Property Water Bill Account #:_____

Name of Installer Firm:_____

Date of Installation:_____

IRRIGATION SYSTEM EVALUATION

Turn on system to determine:

___ No leaks detected

___ Irrigation heads working properly based on irrigation evaluation (provided)

___ Irrigation system meets the requirements for installation of a SMS system

If one of these is not verified provide details below:

_____

_____

_____

The installed soil moisture sensor is one of the approved models allowed for this program

___ Yes   ___ No

SMS EVALUATION

Based on the photo of the installed soil moisture sensor provided by the installer, was the probe installed correctly prior to being covered?

___Yes   ___No

(Note: If the answer is "NO" the installation will be deemed unacceptable, and the contractor will be required to reinstall the probe correctly, providing documentation. The evaluator shall continue the evaluation regardless.)

Identify why the probe was not installed correctly:

_____
_____
_____

Is there a diagram of the probe's location adhered to or beside the irrigation timer?
__Yes   ___No

Did the installer indicate the measurements required to properly locate the probe?
___Yes   ___No

Is the probe location sited by the installer's diagram accurate?
___ Yes   ___No   ___Could not be verified

   If no, mark the location on the diagram where the actual location of the probe resides.

Is the probe located in the zone needing most frequent irrigation?
___Yes   ___No

If no, does reinstallation need to occur due to poor or improper location installation?
___Yes   ___No

Is the valve box location consistent with the location sited in the installer's diagram?
___Yes   ___ No   ___Not required (wireless SMS)

   If no, mark the location on the diagram where the actual location of the valve box resides.

WIRING
Are wire connections from the SMS probe properly encased in a valve-box?
   ___Yes ___ No ___N/A

Are outdoor wire connections protected with waterproof grease caps?
   ___Yes ___No ___N/A

SMS CONTROLLER CONNECTION
Is the SMS controller connected to the timer?
___ Yes   ___ No

If controller is located outdoors, is it protected from weather appropriately?

___ Yes   ___ No

Dependent on the SMS model installed, are the appropriate requirements met for SMS zone placement?

___Yes   ___No

(Note: The zone where a Granular Matrix Sensor (GMS) probe was installed should be the last zone to run. The original last zone in the irrigation timer might need to be swapped with the zone where the GMS probe was installed. Refer to the UF IFAS Recommendations for Optimizing Use of Smart Irrigation Controllers document for guidance.)

CALIBRATION

Is the SMS controller displaying an Error Code?

___Yes   ___No

If yes, refer to the manufacturer's manual for troubleshooting. If the error cannot be fixed, the installation will be deemed unacceptable and the contractor will be required to resolve the issue. (The evaluator shall continue the evaluation regardless.)

Typical threshold values for the different SMSs

Brand	Model	Display	
		Type	Value
Baseline	WaterTec S100	VMC	7-20
Hunter	Soil-Clik	Step bars	5-8
Rain Bird	SMRTY	VMC	7-17
Toro	Precision Sensor	#	50

What is the brand, current reading, and threshold value?

 Brand _____   Current reading _____   Threshold _____

Is the SMS controller in allowing irrigation mode?

___Yes   ___No

If yes, in the irrigation timer, manually start an irrigation cycle. Irrigation should start. Stop irrigation immediately after verifying functionality. Reset the timer to automatic irrigation control.

If no, in the irrigation timer, manually start an irrigation cycle. Irrigation should not start. Reset the timer to automatic irrigation control.

Is the irrigation timer programed following local watering restrictions (day/s of the week, start time/s)?

___Yes   ___No

Maximum run times per zone are typically 30 minutes for sprays and 90 minutes for rotors (see Table 3 in the Guide). Are the run times per zone at or below these values?

___Yes   ___No

       If they are above, adjust each zone to these maximum values.

Notes:

_____
_____
_____
_____
_____
_____
_____

Name of Evaluator: _____

Signature of Evaluator: _____

Date of Evaluation: _____

CHECK LIST FOR ET CONTROLLER INSTALLATION
(Evaluator will receive copy of installation check list along with all documents required for submittal by installers)

Property Owner Name:_____

Property Address:_____

Property Water Bill Account #:_____

Name of Installer Firm:_____

Date of Installation:_____

IRRIGATION SYSTEM EVALUATION
Turn on system to verify the following:
__ No leaks detected
__ Irrigation heads working properly based on evaluation
__ Irrigation system meets the requirements for installation of an ET system

If, one of these is not verified provide details below:

_____
_____
_____

SENSORS:
Is the ET Controller sensor(s) located on a place open to the sky and away from obstructions and any potential obstruction?
___Yes   ___No

Is there a rain sensor included with the ET Controller system?
___Yes   ___No

If the rain sensor has optional setting points, is the sensor set to ¼ inch, if possible? (See Figure 28 in the Guide.)
___Yes   ___No

PROGRAMING:

Is the ET Controller model programmed specifically based on FFL BMPs and recommendations based on the UF/IFAS document? (See Table 4 in the Guide.)

___ Yes   ___No

Is the ET Controller programed to follow local watering restrictions (day/s of the week, start time/s)?

___Yes   ___No

Notes:

_____
_____
_____
_____
_____
_____
_____

Name of Evaluator: _____

Signature of Evaluator: _____

Date of Evaluation: _____