

Reuse and Private Wells to Offset Irrigation with Potable Water in Urban Water Systems

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Editorial Note

The version of the paper that appears in the December 2009 issue of the *Florida Watershed Journal* has the incorrect Table 3. The correct table is shown in this pdf.

BACKGROUND

Irrigation is a major component of public water use in Florida. Single family residential (SFR) customers account for a significant portion of this use. The purpose of this paper is to categorize outdoor water use into the following three categories and to estimate their irrigation use.

- Non-irrigators
- Smaller irrigators
- Larger irrigators

Clustering algorithms are used to accomplish this partitioning. The analysis will show savings rates representing account groups with different usage behavior based on annual average use and monthly variability. Billing data for SFR customers of Gainesville Regional Utilities (GRU) are used to do this evaluation.

METERED IRRIGATION USAGE

The most direct way to evaluate irrigation water use patterns is by inspection of customers with a separate irrigation meter. A case study was conducted with Gainesville Regional Utilities (GRU). One year of monthly data on single family residential (SFR) water use was obtained from GRU for the period from October 2007 to September 2008 for 1,402 dual metered and 29,504 single metered residential customers. The monthly and annual average and peak water use patterns for GRU customers with dual and single meters are shown in Table 1 and Figure 1 for one year running from October 2007 to September 2008. The monthly results show the dramatic differences between indoor and outdoor water use patterns across the year for dual and single metered customers. Mean indoor water use varies little from month to month and averages about 177 gallons per account per day (gpad) for both dual and single meters. Peak indoor water use patterns are very similar for dual and single meter groups with an average of 200 gpad. However,

major differences exist between average and peak water use patterns for dual and single meter customers.

Average outdoor water use for dual meter customers is 432 gpad, nearly seven times larger than the single meter average of 64 gpad. Similarly, peak outdoor water use for dual meter customers is 740 gpad, over five times the peak average usage of 140 gpad for single meter customers. The peak monthly use of 940 gpad occurs in April 2008, of which 740 gpad, or 79%, is for outdoor water use. About 18% of GRU customers have swimming pools. Lee and Heaney (2008) estimate that pools can be expected to add about 13 gpad to indoor water use. Thus, the overall weighted average impact of pools on indoor water use in GRU is about 3 gpad, a minor component of indoor water use that will have minimal impact on overall water use statistics.

Meters	Sample Size	Persons per House	Average Water Use, gpad			Peak Monthly Water Use, gpad		
			Indoor	Outdoor	Total	Indoor	Outdoor	Total
Single	29,504	2.53	177	63.9	241	200	140	340
Dual	1,402	2.6	177	432	609	200	740	940
Total	30,906							
Weighted Average		2.53	177	80.6	258	200	167	367

Table 1. Average and peak indoor and outdoor water use statistics for GRU, 10/07 to 9/08.

