Water Conservation Analysis for Withlacoochee Regional Water Supply Authority

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Figures and Tables

1.0 Introduction

The purpose of this report is to describe the conservation component of the Withlacoochee Regional Water Supply Authority (WRWSA) Plan that was developed using the Conserve Florida Water EZ Guide software for 12 preselected utilities and these results extrapolated for an additional 33 utilities in their four county study area.

2.0 Description of Urban Water Conservation and Supporting Research

A detailed description of EZ Guide and links to our publications are available at our web site (www.conservefloridawater.org). Heaney et al. (2011) present an overview of EZ Guide. Switt et al. released the latest version of the users' manual for EZ Guide in 2013. Heaney (2014) published a brief overview of broader changes in the urban water systems field with new emphasis on bottom up evaluation of urban water demand options.

2.1 Overview

The Conserve Florida Water Clearinghouse was tasked with expanding on early efforts to develop software to evaluate water conservation options, collect and disseminate literature on this topic, and develop and maintain databases on water use patterns and strategies for managing water demand. Brief descriptions of the components of the analysis are presented next.

2.2 Single Family Residential Indoor Water Use

Single family residential (SFR) is typically the largest water use sector. SFR indoor water use has been shown to be quite consistent across Florida and indeed the entire United States with average usage ranging from 60 to 75 gallons per capita per day (gpcd). Indoor water use is declining due to the installation of more water and energy efficient water using devices and is expected to be in the range of 40-60 gpcd for new homes by 2035. Furthermore, the effectiveness of indoor best management practices (BMPs) such as toilet retrofits can be quantified with reasonable accuracy for known persons per house and the ages of these houses. Using a bottom up approach, performance functions can be based on an end use analysis of potential water savings as a function of the number of fixtures retrofitted. This information can be coupled with cost and savings data to find the optimal mix of fixtures to retrofit as described in Friedman (2009), Friedman et al. (2011), Friedman (2013) and Morales and Heaney (2013).

2.3 Single Family Residential Outdoor Water Use

Whereas single family residential (SFR) indoor water use has been declining during the past two decades, SFR outdoor water use has been increasing in some utilities (Palenchar 2009, Friedman et al. 2013, 2014). A major reason for increased SFR outdoor water use has been the growing popularity of in-ground sprinkler systems as shown in Figure 2.1 (Palenchar 2009). Prior to 1980, in-ground sprinkler systems were installed in about 10 % of the new homes in Gainesville Florida. However, by 2008, nearly 90% of new homes have in-ground sprinkling systems. In-ground systems have been shown to use more water than hand watering systems. Total water use for irrigation depends on the irrigated area and the application rate. The EZ Guide database includes information on the irrigable area for every SFR parcel. Irrigation application rates vary

widely. Romero and Dukes (2011) estimate that the necessary application rate for WRWSA is 20.4 inches per year. Our studies indicate that about half of the SFR customers over irrigate. Thus, irrigation conservation efforts should focus on the overirrigators. A recent study for WRWSA indicates that significant savings can be achieved if larger over-irrigators participate in irrigation audits (Nancy H. Smith 2013).

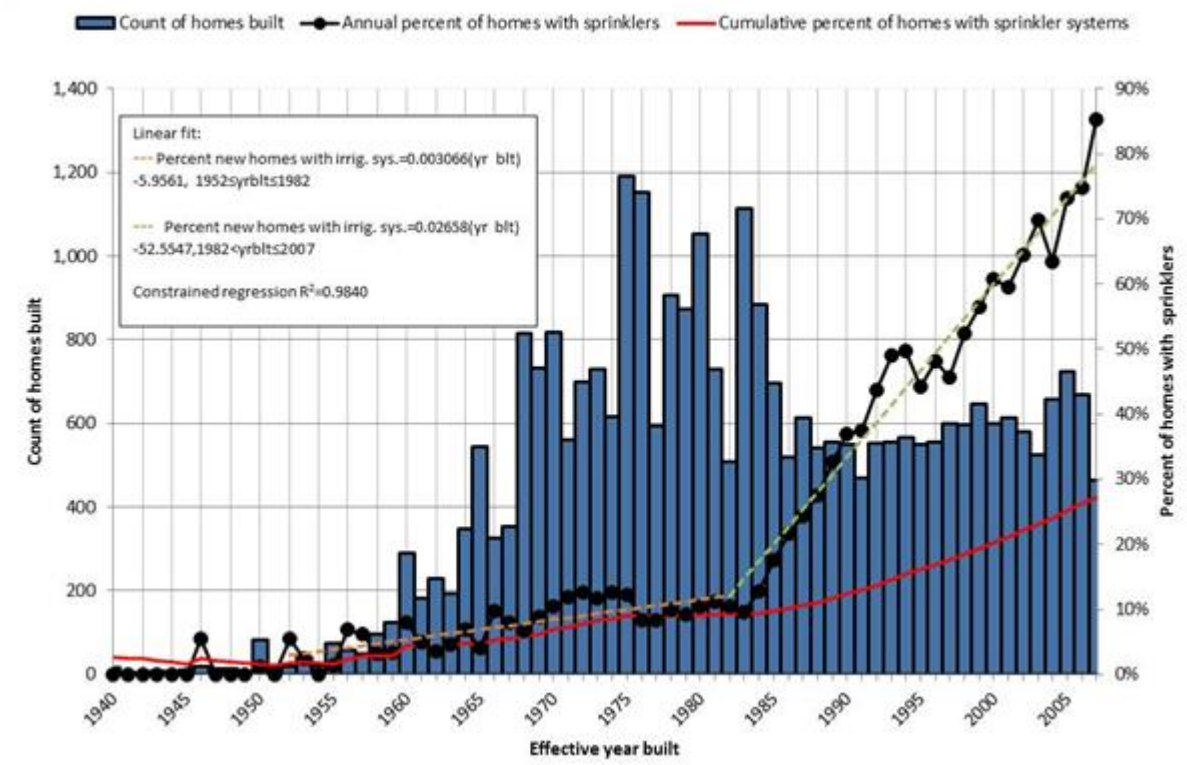

Figure 2.1. Annual trends in the popularity of in-ground sprinklers in Gainesville, Florida from 1940 to 2008 (Palenchar 2009, Friedman et al. 2013, 2014).

Whereas the number of irrigators appears to be increasing, their impact on potable water use can be lessened if they use alternative sources of irrigation water including wastewater and stormwater reuse and/or private wells. The proportion of SFR customers who irrigate on the potable water system can be estimated if their monthly water use data are linked with parcel attribute data. However, this linkage has only been done for a few utilities in Florida and none within the WRWSA.

