Water Savings of ET vs. Timed Water Applications

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Purpose

This paper discusses the results of 2 years of a 3 year irrigation scheduling study commenced in August 2010 in central Florida outside of the Orlando area on turf grass (St. Augustine 'Floratam'). The purpose of this study is to compare and measure the water conservation capabilities of two different types of irrigation system controls. One is a conventional timer based control, operating on a set duration and frequency; the other is a weather driven, evaporation/transpiration derived control that utilizes a computer based algorithm to determine the frequency and duration of the irrigation cycle.

Methodology

The test area consisted of twelve 15 x 15 foot plots all irrigated with spray sprinklers on a 15 foot x 15 foot spacing on each corner. The plots where individually metered and controlled from a Rain ESP-LX field satellite, controlled by a Rain Bird MaxiCom central control system.. The ET calculation was provided by a Campbell Scientific weather station located approximately 30 feet from the plots installed on the same turf grass. The plots consisted of 4 control plots, 4 weather based plots and 4 time based plots (Figure 1). Water use was tracked monthly. Weather, including rainfall, ET and run times were tracked daily. Effective rainfall was considered to the first 0.5 inches of any given storm. Additionally, the plots where evaluated for turf quality each month based on the University of Florida protocol.

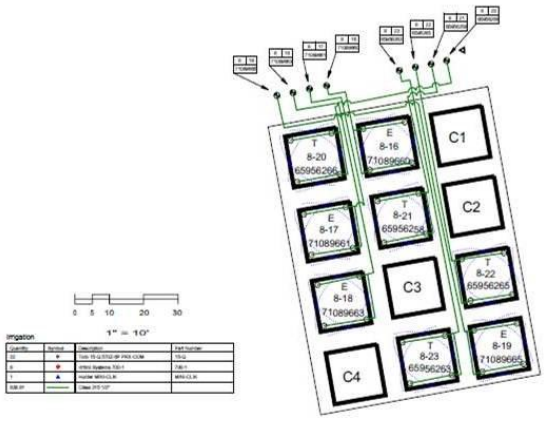

Figure 1. Plot Layout

The time based plots were irrigated with 0.75 -1 inches of reclaimed water per week only on Tuesdays and Thursdays as per the existing statute in effect from the South Florida Water Management district. The ET based plots were irrigated based on the ET reading from the weather station with a Landscape Coefficient of 0.8 and watered on an as needed basis with no restriction as to how many days per week. The control plots were watered for establishment and

received only direct rainfall and are maintained in the same frequency and with the same strategy as the irrigated test plots. Irrigation for all plots is typically between midnight and 7:00 am.

Toro 570Z-6PRXCOM spray sprinklers with 15Q Toro Precision nozzles in each irrigated plot provide the irrigation. This sprinkler has pressure regulation, check valve and a high flow shut off device that automatically reduces flow if a nozzle is removed or damaged. Each of the 12 plots is controlled by a dedicated Irritrol 700-01 valve with a 40 psi inline pressure regulator. Upstream of each electric valve is a 5/8 inch water meter to quantify water usage.

In August 2010 an irrigation audit was conducted to measure the uniformity and precipitation rate of each plot. While it is standard practice to link similar sized areas with similar irrigation, eight individual audits were conducted, one for each plot. The auditing method was identical for each plot following the Irrigation Association's auditing guidelines. After catchment placement each zone was operated for exactly 10 minutes and the volume of each catchment recorded. There was no wind measured at the adjacent weather station anemometer during the course of the eight audit catchment tests. The results of each test were analyzed to calculate DULQ, DULH, and Run Time Multiplier (RTM). The results are shown in Table 1.