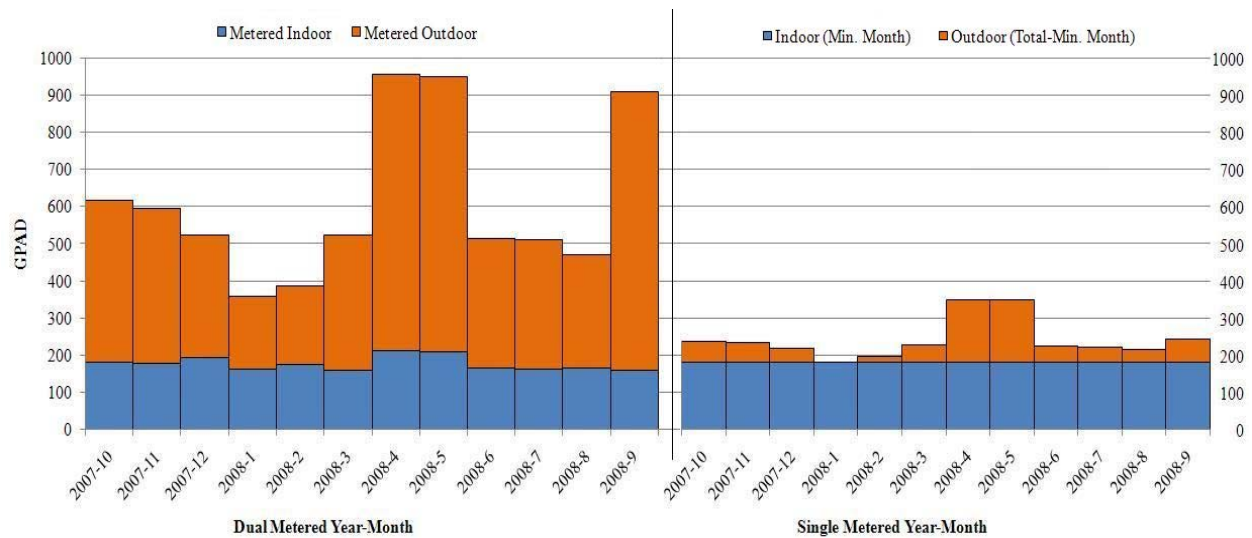


Figure 1. Average indoor and outdoor water use for 1,402 dual metered (left figure) and 29,504 single metered (right figure) residential accounts in Gainesville, Florida.

The benchmark outdoor water use for three areas using dual meters was 395 gpad that was the basis for estimating potential savings from switching outdoor water use to alternative sources (Andrade and Smith 2002). Assuming 2.5 persons per house and 70 gpcd for indoor use, then the total daily water use for these houses would be 570 gpad. The corresponding gallons per month for customers with dual meters are 615 gpad for Gainesville and 513 gpad for Ocoee. Thus, SFR homes with separate irrigation meters can be expected to use an average of 500 to 600 gpad.

Cumulative density functions for the 29,504 single and 1,402 dual metered single family residential customers served by GRU are shown in Figure 2. The median usage for dual metered customers is about 530 gpad and about 200 gpad for single metered customers, about 38% of the median for the dual metered customers. Alternatively, the median usage for the dual metered customers is in the upper 8% of the usage for the single metered customers. Thus, the dual metered customers represent very high end users and are not representative of single family residential users. Accordingly, the current estimated savings for the irrigation offset users should only be applied to these very high end users, not the entire population of single family residential users.

