Evaluating the Operation of Residential WIFI Based Irrigation Controllers

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Abstract

Smart controllers for residential end users have been available for over 20 years. Originally these controllers either used on site climate sensors or communicated via signal service providers (such as pager technology) to determine local evapotranspiration or plant water requirements. As technology in general has evolved over the last 20 years, so have residential smart irrigation controllers. Many manufacturers now market WiFi based irrigation controllers than can incorporate data from a growing number of weather networks to manage local irrigation needs. In 2017 a study was begun to evaluate the effectiveness of six commercially available wifi based irrigation controllers. Controllers were programmed to irrigate the same type of landscapes and bench tested simultaneously from the summer through the fall and winter of 2017. This paper compares controller performance and hopes to guide end users to selecting a wifi based controller.

Background

A testing facility was developed in 2008 to evaluate the performance of smart irrigation controllers. Most of the controllers evaluated between 2008 and 2014 used an onsite weather sensor to calculate irrigation schedules or adjust a pre-programmed irrigation runtime. Since then, manufacturers have advanced their smart controller technologies to incorporate WiFi technologies that allow residential irrigation controllers to access an array of internet based weather networks. As many new residential home constructions now include wireless networking, more homeowners and contractors are adopting wireless internet based controllers because of their ability to access local weather data as well as enable remote access and management of the irrigation controller through smart devices such as cell phone, tablets and other Internet of Things (IoT) Devices.

As the number of residential WiFi based irrigation controller's increase in the marketplace, homeowners and contractors have a difficult decision of choosing a controller. To help address these concerns, in the summer of 2017, six commercially available WifI controllers were selected to be evaluated that were being marketed and installed in Texas. These controllers are identified in Table 1.

Table 1. Residential Wifi Controllers

Controller	Manufacturer	Model
A	Hunter	Hydrawise-HC
B	Rainbird	ESP-TM2 LNK Wifi
C	Rachio	Generation 2
D	Skydrop	Halo Controller
E	RainMachine	Touch HD
F	Orbit	B-HYVE

Evaluation Methodology

The six controllers were installed in a laboratory and connected datalogger (See Figure 1). Each controller was programmed for six different virtual landscape zones that varied in plant water requirements, soil type, root zone depth and sprinkler type (precipitation rate). The virtual landscape is defined in detail in Table 2. However all controllers varied in how they were programmed. Some controllers asked specific questions about the landscape during the setup process while other controllers required the user to program in a "peak" irrigation schedule. For this purpose, a peak irrigation schedule was calculated using historic ETo data for College Station, Texas. The details of the calculated peak irrigation schedule are shown in Table 3. As part of this evaluation, no rain shut off device was connected to the controllers to evaluate their ability to manage rainfall.

The datalogger recorded when each station turns on and off. Post testing analysis calculated irrigation runtimes and irrigation amounts were determined using the precipitation rate defined in the virtual landscape. Irrigation amounts over various time periods were compared to a daily calculated soil moisture balance using ETo data from the TexasET Network (http://TexasET.tamu.edu) for College Station, Texas. A comparison was also made to weekly irrigation watering requirements (7 day water balance).