Table 1: Auditing Results

Valve #	**Irrigation Type**	**DU_{LQ}**	**DU_{LH}**	**RTM**	**Precipitation Rate**
8-16	ET	64.2 %	82.3%	1.28	0.93 inches/hr
8-17	ET	73.7%	85.5%	1.18	0.91 inches/hr
8-18	ET	64.4%	80.8%	1.28	0.88 inches/hr
8-19	ET	48.5%	72%	1.45	0.82 inches/hr
8-20	2x/week	64.8%	82.2 %	1.27	0.85 inches/hr
8-21	2x/week	55.5%	80.4%	1.36	0.88 inches/hr
8-22	2x/week	67.1%	83.9%	1.25	0.88 inches/hr
8-23	2x/week	61.4%	81.2%	1.31	0.85 inches/hr
Average ET	ET	70.6%	85.4%	1.22	0.87 inches/hr
Average 2x/week	2x/week	65.5%	84.6%	1.26	0.86 inches/hr
Average	All	69.7%	85.4%	1.22	0.87 inches/hr

The variation in DU_{LQ} is difficult to explain. In almost all cases two of the four corner catchments were extremely low volumes. If the cause was because of the catchment being too close to the sprinklers one would expect all four corners to be consistently low. Additionally, in most cases, the corner catchments on the east side of the plots were the lowest readings. This could be explained if there had been a wind out of the east, but there was no wind measured or discernible. It is noteworthy that, except in one instance, the DU_{LH} is consistent and shows high uniformity.

Since no bias or testing errors were discovered, the course of action used was the average for each irrigation type. For the time based irrigation, each zone was programmed to apply a net of 0.875" per week, using the RTM, which falls between the DU_{LQ} and DU_{LH} values. The run times therefore were the following:

0.875”/0.86iph = 1.017 hours
1.017 hours x 1.26 = 1.28 hours or 77 minutes per week, 39 minutes per run day
For the ET based irrigation 0.88 inches/hr is the precipitation rate and the Landscape Coefficient (K_L) is 0.8 (K_S=0.8, K_D=1.0, K_{MC}=1.0).

Data Recording and Reporting

Water meters are read and recorded monthly. Photos of each plot are taken monthly with a brief description of the observed quality of the turf in each plot, and a log is maintained to record mowing, fertilization, pest management, irrigation schedules of each plot and any irrigation system maintenance (adjustment of sprinklers, etc).

Observations

Figure 2 shows the monthly readings of the water meters for each of the irrigated plots. The zone number and meter number are indicated as well as the total monthly run time

IRRIGATION TEST PLOT STUDY
WATER METER READINGS 1-Jul 31-Jul-12

ET irrigated test plots

Meter #	Zone number	Ending reading 31-Jul-12	Begining reading 1-Jul-11	Total gallons
71089660	8-16	10,361.5	10,013.2	348.3
71089661	8-17	11,542.5	11,175.2	367.3
71089663	8-18	10,365.1	10,005.9	359.2
71089665	8-19	9,147.4	8,823.7	323.7

Time irrigated test plots

Meter #	Zone number	Ending reading 31-Jul-12	Begining reading 1-Jul	Total gallons
71089666	8-20	12,476.5	11,690.5	786.0
71089667	8-21	12,932.0	12,235.9	696.1
71089668	8-22	12,328.4	11,678.2	650.2
71089669	8-23	13,094.7	12,411.0	683.7

ET irrigated test plots average total run time (min) per zone 1 July 12:01am to 31 July 11:59pm:
154

Timed irrigated test plots average total run time (min) per zone 1 July 12:01am to 31 July 11:59pm:
273

Figure 2. Water Meter Readings

Figure 3 shows the average turf quality trends over time. As expected the irrigated plots have a higher quality then the control plots by a visible amount. The irrigated plots track close to the same, but the ET plots at times show a slightly higher turf quality rating. In reality, both irrigation schedules are providing an acceptable quality of turf.