Another factor that determines outdoor water use is the trend in irrigable area that is estimated for each parcel as part of EZ Guide evaluations. Results for Gainesville, Florida are shown in Figure 2.2. Irrigable area per new house increased steadily from about 5,000 square feet in 1940 to about 15,000 square feet in the mid-1980's when it began to decline to about 10,000 square feet in 2008.

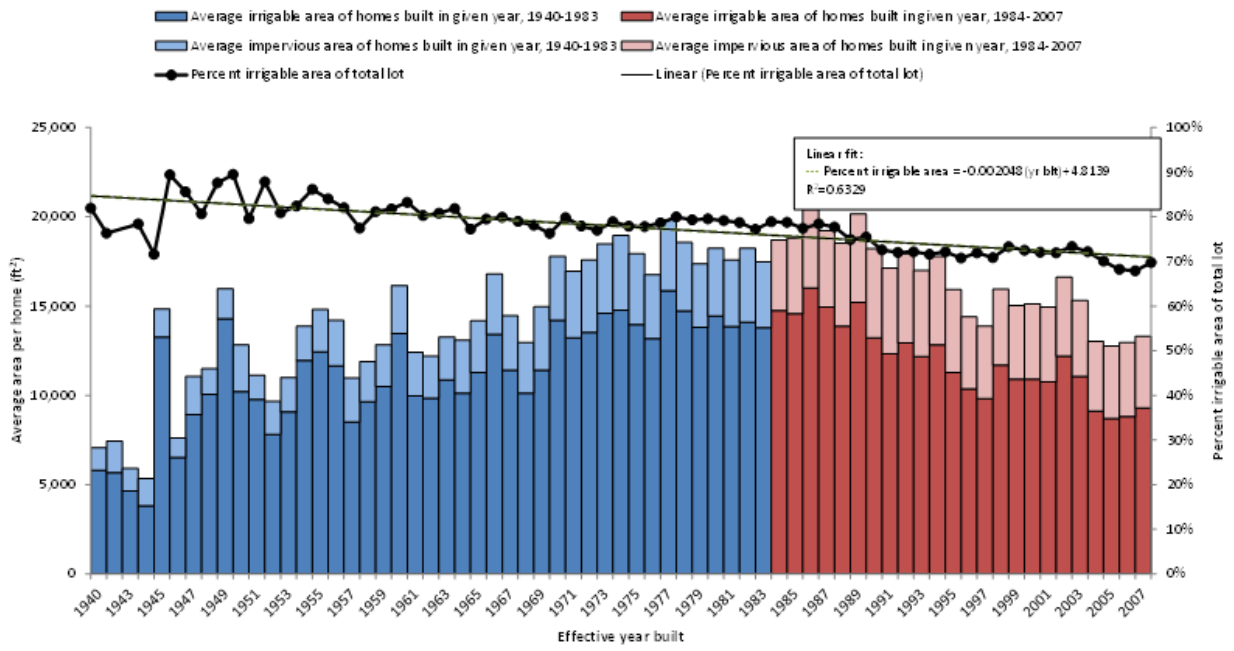

Figure 2.2. Trends in irrigated area per house from 1940 to 2008 in Gainesville, Florida (Palenchar 2009, Friedman et al. 2013, 2014).

Trends in irrigable area per single family residence (SFR) for the 12 benchmark utilities in WRWSA are shown in Table 2.1. Overall, the average irrigable area has declined by about 18% based on comparing the pre-1983 data with the post-1994 data. Maximum irrigated areas average about 23,600 square feet and the minimum irrigable areas exhibit a significant downward trend to their present value of about 3,200 square feet. Average irrigable areas are increasing in six of the twelve utilities as shown in Table 2.1.

Table 2.1. Sizes and trends in irrigable areas for 12 utilities in WRWSA that account for 84% of the total water use.

			1	2	3	4	5	6	7	8	9
Count	County	Method	Utility	2010 SFR parcels	2010 & 2035 irrig. sf/ parcel, < 83	2010 & 2035 irrig sf/ parcel, 83-94	2010 & 2035 irrig sf/parcel > 94	2010 <83 parcels	2010 83-94 parcels	2010 >94 parcels	Average irrigable area per parcel, sf
1	Citrus	EZG	Citrus County Utilities	21,754	13,089	16,483	17,010	3,263	6,546	11,945	16,263
2	Citrus	EZG	Crystal River	1,196	10,292	3,481	6,525	624	422	150	7,416
3	Citrus	EZG	Inverness	10,166	14,085	13,179	14,358	4,240	3,717	2,209	13,813
4	Hernando	EZG	Hernando Cty. Utilities	41,779	11,568	7,832	7,021	4,317	11,282	26,180	7,710
5	Hernando	EZG	Brooksville	3,793	15,670	21,307	21,560	2,394	762	638	17,793
6	Marion	EZG	Ocala	17,450	14,252	14,142	12,752	411	9,577	7,462	13,550
7	Marion	EZG	Belleview	4,613	23,895	18,196	16,092	262	1,614	2,737	17,271
8	Marion	EZG	Dunnellon	3,263	14,289	16,483	21,559	126	926	2,211	19,838
9	Marion	EZG	Marion County Utilities	29,021	15,729	12,438	7,983	1,083	2,606	25,332	8,672
10	Sumter	EZG	Bushnell	1,143	21,787	20,828	23,663	591	279	273	22,001
11	Sumter	EZG	The Villages	36,342	4,846	3,829	3,246	726	3,122	32,494	3,328
12	Sumter	EZG	Wildwood	3,616	18,878	25,822	22,915	1,933	698	985	21,318
		EZG	Sub-total	174,136				19,970	41,551	112,616	
		EZG	Wgt. Avg.		12,141	10,949	9,909				10,413

2.4 Commercial, Industrial, and Institutional Water Use

One of the major improvements in EZ Guide is the ability to estimate water use by 55 commercial, industrial, and institutional (CII) sectors. The 55 sectors are defined using the state of Florida property appraiser's taxonomy. The heated area for every CII establishment is determined using EZ Guide. Water use per square foot of heated area is determined using data from several thousand CII parcels for which water use data per square foot has been estimated. Details of the CII methodology are described in Morales (2010), Morales and Heaney (2010), and Morales et al. 2011 and 2013). SWFWMD reports commercial and industrial water use in their annual reports. This value is used as a cross check on our estimates.

2.5 Unaccounted for Water

The last term in the water budget is unaccounted for water (UAW). We have done extensive research on this topic (Friedman 2009, Friedman and Heaney 2009, Friedman et al. 2013, and Morales et al. 2013). EZ Guide accepts the estimates of UAW that are provided in the SWFWMD annual water use reports except as follows:

- If the reported UAW is less than 5%, then 5% is used as the default value
- If no value is specified, then 10% is assumed as the default value.