Figure 1. Controller installation and Setup in the Lab

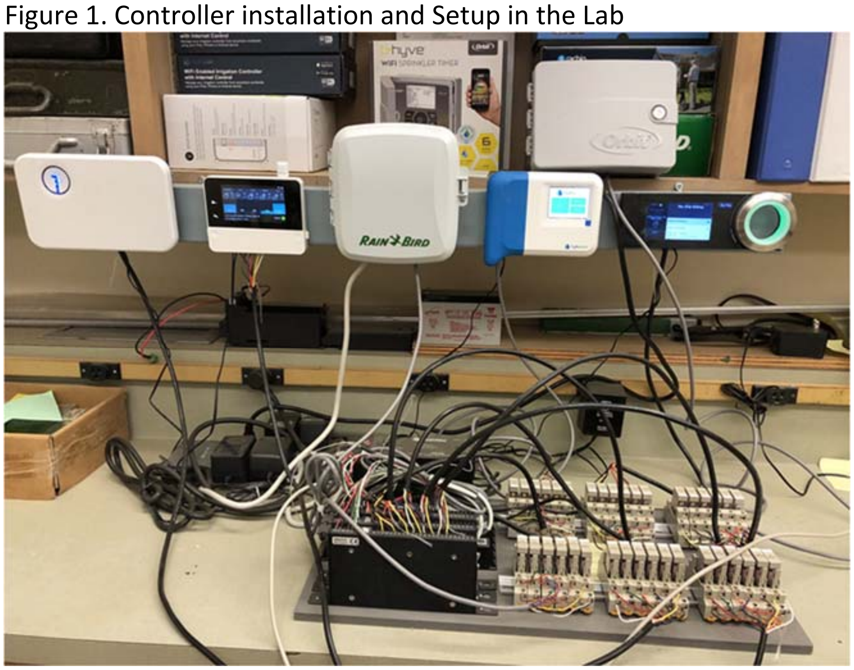

Table 2. The virtual landscapes as defined by Representative Texas Landscapes

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Plant Type	Flowers	Turf	Turf	Groundcover	Small Shrubs	Large Shrubs
Plant Coefficient (Kc)	.8	.6	.6	.5	.5	.3
Root Zone Depth (in)	3	4	4	6	12	20
Soil Type	Sand	Loam	Clay	Sand	Loam	Clay
MAD (%)	50	50	50	50	50	50
Adjustment Factor (Af)	1	.8	.6	.5	.7	.5
Precipitation Rate (in/hr)	.2	.85	1.4	.5	.35	1.25
Slope (%)	0-1	0-1	0-1	0-1	0-1	0-1

Table 3. Texas Landscapes, Peak Watering Schedule for College Station

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Plant Type	Flowers	Turf	Turf	Groundcover	Small Shrubs	Large Shrubs
Peak Month (July) ETo, in	7.10	7.10	7.10	7.10	7.10	7.10
Weekly ETc, in	1.28	.77	.58	.40	.56	.25
Plant Available Water, in	.23	.57	.70	.45	1.70	3.50
# Of Irrigation Days Per Week	7	2	2	2	1	1
Days	Every Day	Mon/Thurs	Mon/Thurs	Mon/Thurs	Mon	Mon
Total Runtime Per Day	54	28	12	24	96	12
Cycles Per Day	2	2	2	2	2	2
Runtime Per Cycle	27	24	6	12	48	6

Table 4. Programmable Features of each Residential WiFi Controller

Controller	Runtime - Frequency	Sprinkler/ PR (in/hr)	Plant Type, kc	Root Zone	Soil Type	Sun/ Shade	MAD	Other Advanced*
Hunter	X							
Rainbird	X							
Rachio		X	X	X	X	X	X	X
Skydrop		X	X		X	X		
RainMachine	X		X					
Orbit	X	X	XX	X	X	X	X	XX

Other Advanced Includes settings such as Available Water, Field Capacity, Wilting Point, Efficiency, etc.

Results

Figures 2 through Figure 5 show the amount of irrigation applied per controller for each station during the evaluation period. To simplify analysis, data was graphed seasonally for typical Summer, Fall and Spring periods common in College Station, Texas.

Additionally in Figures 6-10, the irrigation pattern of three zones was graphed to evaluate the seasonal performance of the controllers. The three zones selected represent significant differences in plant water requirements and required irrigation frequency. Controller D is not listed for this analysis as the datalogger recorded no operation of the controller between 6/12/18 and 8/24/18. It is uncertain at this time whether this was datalogger hardware related or a problem with the controller operation.