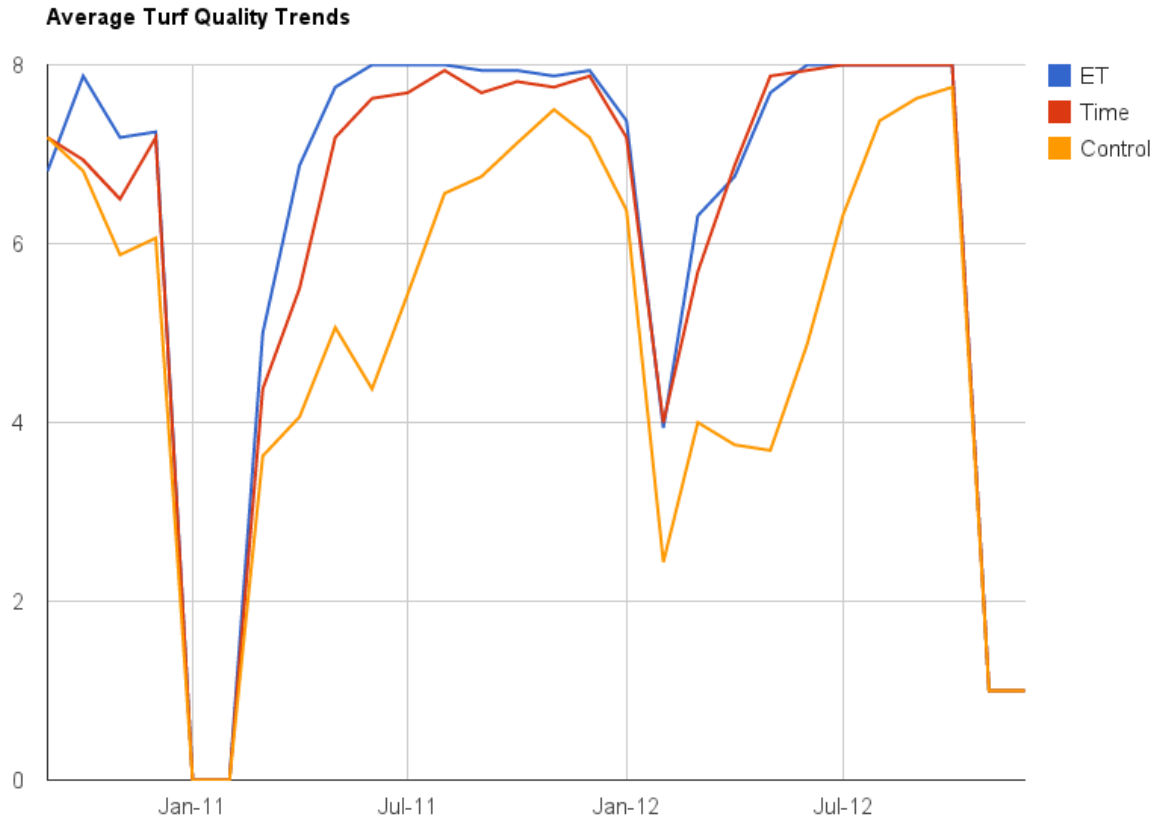

Figure 3. Average Turf Quality Trends

Figure 4 shows the monthly run time average for the two different scheduling scenarios over the last two years. In all 24 months the graph shows that the timed irrigation operated longer than the ET based scheduling. The graph also shows that during the months of May, June and July the two schedules are closer together, time wise, compared to the rest of the year. The difference is significant as in some months the timed plots are operating over 100 minutes more.