2.6 Final Water Budget

With regards to model calibration, the primary unknown in the final water budget is the SFR outdoor water use. It is calculated as the residual using the following equation

$$\text{SFR out} = \text{Total} - \text{SFR in} - \text{CII} - \text{UAW} \qquad \text{equation 2.1}$$

Knowing SFR in, the number of irrigators (NI) can be calculated as a function of the average irrigable area (IA) and the average application rate (AR) of 20.4 inches per year as shown in equation 2.2.

$$NI = \text{SFR out}/(k*IA*AR) \qquad \text{equation 2.2}$$

Where k = conversion factor.

3.0 Results

The results of the conservation evaluations for the 12 utilities that included an EZ Guide analysis and the other 33 utilities are presented in this section.

3.1 Water Use Patterns by Sector

EZ Guide was used for developing water conservation plans via a bottom up approach that includes parcel level information regarding the attributes of the individual customers such as irrigable area. Benchmark utilities including Gainesville Regional Utilities, Hillsborough County Water Utility and Sanford Water Utility have been analyzed in detail using customer level monthly water billing data that are linked with the customer attribute data to provide default estimates on water use patterns. The selected methodology was to do EZ Guide analyses for 12 utilities in WRWSA and then extrapolate these results to the remaining 33 utilities. EZ Guide is calibrated for each of the 12 utilities for 2010 water use conditions to do a water budget that matches closely with measured total water use and population estimates that were provided. Water use is the sum of single family residential indoor and outdoor water use, multi-family water use, commercial, industrial, and institutional water use, and unaccounted for water. The results are shown in Table 3.1a.

The total 2010 population for WRWSA was about 547,000 of which 448,000 are contained in the 12 utility EZ Guide sample. Similar numbers for 2035 are a total of 785,000 including 656,000 in the 12 utility sample. Overall, the 12 utilities account for about 82% of the total

population served. The 2007-11 gross gpcd for the 12 utilities averaged 186 with a minimum of 87 and a maximum of 281. The other 33 utilities had a lower average gross gpcd of 145 with a minimum of 57 and a maximum of 270. The overall population weighted gross gpcd was 179. The 12 EZ Guide utilities accounted for 85% of the total water use in 2010. The overall population (col. 2 and 5) and water use data (col. 6 and 7) were provided to us. The breakdowns of residential water use into single and multi-family components were outputs of the EZ Guide analysis. Occasionally, the provided data differed from our estimates and it was necessary to adjust our numbers to conform to the provided estimates. Using GIS boundary information provided to us, the number of SFR parcels was determined as shown in Column 8. Overall, there are an estimated 2.6 persons per SFR parcel. This ratio was used to estimate the number of parcels in the other 33 utilities. Columns 9 to 13 for the 12 utilities provide the estimated percent of total water use by sector. All of these percentages are output from the calibrated EZ Guide analysis. The percentages for the other 33 utilities were obtained primarily from the Table A-2 of the 2010 SWFWMD annual water use report. Overall, about one third of the total water use is for SFR indoor purposes and another one third for SFR outdoor irrigation. MFR use accounts for about 7 % whereas CII accounts for 16%. The remaining 9% is unaccounted for water. The associated 2010 SFR gpcd averages 69.4 for SFR indoor and 67.6 for the MFR. These values correspond closely with other Florida and national estimates of indoor water use. The overall average gpcd varies a little due to the influence of the blend of older and newer single family residences. The information in Table 3.1a helps explain the nature of the gross gpcd and the separate influence of each end use.

The results from the 12 EZ Guide analyses were extrapolated to the other 33 utilities as shown in Table 3.1a. The primary source of information for the apportionment of water use for the other 33 utilities is the 2010 SWFWMD annual water use report statistics.

Table 3.1a. Water use patterns in the Withlacoochee Regional Water Supply Authority.