Figure 2. August –September 2017 Analysis

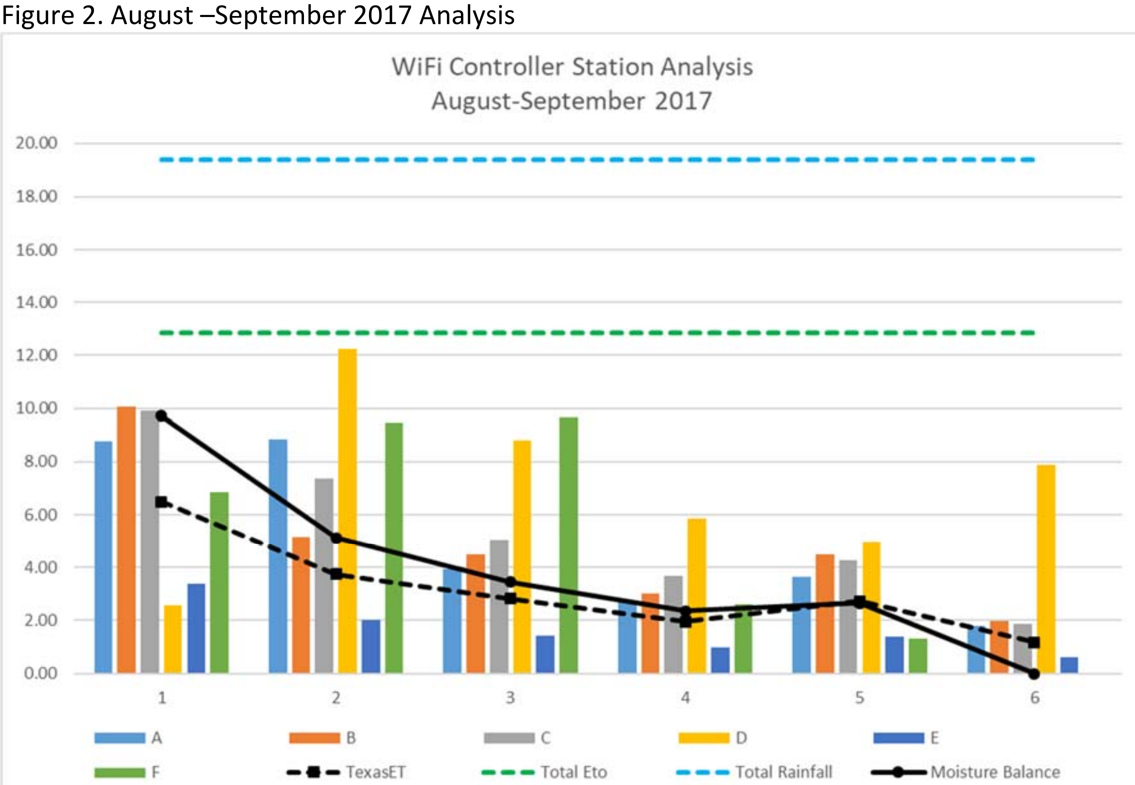

Figure 3. October – December 2017 Analysis

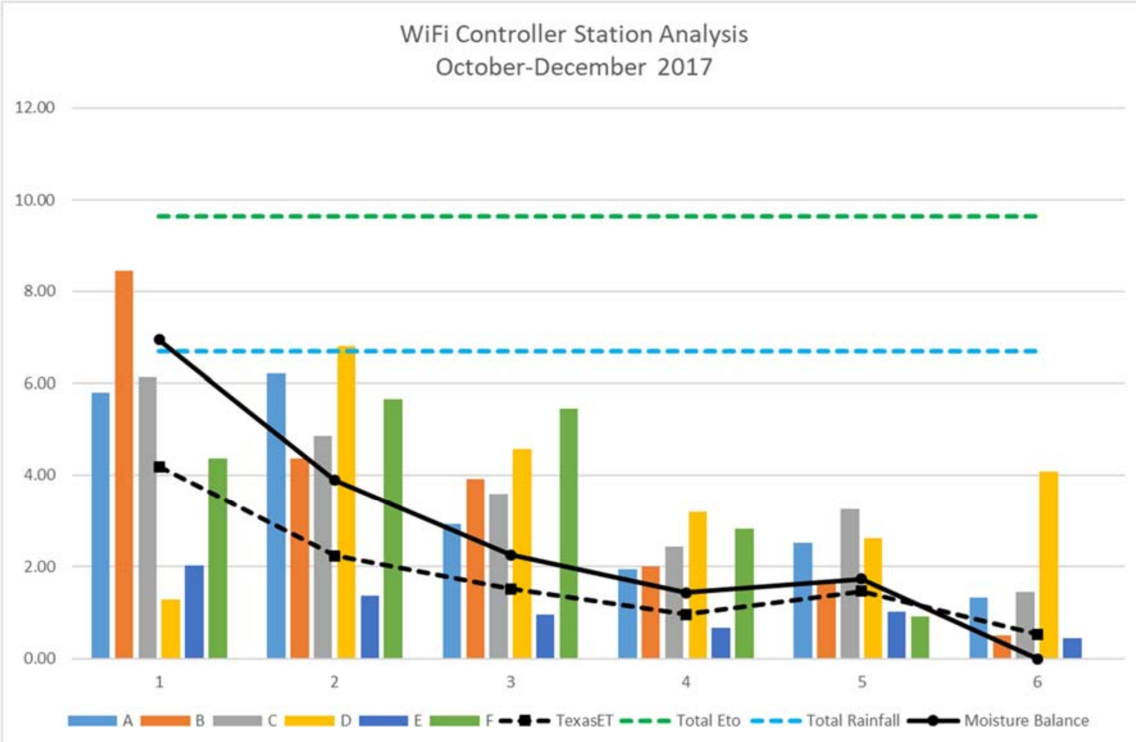

Figure 4. March- April 2018 Analysis

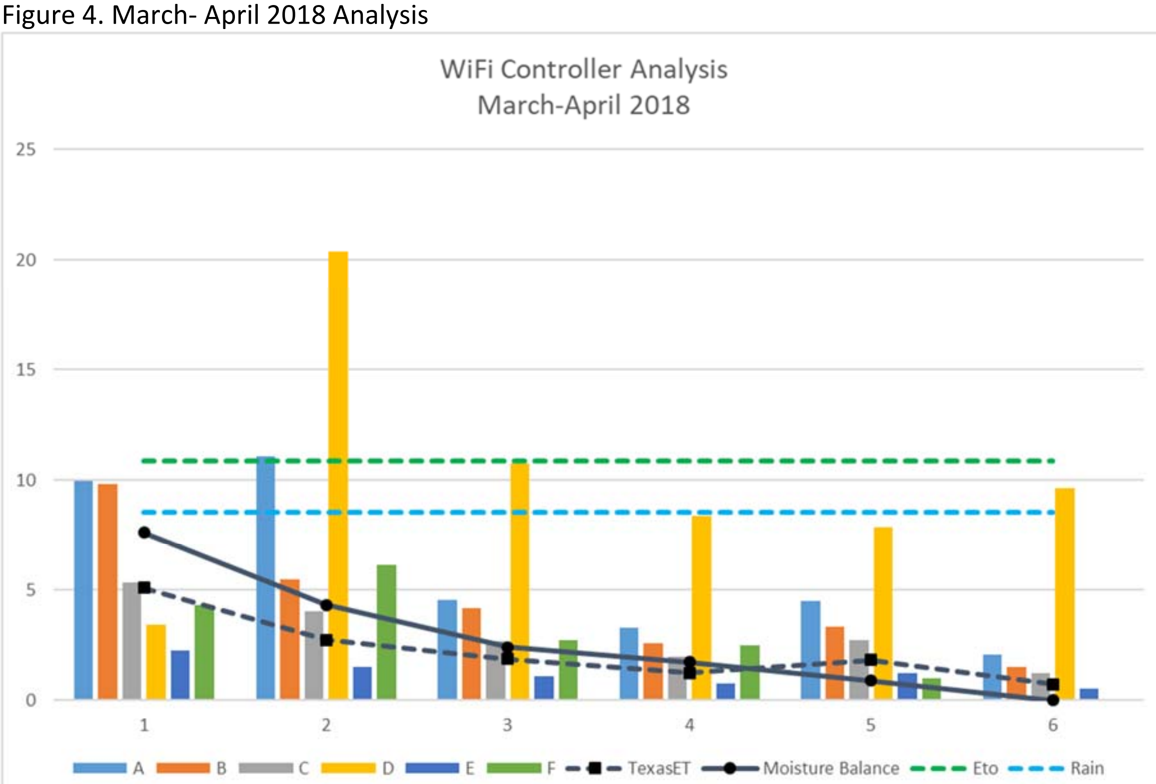

Figure 5. May- August 2018 Analysis

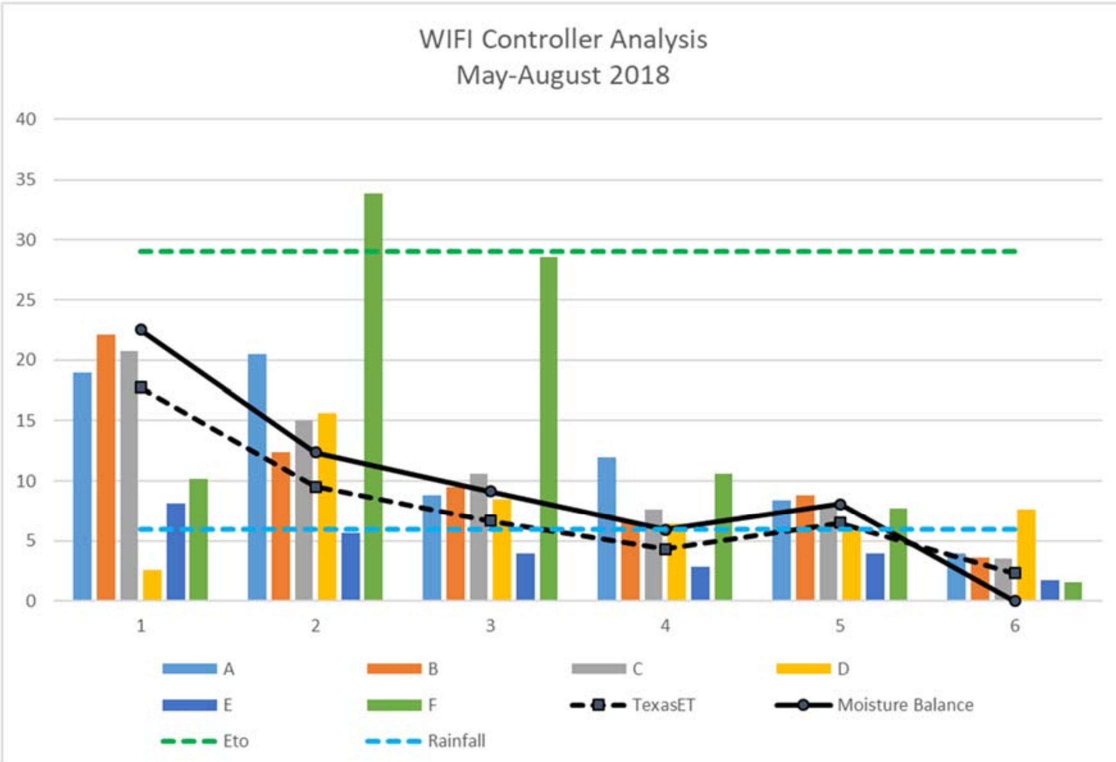

Figure 6. Controller A Irrigation Runtime and Frequency