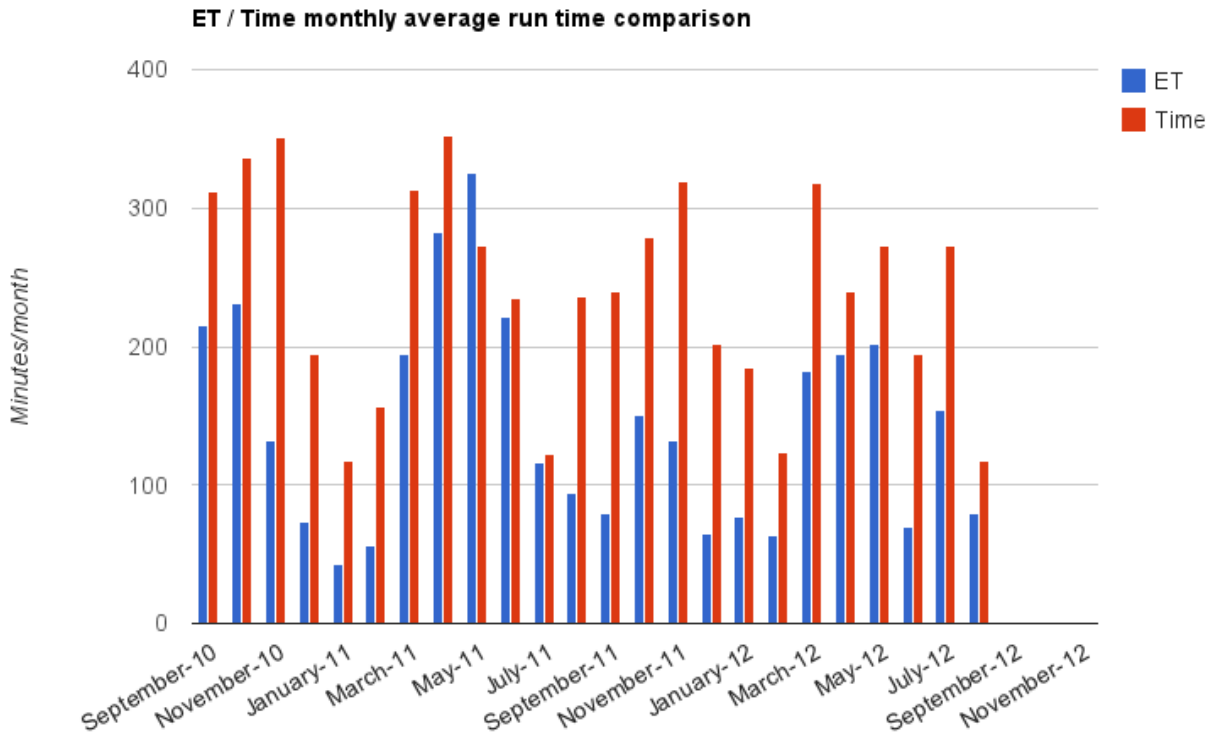

Figure 4. Run Time Comparison

Figure 5 shows the monthly average water use between the two types of scheduling. The figure shows that except for two months in the spring or 2011, the ET based controllers used less water than the timed based scheduling. This is not unexpected as the ET based controlled are designed to match the weather and the timed based to just put down a certain amount of water. Timing on the timed based controllers is based on current water restricts as described previously.