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Count	County	Method	Utility	2010 population	2010 single family residential population	2010 multi-family residential population	2035 population	2007-11 gross gpcd	2010 gross mgd	2010 SFR parcels	2010 % SFR in	2010 % SFR out	2010 %MFR	2010 %CII	2010 & 2035 % UAW	2010 Total %	2010 SFR indoor gpcd	2010 MFR indoor gpcd
1	Citrus	EZG	Citrus County Utilities	48,432	46,500	1,932	74,864	174	8.43	21,754	38.8%	35.0%	1.4%	14.8%	10.0%	100.0%	70.3	61.1
2	Citrus	EZG	Crystal River	4,580	2,664	1,916	5,752	119	0.55	1,196	36.3%	1.5%	25.7%	21.5%	15.0%	100.0%	74.3	73.1
3	Citrus	EZG	Inverness	24,222	22,100	2,122	27,001	143	3.46	10,166	47.2%	21.7%	4.1%	22.0%	5.0%	100.0%	74.0	66.9
4	Hernando	EZG	Hernando Cty. Utilities	125,578	96,637	28,941	154,760	150	18.84	41,779	35.9%	29.1%	10.3%	14.3%	10.4%	100.0%	70.0	67.0
5	Hernando	EZG	Brooksville	16,417	9,562	6,855	25,805	93	1.53	3,793	38.8%	2.1%	27.0%	26.4%	5.7%	100.0%	62.0	60.1
6	Marion	EZG	Ocala	58,375	45,406	12,969	69,234	224	13.08	17,450	24.8%	19.6%	7.0%	38.6%	10.0%	100.0%	71.4	70.6
7	Marion	EZG	Belleview	14,513	10,654	3,859	23,862	102	1.48	4,613	51.3%	5.2%	17.1%	16.4%	10.0%	100.0%	71.3	65.6
8	Marion	EZG	Dunnellon	6,191	5,600	591	7,868	87	0.54	3,263	56.0%	0.0%	5.0%	18.0%	21.0%	100.0%	53.9	45.6
9	Marion	EZG	Marion County Utilities	69,155	63,505	5,650	118,362	199	13.74	29,021	31.5%	48.3%	2.9%	5.5%	11.8%	100.0%	68.2	70.5
10	Sumter	EZG	Bushnell	3,793	1,834	1,959	4,333	150	0.57	1,143	22.7%	13.4%	25.4%	28.5%	10.0%	100.0%	70.6	73.9
11	Sumter	EZG	The Villages	65,420	65,420	-	92,152	281	18.40	36,342	24.2%	66.6%	0.0%	3.4%	5.8%	100.0%	68.1	
12	Sumter	EZG	Wildwood	11,252	7,650	3,602	51,910	258	2.92	3,616	18.2%	36.5%	9.1%	29.2%	7.0%	100.0%	69.5	73.8
		EZG	Sub-total	447,928	377,532	70,396	655,903		83.52	174,136								
		EZG	Wgt. Avg. or %	100.0%	84.3%	15.7%		186		27,123	33.3%	34.1%	6.9%	16.1%	9.5%	100.0%	69.4	67.6
1	Citrus	Extrap.	Floral City Water Association	7,527	6,344	1,183	7,439	57	0.43	2,926	78.3%	0.0%	14.6%	0.0%	7.1%	100.0%	53.0	53.0
2	Citrus	Extrap.	Rolling Oaks Utilities	9,767	8,232	1,535	10,318	143	1.40	3,797	40.9%	31.5%	7.4%	12.2%	8.0%	100.0%	69.4	67.6
3	Citrus	Extrap.	Homosassa Special Water District	5,400	4,551	849	7,356	137	0.74	2,099	42.7%	2.6%	7.8%	24.5%	22.4%	100.0%	69.4	67.6
4	Citrus	Extrap.	Gulf Hwy. Land Corp.	600	506	94	568	183	0.11	233	32.0%	52.2%	5.8%	0.0%	10.0%	100.0%	69.4	67.6
5	Citrus	Extrap.	GCP Walden Woods 1&2	403	340	63	413	205	0.08	157	28.5%	46.1%	5.2%	4.3%	15.9%	100.0%	69.4	67.6
6	Citrus	Extrap.	Ozello Water Assoc.	4,174	3,518	656	4,999	117	0.49	1,623	50.0%	14.9%	9.1%	16.0%	10.0%	100.0%	69.4	67.6
7	Citrus	Extrap.	Small Utilities	3,688	3,108	580	3,704	153	0.56	1,434	38.2%	28.8%	6.9%	16.0%	10.0%	100.0%	69.4	67.6
8	Hernando	Extrap.	Small Utilities	849	716	133	775	133	0.11	330	44.0%	22.0%	8.0%	16.0%	10.0%	100.0%	69.4	67.6
9	Marion	Extrap.	Small Utilities	1,113	938	175	1,440	200	0.22	433	29.2%	39.4%	5.3%	16.0%	10.0%	100.0%	69.4	67.6
10	Marion	Extrap.	Bay Laurel Community Dev. Dist.	7,844	6,611	1,233	18,696	270	2.12	3,049	21.7%	48.4%	3.9%	16.0%	10.0%	100.0%	69.4	67.6
11	Marion	Extrap.	Marion Utilities, Inc.	959	808	151	1,035	140	0.13	373	41.8%	40.6%	7.6%	0.0%	10.0%	100.0%	69.4	67.6
12	Marion	Extrap.	Utilities Inc. of Florida	975	822	153	1,509	135	0.13	379	43.3%	38.8%	7.9%	0.0%	10.0%	100.0%	69.4	67.6
13	Marion	Extrap.	Sun Communities Operating LP	808	681	127	750	154	0.12	314	38.0%	45.2%	6.9%	4.9%	5.0%	100.0%	69.4	67.6
14	Marion	Extrap.	Marion Utilities, Inc.	721	608	113	1,005	164	0.12	280	35.7%	43.0%	6.5%	4.9%	10.0%	100.0%	69.4	67.6
15	Marion	Extrap.	Century Fairfield Village, Ltd.	605	510	95	606	120	0.07	235	48.7%	32.4%	8.8%	0.0%	10.0%	100.0%	69.4	67.6
16	Marion	Extrap.	Association of Marion Landing Owners, Inc.	1,244	1,048	196	1,310	146	0.18	484	40.1%	42.7%	7.3%	0.0%	10.0%	100.0%	69.4	67.6
17	Marion	Extrap.	Marion Utilities, Inc. & Spruce Creek Dev. Co.	5,408	4,558	850	8,984	184	1.00	2,102	31.8%	52.4%	5.8%	0.0%	10.0%	100.0%	69.4	67.6
18	Marion	Extrap.	Windstream Utilities Company	2,403	2,025	378	4,354	251	0.60	934	23.3%	62.5%	4.2%	0.0%	10.0%	100.0%	69.4	67.6
19	Sumter	Extrap.	Cedar Acres	546	460	86	631	80	0.04	212	73.1%	0.0%	13.3%	9.0%	5.0%	100.0%	69.4	67.6
20	Sumter	Extrap.	Continental CC	1,382	1,165	217	1,503	195	0.27	537	30.0%	7.8%	5.4%	51.8%	5.0%	100.0%	69.4	67.6
21	Sumter	Extrap.	Lake Panasoffkee	3,733	3,146	587	4,242	64	0.24	1,451	84.3%	0.0%	15.7%	0.0%	10.0%	100.0%	64.0	64.0
22	Sumter	Extrap.	Small Utilities	1,539	1,297	242	3,216	150	0.23	598	39.0%	28.9%	7.1%	15.0%	10.0%	100.0%	69.4	67.6
23	Sumter	Extrap.	Webster	757	638	119	1,196	126	0.10	294	46.4%	20.1%	8.4%	15.0%	10.0%	100.0%	69.4	67.6
24	Marion	Extrap.	Sunshine Utilities / South Marion Regional System	2,549	2,148	401	3,305	199	0.51	991	29.4%	29.0%	5.3%	26.3%	10.0%	100.0%	69.4	67.6
25	Marion	Extrap.	Tradewinds Utilities, Inc.	1,157	975	182	1,252	102	0.12	450	57.4%	14.0%	10.4%	8.2%	10.0%	100.0%	69.4	67.6
26	Marion	Extrap.	Residential Water Systems / High Pointe	1,758	1,482	276	1,792	146	0.26	683	40.1%	23.4%	7.3%	19.3%	10.0%	100.0%	69.4	67.6
27	Marion	Extrap.	Sunshine Utilities / Ocala Heights	1,020	860	160	1,140	120	0.12	397	48.7%	18.6%	8.8%	13.8%	10.0%	100.0%	69.4	67.6
28	Marion	Extrap.	Rolling Greens Communities	2,013	1,697	316	2,013	181	0.36	783	32.3%	27.5%	5.9%	24.3%	10.0%	100.0%	69.4	67.6
29	Marion	Extrap.	Aqua Utilities of Florida, Inc. / Ocala Oaks	1,509	1,272	237	1,917	112	0.17	587	52.2%	17.0%	9.5%	11.3%	10.0%	100.0%	69.4	67.6
30	Marion	Extrap.	Marion County Utilities / Silver Springs Shores, Deerpath, South Oak Sub.	12,553	10,580	1,973	16,193	134	1.68	4,880	43.7%	11.7%	7.9%	26.7%	10.0%	100.0%	69.4	67.6
31	Marion	Extrap.	Marion Utilities, Inc. / Fore Acres	1,095	923	172	1,109	110	0.12	426	53.2%	16.4%	9.7%	10.8%	10.0%	100.0%	69.4	67.6
32	Marion	Extrap.	Sunshine Utilities / Sun Ray Estates	1,709	1,440	269	1,738	127	0.22	664	46.1%	8.3%	8.4%	27.3%	10.0%	100.0%	69.4	67.6
33	Marion	Extrap.	Small Utilities	11,699	9,860	1,839	12,702	115	1.35	4,548	50.9%	16.9%	9.2%	13.0%	10.0%	100.0%	69.4	67.6
		Extrap.	Sub- total	99,507	83,869	15,638	129,210		14.4	38,684								
		Extrap.	Wgt. Avg.					145			39.6%	28.4%	7.2%	14.8%	10.2%	100%		
		Total	Total	547,435	461,401	86,034	785,113		97.9	212,820								
		Total	Wgt. Avg.					179			34.2%	33.3%	7.0%	15.9%	9.6%	100.0%		