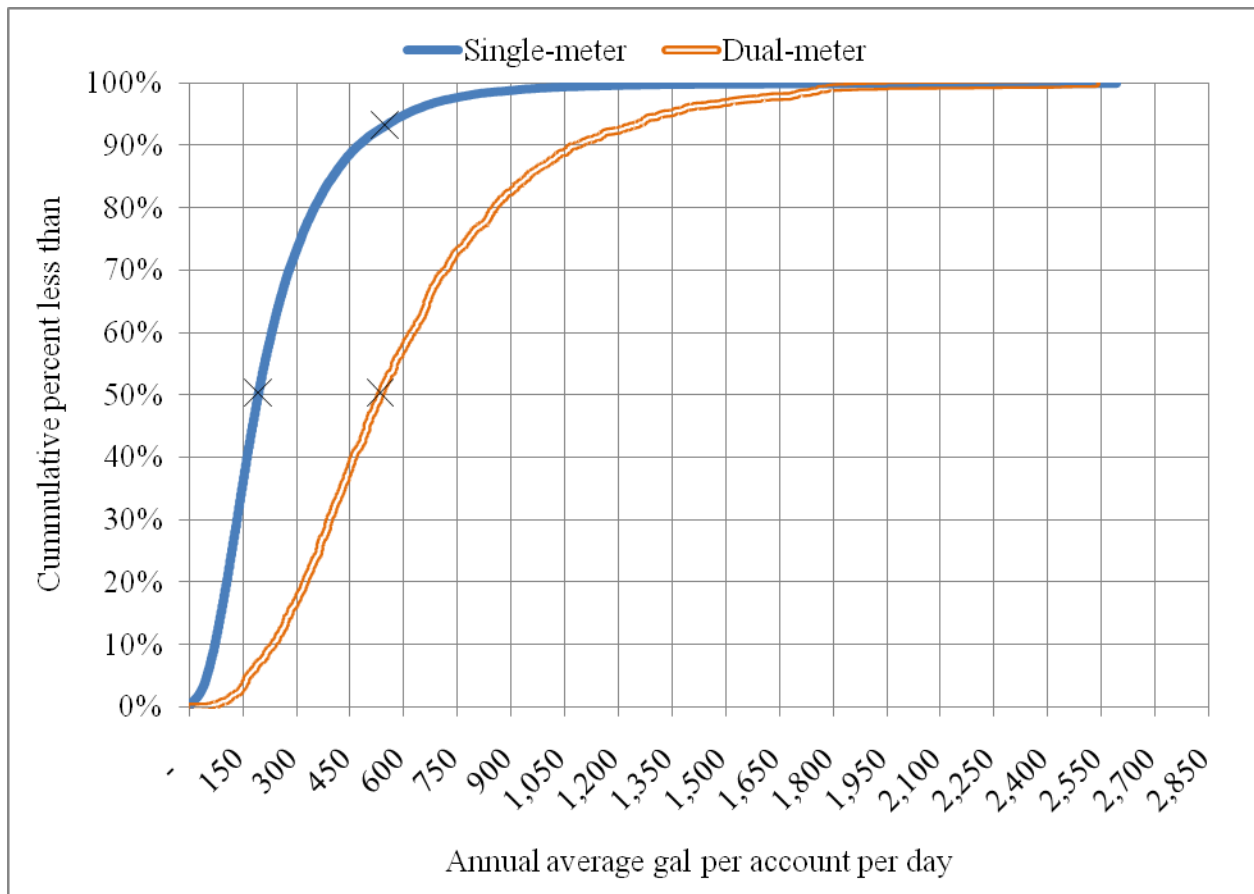


Figure 2. Cumulative frequency distributions of total water use for single and dual metered single family residential accounts in Gainesville, Florida

IRRIGATION USAGE FROM BILLING RECORDS

Ideally, the utility has information on customers who are using reuse water or have private wells. Whitcomb (2005) surveyed a cross section of 3,521 homes in 16 cities in Florida regarding their water use patterns including their irrigation source. The percentage of irrigation that is provided by the utility ranges from as low as 21% for Melbourne and St. Petersburg to a high of 100% in

Tallahassee with an average of 64%. Customers who use wells or surface sources for their irrigation water are very difficult to track. Private residential irrigation wells do not require a permit so there is no central data source to identify their prevalence. As Whitcomb's (2005) survey shows, this proportion varies widely from utility to utility and it is difficult to find data directly on indoor vs. outdoor water use. This information can be collected by surveys of some or all of the customers. A direct way to estimate the offline customers has been developed using billing data for a year or two to infer from the time series signatures of the water use patterns how many customers appear to be using water only for indoor purposes.

Single family residential users can be grouped into categories that are of interest using the k-means clustering algorithm. This analysis was performed using XLSTAT© Version 2009.4.03 (Addinsoft 2009). Each data point is the mean and standard deviation of the monthly water use for the customer. The mean gives a direct measure of the size of the water use whereas the standard deviation measures the variability in water use for each customer. Thus, offline irrigation users would be expected to have a monthly water use pattern similar to the indoor water use shown in Figure 1 with relatively low variability. The mean indoor water use is directly proportional to the persons per house. The users were divided into the following three clusters: 1) larger users with higher variation, 2) medium users with medium variation, and 3) smaller users with lower variation. We hypothesize that cluster 3 members correspond to customers who are using other sources of irrigation water or that they have no or minimal demand for irrigation water.

The results of the clustering for all of the 1,402 dual meter and 29,504 single meter customers are shown in Figure 3 and Table 2. Nearly 71% of the SFR customers have little or no irrigation. Thus, it would be counterproductive to target this group for irrigation retrofits. On the other hand, the top 5% to 10% of the users are the prime candidates for switching to alternative water sources. In this case, significant savings could be achieved albeit for only a small portion of the users.