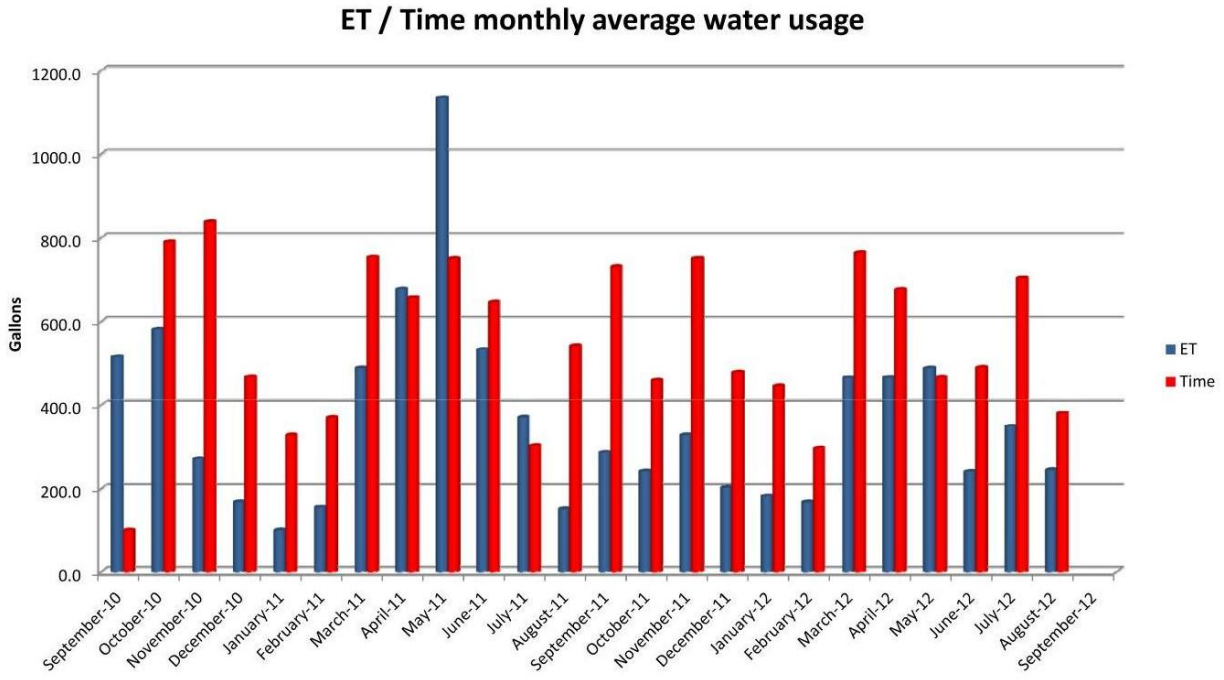

Figure 5. Average Water Usage

Figure 6 shows the cumulative water use of the two systems over the two years. The graphs show that the ET based plots have used approximately 8,000 gallons and the timed plots over 12,000 gallons. This represents over a 33% water savings over the last two years with some months saving more than 50%.

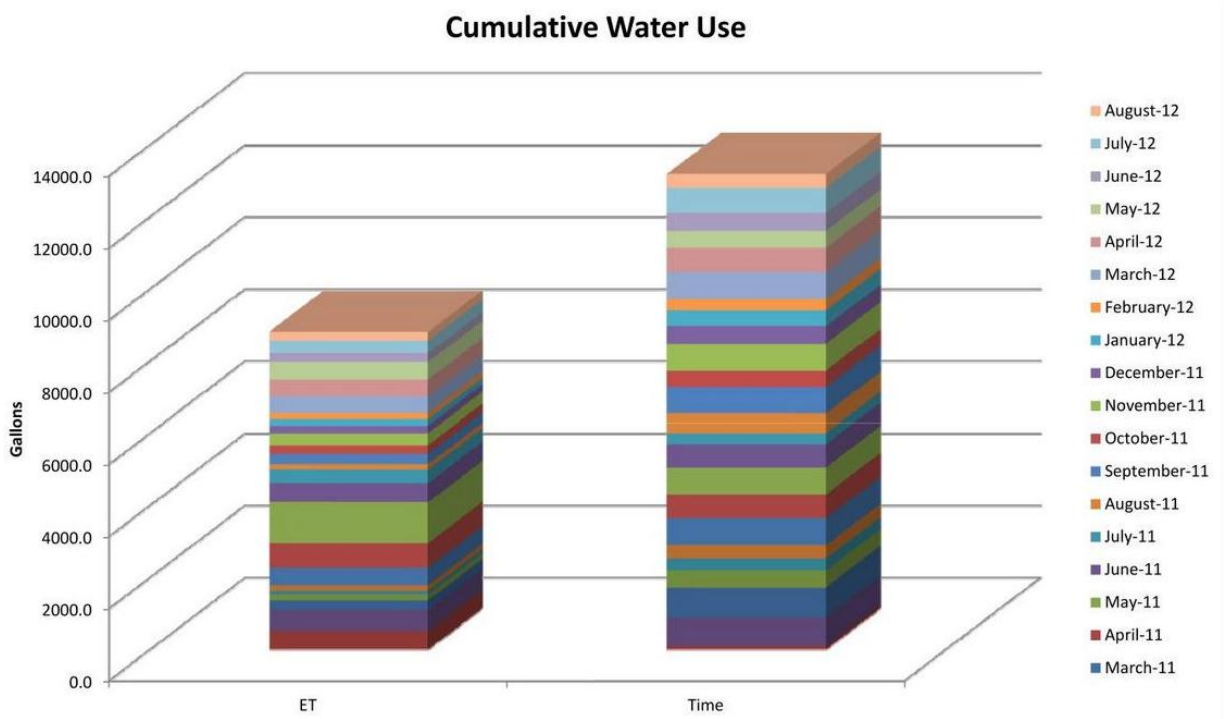

Figure 6. Cumulative Water Use

Conclusions

The study shows that the ET based control system saves significant water over the mandated schedule. Rarely does the ET based schedule use more water than the time based schedule. The ET based schedule also better matches the weather making it more realistic. The quality of the turf is similar between the two different schedules. The overall operating time on the ET based schedule is much lower which reduces the overall water window and wear and tear on equipment. Although this study utilized a sophisticated onsite weather station, one could surmise that ET based controller should have similar water savings.