Brief explanations of the entries in Table 3.1a are presented in Table 3.1b.

Table 3.1b. Explanations of entries in Table 3.1a.

Column	Description
1	Utility name
2	Given 2010 population
3	2010 single family residential population from EZ G or 84.3% of total population
4	2010 multi-family residential population from EZ G or 15.7% of total population
5	Given 2035 population
6	Given 2007-11 gross gpcd
7	Calculated 2010 mgd = Col. 2*Col. 6/1,000,000
8	2010 parcels from EZ G or Col. 2*EZ G ratio of total parcels/total population for all of EZ G
9	2010 % SFR indoor water use from calibrated EZ G water budget or based on 2010 SWFWMD water use report
10	2010 % SFR outdoor water use calculated as the residual in the water budget =Col. 16-Col. 9-Col. 11-Col. 12-Col. 13
11	2010 % MFR water use from calibrated EZ G water budget or based on 2010 SWFWMD water use report
12	2010 % commercial, industrial and institutional (CII) water use from calibrated EZ G water budget or 2010 SWFWMD water use report (%I/C+%R/A+%F&O)
13	2010 and 2035 % unaccounted for water (UAW) from 2010 SWFWMD water use report. Min. value = 5%. Default = 10%.
14	2010 total % water use = 100%
15	Single family residential (SFR) indoor gallons per capita per day from EZG or weighted average of all of EZG
16	Multi- family residential (MFR) indoor gallons per capita per day from EZG or weighted average of all of EZG

3.2 BMP Options and Selected Results

The indoor and outdoor BMPs that were evaluated are shown in Table 3.2 along with their assumed service lives. These BMPs are available for use by each of the 64 sectors. A complete end use inventory is done for each historical and projected year of how many of these BMPs are in service and which water use rate is associated with each BMP, e.g., a 1.1, 1.3, 1.6, 3.5, or 5.0 gallon per flush toilet. This end use inventory is an important feature of EZ Guide. As we move forward in time, the older, typically less efficient, fixtures are replaced by improved options, e.g., replacing a 5.0 gallon with a 1.6 gallon per flush toilet. A BMP can be replaced before it has reached the end of its service life if a more cost-effective option is available. For the analysis, the base year is 2010 and the 20 year planning horizon runs from 2015 to 2035. Residential toilets are assumed to have a 40 year service life. The 5.0 gallons per flush (gpf) toilets are assumed to be used up to 1982. Thus, the last 5.0 gpf toilet will be replaced in 2022. If all of these older toilets are replaced in 2015, then the water savings only last until 2022 when a replacement model would be installed. Most of the BMPs have much shorter service lives. For example,

residential showerheads have an assumed service life of only 8 years. Thus, they will be replaced multiple times during the 20 year planning horizon.

Table 3.2. Available BMPs and assumed service lives in the EZ Guide analysis.

Fixture Type	Service Life, years	Source
Toilet - Residential	40	CFWC
Toilet - CII	25	CFWC
Urinal-CII	25	CFWC
Clothes Washer-Residential	11	CFWC
Showerhead - Residential	8	CFWC
Showerhead - CII	8	CFWC
Faucet - Residential	15	CFWC
Faucet - CII	15	CFWC
Pre-rinse Spray Valve-CII	5	CFWC
Water Audit-CII	5	CFWC
Soil Moisture Sensor-Residential	5	CFWC
Non Potable Irrigation System (eg. Reuse)-Residential	25	CFWC
Irrigation Audit-Residential	5	CFWC

The resultant estimated blend of BMPs for the twelve benchmark utilities during the planning horizon from 2015 to 2035 is shown in Table 3.3. The overall population weighted average gpcd is 186. The results shown are for a 15% reduction in gross gpcd or an average reduction of 27.9 gpcd. Results for 5 and 10% reductions in gross gpcd are also available. The BMP with the largest potential impact is residential faucets that account for 45.6% of the overall savings. Residential faucets with a service life of 15 years have an increased cost-effectiveness due to the added energy savings from more efficient models. Residential soil moisture sensors with a 5 year service life account for 16.3% of the savings. Residential shower heads with an 8 year service life account for 13.9% of the savings. Irrigation audits account for 7.5% of the savings. These audits can yield large savings per irrigator. However, the market for these audits among users with high water application rates is relatively small. Also, the savings may not last very long. Residential toilets account for only 2.3% of the total savings because few of the less efficient toilets remain to be replaced after 2015.

The results also show relatively wide variability in importance across the 12 utilities. Utilities with existing low gpcds may have smaller water use by the commercial, industrial, and institutional (CII) sector, larger irrigation reuse programs, and smaller unaccounted for water. At the upper end of the gross gpcd are utilities with relatively large potable water irrigation and larger CII water use. Overall, the results shown in Table 3.3 indicate a mix of selected BMPs that varies based on the nature of the utilities and the performance and cost assumptions used as input to EZ Guide.

Table 3.3. Selected mix of BMPs based on EZ Guide analysis of the twelve benchmark utilities.