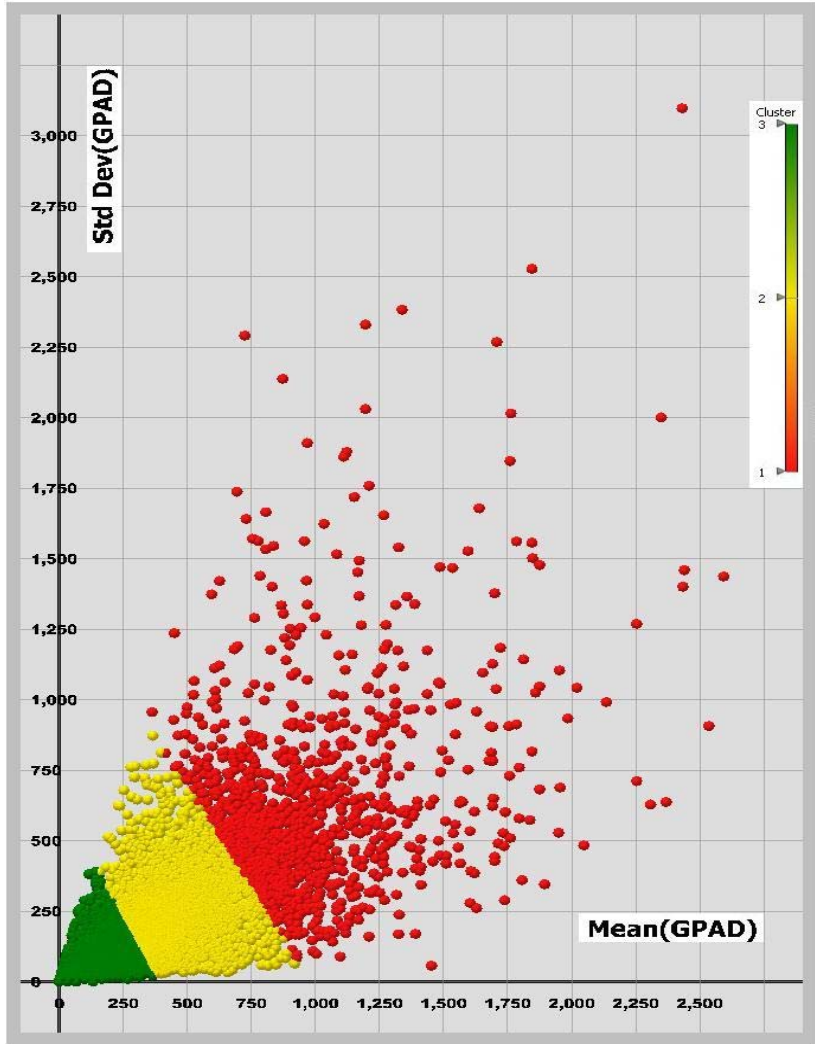


Figure 3. Results of clustering the 30,906 customers into three categories: 1 (upper irrigation), 2 (mid-range irrigation), and 3 (minimal irrigation/offline).

Irrigation Group	Mean GPAD	Standard Deviation GPAD	% of SFR Customers	% of SFR Water Use
Minimal/Offline	156	65	70.6%	42.5%
Mid-range	434	233	25.3%	42.4%
Upper	949	598	4.1%	15.1%
Total			100.0%	100.0%
Average	259			

Table 2. Statistics of the membership in each cluster.

ESTIMATED SAVINGS RATES FOR IRRIGATION OFFSETS

The current default estimate in the *Guide* for irrigation offsets for SFR parcels indicate average savings of 300 gpad. This savings estimate is based on assuming that dual meter single family

residences are a representative sample of the population. Our analysis of a large population of 30,906 SFR customers of GRU, including 1,402 dual meter customers, shows that dual meter users represent the upper 5 to 10% of users. A more realistic default estimate for SFR irrigation offset savings can be obtained by categorizing SFR users based on their recent monthly water use patterns. This analysis will provide a sound basis for estimating the potential market for irrigation offsets. The detailed cluster analysis of 1,402 dual meter and 29,504 single meter customers served by GRU indicated that over 70% of the single meter customers have little or no demand for irrigation water for several reasons including: 1) their irrigation water comes from reuse, private wells, or other alternative sources; 2) they choose not to irrigate. The key signature of such users is that their monthly indoor water use is relatively constant as shown in Figure 1. In this case, the key factor that determines monthly water use is the number of people per SFR account that varies from 0 to 7 or 8 with a typical value of about 2.5.

The recommended approach for estimating the savings rates for irrigation offsets for SFR customers in Florida is to divide the customers into clusters as described in this paper using available software. The results of the clustering will tell the average irrigation use at present. Multiply this number by 30 or 50% depending upon whether the option is unmetered or metered, respectively. Finally, calculate the expected savings as shown in Table 3. This approach suggests a clear strategy of targeting the higher end irrigation users with the highest variability in use. In the case of GRU, this target population would be about the top 10% of the users.

Irrigation Group	% of Total	GPAD Irrigation#	Offset %	GPAD Savings
Minimal	70.6%	0	50%	0
Mid-range	25.3%	259	50%	130
Upper	4.1%	774	50%	387
Total	100.0%			
Wgt. Avg.		97	50%	49

*Offset = 30% for unmetered and 50% for metered alternative source. # Total water use – 2.5 persons/house*70 gpcd

Table 3. Default savings estimate for BMP 1 (non-potable irrigation source replacements) for single family residential users.

ACKNOWLEDGEMENTS

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