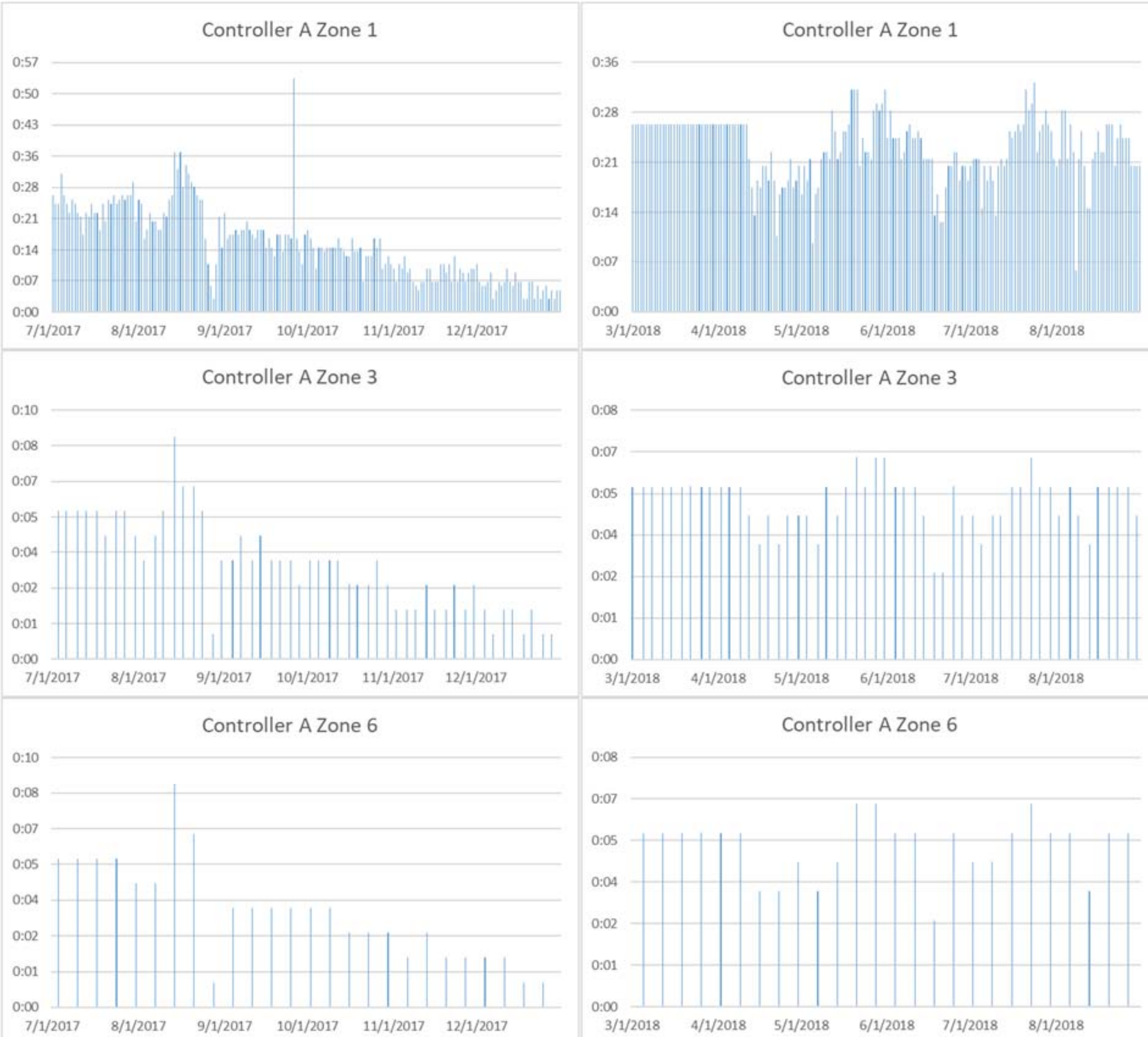

Figure 7. Controller B Irrigation Runtime and Frequency

Figure 8. Controller C Irrigation Runtime and Frequency

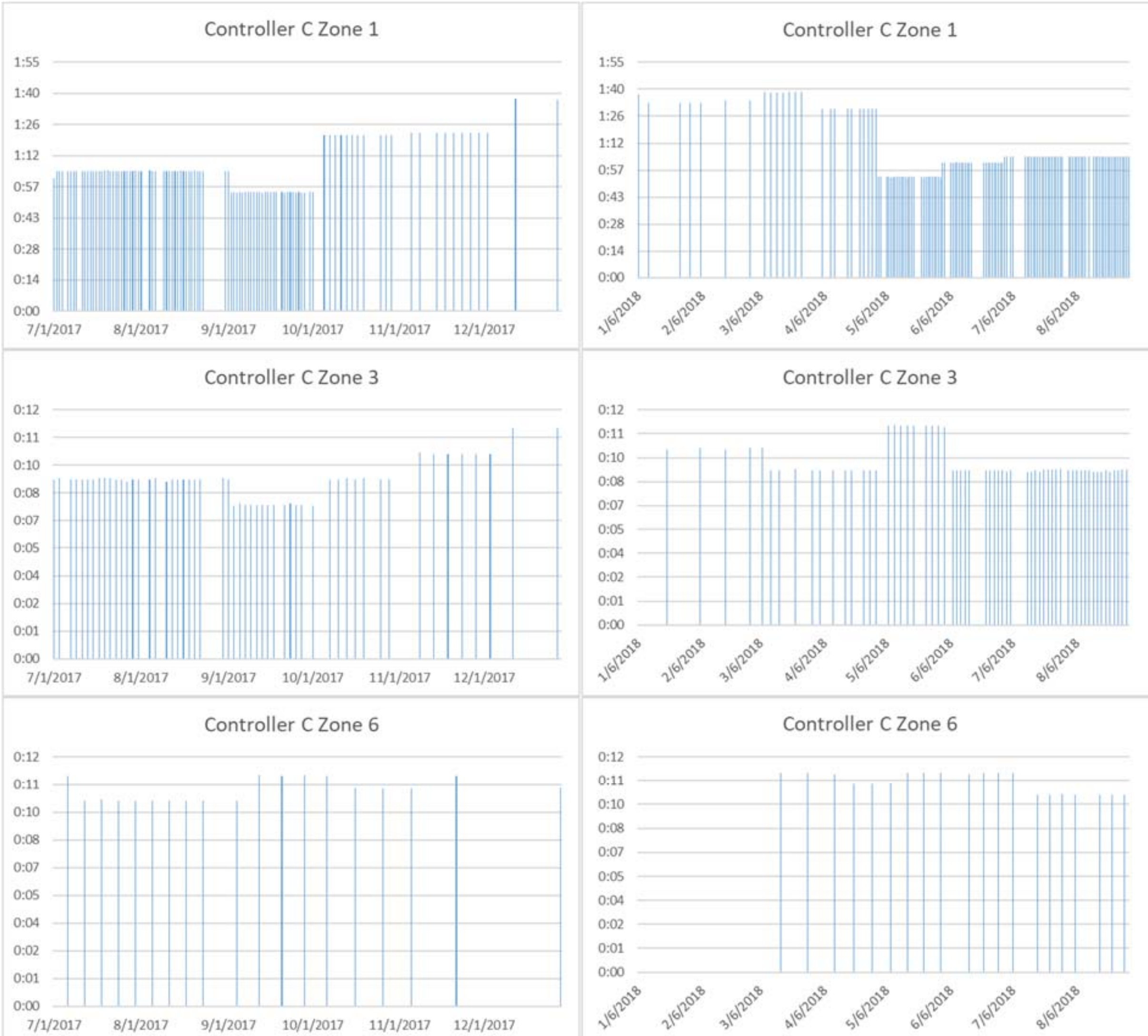

Figure 9. Controller E Irrigation Runtime and Frequency

Figure 10. Controller F Irrigation Runtime and Frequency

Summary

Performance of all controllers varied throughout the evaluation period. Based on the first year of performance, most WiFi based irrigation controllers showed that they can do an effective job of responding to the seasonal water requirements of landscapes compared to a fixed conventional time based irrigation controllers, either by adjusting runtime and/or frequency of irrigation. However, some controllers did irrigated much more or less than was determined based on the daily soil moisture balance. Analysis shows some controllers change the irrigation runtime as water requirements vary but that some controllers only adjust the frequency of irrigation as seasonal water requirements change. Controllers also showed a positive response to rainfall events even though no rain shut off device was connected to the controllers. Future continued evaluation will help determine the water conservation potential of WiFi based residential irrigation controllers. Additionally, future evaluation with the inclusion of a rain sensor could also help prevent controllers from irrigating any excessive amounts.