BMP Type	Average (Population weighted) or Total	Belleview	Brooksville	Bushnell	Citrus County Utilities	Crystal River	Dunellon	Hernando County Utilities	Inverness	Marion County Utilities	Ocala	Wildwood	The Villages
2010 Gross GPCD	186	101	93	150	174	120	87	150	143	199	224	260	281
2010 Population	447,928	14,513	16,417	3,793	48,432	4,580	6,191	125,578	24,222	69,155	58,375	11,252	65,420
2010 Total Water Use (MGD)	**83.529**	1.469	1.529	0.570	8.446	0.550	0.540	18.827	3.460	13.740	13.081	2.920	18.397
BMPs													
Toilet - Residential	**2.3%**	3.5%	1.7%	5.9%	4.0%	3.7%	2.7%	1.6%	2.1%	1.9%	2.4%	8.7%	1.1%
Toilet - Commercial	**1.5%**	2.0%	3.7%	4.9%	1.3%	10.9%	2.7%	1.0%	1.7%	0.3%	3.3%	2.4%	0.4%
Urinal	**3.5%**	4.7%	8.0%	7.0%	2.3%	16.1%	5.0%	3.7%	3.6%	0.8%	7.7%	1.8%	0.9%
Clothes Washer	**0.0%**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Showerhead - Residential	**13.9%**	31.3%	14.3%	17.0%	17.6%	10.0%	18.6%	12.1%	16.9%	13.1%	13.2%	13.9%	10.5%
Showerhead - Commercial	**0.7%**	0.0%	0.6%	0.9%	0.3%	2.9%	0.2%	0.2%	0.9%	0.2%	3.4%	0.7%	0.1%
Faucet - Residential	**45.6%**	50.8%	59.2%	46.9%	55.1%	36.0%	45.6%	57.9%	54.4%	30.9%	45.1%	33.2%	25.6%
Faucet - Commercial	**3.9%**	6.3%	9.9%	9.3%	2.4%	17.5%	6.0%	3.9%	4.2%	1.0%	7.9%	2.8%	1.1%
Pre-rinse Spray Valve	**0.1%**	0.0%	0.5%	0.5%	0.0%	0.8%	0.3%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%
Water Audit	**1.2%**	1.3%	1.2%	4.1%	0.7%	0.3%	3.6%	0.3%	0.6%	0.5%	1.8%	18.4%	0.6%
Soil Moisture Sensor	**16.3%**	0.0%	0.8%	2.6%	12.2%	1.3%	6.6%	19.4%	11.5%	19.6%	11.5%	6.4%	27.9%
Non Potable Irrigation System (eg. Reuse)	**3.6%**	0.0%	0.2%	0.8%	4.1%	0.4%	2.2%	0.0%	3.8%	6.5%	3.8%	2.1%	9.3%
Irrigation Audit	**7.5%**	0.0%	0.0%	0.0%	0.0%	0.0%	6.6%	0.0%	0.0%	25.1%	0.0%	9.6%	22.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

3.3 Cost-Effectiveness of BMPs

Water conservation competes with other supply and demand management options. It is important to show that conservation options are cost-effective. Using a bottom up approach, the anticipated water use and associated savings for each BMP and for each cluster of users is determined, e.g., the 500 customers who could convert a one toilet home with a 5.0 gallon per flush toilet that is used by four people to a 1.6 gallon per flush model. The end use inventory in EZ Guide determines the cost effectiveness of each fixture for each user group. The optimization algorithm in EZ Guide ranks the BMP options from least to most costly per 1,000 gallons of water saved. The resulting supply curve shows the marginal and total benefit curves as shown in Figures 3.1 and 3.2 respectively. The water savings rate for this illustration is $3.00 per 1,000 gallons, the horizontal line on Figure 3.1. The BMP unit cost curve is shown in blue. Each dot represents a unit cost and an amount of water that can be saved. As you can see from Figure 3.1, dozens of options are included. In accordance with the law of supply and demand from basic microeconomics, the optimal solution occurs at the intersection of the supply and demand curves and results in a cumulative daily savings of about 590 kgals./day. Total benefits minus total costs are maximized at this level of water savings. An equivalent way to present these results is by plotting total benefits and total costs as shown in Figure 3.2. At 590 kgals./day, total benefits equal about $1,700 per day while total costs equal about $650/ day. Thus, the maximum net benefits per day = $1,700 – $650 = $1,050.

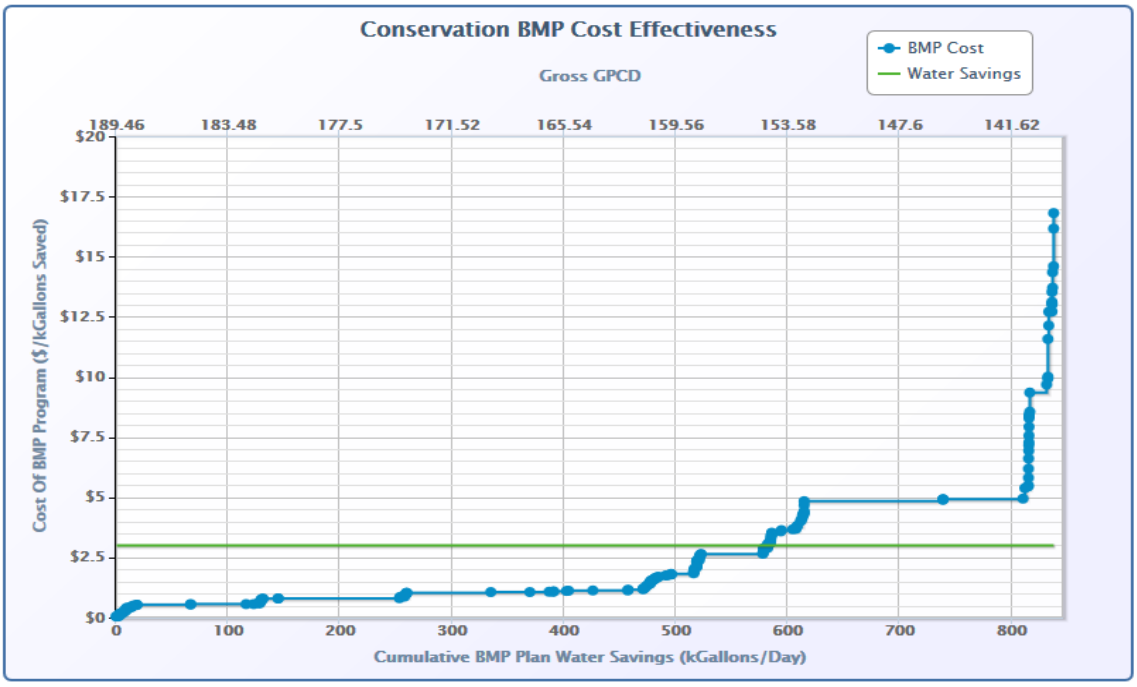

Figure 3.1. Illustrative market supply curve for conservation BMPs based on EZ Guide analysis.

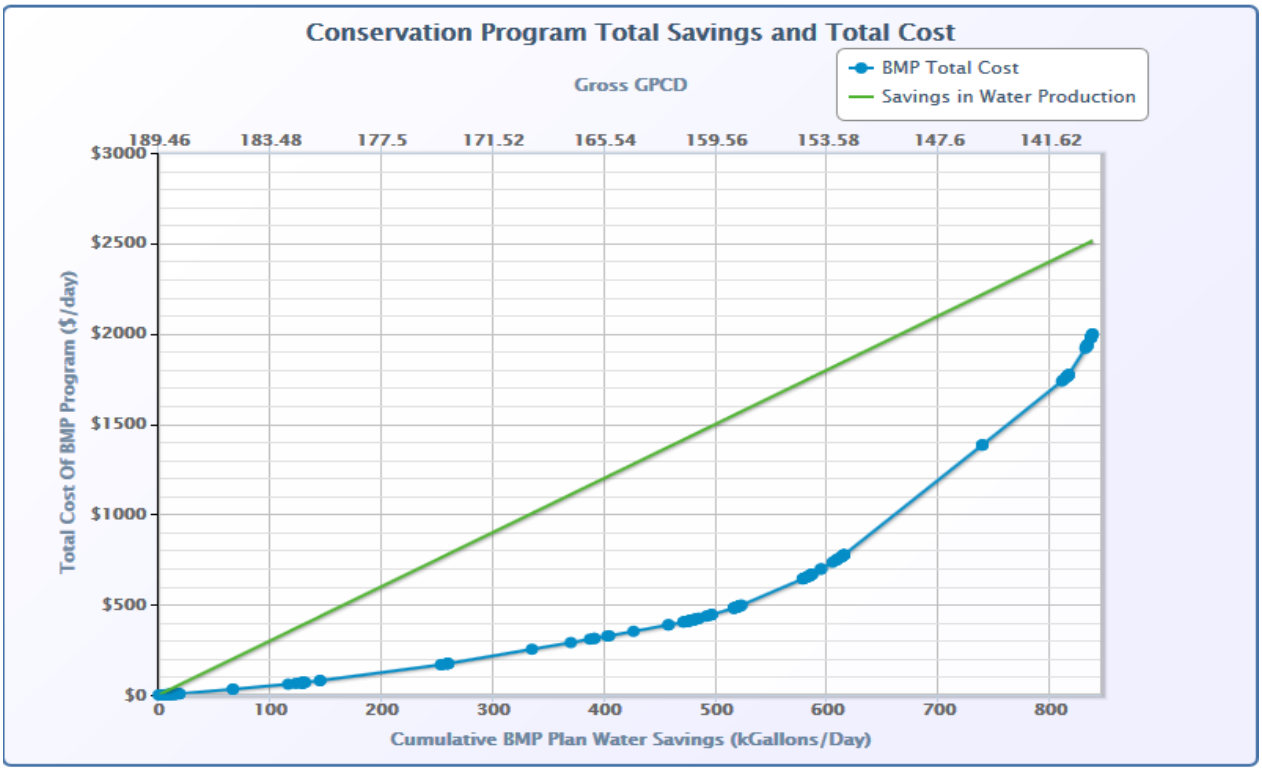

Figure 3.2. Illustrative total benefit and total cost curves for the BMP optimization based on EZ Guide analysis.

EZ Guide estimates the maximum attainable reduction in gpcd if all available BMPs are implemented. In the above illustration shown as Figure 3.2, it is technically possible to reduce gpcd from about 189 to 140, or 49 gpcd with an associated savings of about 830 kgals./day. However, net benefits are maximized when the savings are 590 kgals./day or a new gpcd of about 154, a 19% reduction. As part of the scope of work, it was decided to find the optimal solutions for 5, 10, and 15% reductions in gpcd. This is done in EZ Guide by specifying a target gpcd reduction. Then, EZ Guide calculates the least costly way to achieve this goal. Only one run is needed since the overall results can be determined from inspection of the unit and total cost and benefit figures that are similar to Figures 3.1 and 3.2. For example, a 10 % reduction in gpcd can be achieved for a total cost of about $250 per day and an associated savings of 19 gpcd or 330 kgals./day.

The results of the actual cost analysis for the 12 EZ Guide utilities and the extrapolated results for the other 33 utilities are shown in Table 3.4. At the 15% reduction in gpcd, the total savings for the 12 utilities are 1.76 mgd, a reduction of 28 gpcd from the original 186 gpcd. The annual cost per person to achieve a 15% reduction is $10.33 with a range from $3.19 to $19.53. The average cost per kgal. is $1.04 with a range from $0.49 to $2.17, well below the estimated $3.00 per kgal. saving rate that is used in the analysis. The highest cost per kgal. saved is $2.17 for Dunnellon who already has a low gross gpcd of 87. Unit costs would tend to increase as gpcd decreases since the most cost effective demand reduction options have already been implemented.

Table 3.4. Costs for 5, 10, and 15% reductions in gross per capita water use for WRWSA.

			1	2	3	4	5	6	7	8	9	10
							15% Reduction in gross gpcd				10% red.	5% red.
Count	County	Method	Utility	2010 pop.	2007-11 gross gpcd	2010 Savings, K gal./day	2010 Savings, gpcd	2010 Cost, $/day	Annual $ / person	Avg. $ / k gal.	2010 Cost, $/day	2010 Cost, $/day
1	Citrus	EZG	Citrus County Utilities	48,432	174	1,264	26.1	$ 1,550	$ 11.68	$ 1.23	$ 800	$ 400
2	Citrus	EZG	Crystal River	4,580	119	82	17.9	$ 40	$ 3.19	$ 0.43	$ 24	$ 10
3	Citrus	EZG	Inverness	24,222	143	520	21.5	$ 453	$ 6.83	$ 0.87	$ 280	$ 120
4	Hernando	EZG	Hernando Cty. Utilities	125,578	150	2,100	22.5	$1,900	$ 5.52	$ 0.90	$1,300	$800
5	Hernando	EZG	Brooksville	16,417	33	229	14.0	$240	$ 5.34	$ 1.05	$120	$40
6	Marion	EZG	Ocala	58,375	224	1,361	33.6	$ 1,925	$12.04	$ 0.98	$ 1,000	$ 300
7	Marion	EZG	Belleview	14,513	102	222	15.3	$ 163	$ 4.10	$ 0.73	$ 100	$ 40
8	Marion	EZG	Dunnellon	6,191	87	39	16.0	$ 215	$12.68	$ 2.17	$ 160	$ 60
9	Marion	EZG	Marion County Utilities	63,155	193	2,000	30.0	$ 2,050	$10.82	$ 1.03	$ 1,200	$ 450
10	Sumter	EZG	Bushnell	3,793	150	84	22.5	$ 90	$ 8.66	$ 1.07	$ 50	$ 20
11	Sumter	EZG	The Villages	65,420	281	2,800	42.2	$ 3,500	$ 19.53	$ 1.25	$ 1,900	$ 1,000
12	Sumter	EZG	Wildwood	11,252	258	435	38.7	$ 550	$ 17.84	$ 1.26	$ 299	$ 122
		EZG	Sub-total	447,328		11,796		$ 12,676			$ 7,233	$ 3,362
		EZG	Wgt. Avg.		186	1,756	28		$10.33	$ 1.04		
1	Citrus	Extrap.	Floral City Water Assoc.	7,527	57	64	8.6	$ 67	$ 3.25	$ 1.04	$ 38	$ 18
2	Citrus	Extrap.	Rolling Oaks Utilities	3,767	143	210	21.5	$ 218	$ 8.14	$ 1.04	$ 124	$ 58
3	Citrus	Extrap.	Homosassa Spec. Water Dist.	5,400	137	111	20.6	$ 115	$ 7.80	$ 1.04	$ 66	$ 31
4	Citrus	Extrap.	Gulf Hwy. Land Corp.	600	183	16	27.5	$ 17	$10.42	$ 1.04	$ 10	$ 5
5	Citrus	Extrap.	GCP Walden Woods 1&2	403	205	12	30.8	$ 13	$ 11.67	$ 1.04	$ 7	$ 3
6	Citrus	Extrap.	Ozello Water Assoc.	4,174	117	73	17.6	$ 76	$ 6.66	$ 1.04	$ 43	$ 20
7	Citrus	Extrap.	Small Utilities	3,688	153	85	23.0	$ 88	$ 8.71	$ 1.04	$ 50	$ 23
8	Hernando	Extrap.	Small Utilities	849	133	17	20.0	$ 18	$ 7.57	$ 1.04	$ 10	$ 5
9	Marion	Extrap.	Small Utilities	1,113	200	33	30.0	$ 35	$ 11.39	$ 1.04	$ 20	$ 9
10	Marion	Extrap.	Bay Laurel Community Dev. Dist.	7,844	270	318	40.5	$ 330	$ 15.38	$ 1.04	$ 189	$ 88
11	Marion	Extrap.	Marion Utilities, Inc.	959	140	20	21.0	$ 21	$ 7.97	$ 1.04	$ 12	$ 6
12	Marion	Extrap.	Utilities Inc. of Florida	975	135	20	20.3	$ 21	$ 7.69	$ 1.04	$ 12	$ 5
13	Marion	Extrap.	Sun Communities Operating LP	808	154	19	23.1	$ 19	$ 8.77	$ 1.04	$ 11	$ 5
14	Marion	Extrap.	Marion Utilities, Inc.	721	164	18	24.6	$ 18	$ 9.34	$ 1.04	$ 11	$ 5
15	Marion	Extrap.	Century Fairfield Village, Ltd.	605	120	11	18.0	$ 11	$ 6.83	$ 1.04	$ 6	$ 3
16	Marion	Extrap.	Association of Marion Landing Owners, Inc.	1,244	146	27	21.9	$ 28	$ 8.31	$ 1.04	$ 16	$ 8
17	Marion	Extrap.	Marion Utilities, Inc. & Spruce Creek Dev. Co.	5,408	184	149	27.6	$ 155	$10.48	$ 1.04	$ 89	$ 41
18	Marion	Extrap.	Windstream Utilities Company	2,403	251	90	37.7	$ 94	$14.29	$ 1.04	$ 54	$ 25
19	Sumter	Extrap.	Cedar Acres	546	80	7	12.0	$ 7	$ 4.56	$ 1.04	$ 4	$ 2
20	Sumter	Extrap.	Continental CC	1,382	135	40	29.3	$ 42	$ 11.10	$ 1.04	$ 24	$ 11
21	Sumter	Extrap.	Lake Panasoffkee	3,733	64	36	9.6	$ 37	$ 3.64	$ 1.04	$ 21	$ 10
22	Sumter	Extrap.	Small Utilities	1,539	150	35	22.5	$ 36	$ 8.54	$ 1.04	$ 21	$ 10
23	Sumter	Extrap.	Webster	757	126	14	18.9	$ 15	$ 7.18	$ 1.04	$ 8	$ 4
24	Marion	Extrap.	Sunshine Utilities / South Marion Regional System	2,549	199	76	29.9	$ 79	$ 11.33	$ 1.04	$ 45	$ 21
25	Marion	Extrap.	Tradewinds Utilities, Inc.	1,157	102	18	15.3	$ 18	$ 5.81	$ 1.04	$ 11	$ 5
26	Marion	Extrap.	Residential Water Systems / High Pointe	1,758	146	39	21.9	$ 40	$ 8.31	$ 1.04	$ 23	$ 11
27	Marion	Extrap.	Sunshine Utilities / Ocala Heights	1,020	120	18	18.0	$ 19	$ 6.83	$ 1.04	$ 11	$ 5
28	Marion	Extrap.	Rolling Greens Communities	2,013	181	55	27.2	$ 57	$ 10.31	$ 1.04	$ 32	$ 15
29	Marion	Extrap.	Florida, Inc. / Ocala Oaks	1,509	112	25	16.8	$ 26	$ 6.38	$ 1.04	$ 15	$ 7
30	Marion	Extrap.	Utilities / Silver Springs Shores, Deerpath, South Oak Sub.	12,553	134	252	20.1	$ 262	$ 7.63	$ 1.04	$ 150	$ 70
31	Marion	Extrap.	Marion Utilities, Inc. / Fore Acres	1,035	110	18	16.5	$ 19	$ 6.26	$ 1.04	$ 11	$ 5
32	Marion	Extrap.	Sunshine Utilities / Sun Ray Estates	1,709	127	33	19.1	$ 34	$ 7.23	$ 1.04	$ 19	$ 9
33	Marion	Extrap.	Small Utilities	11,639	115	202	17.3	$ 210	$ 6.55	$ 1.04	$ 120	$ 56
		Extrap.	Sub- total	33,507		2,161	728	2,248			1,282	596
		Extrap.	Wgt. Avg.		145				$ 8.24	$ 1.04		
		Total	Total	547,435		13,957	728	14,924			8,515	3,958

4.0 Summary and Conclusions

4.1 Summary

The purpose of this analysis is to develop a water conservation plan for 45 utilities served by the Withlacoochee Regional Water Supply Authority. The selected procedure was to do EZ Guide analyses of 12 of the utilities and extrapolate these results to the other 33 utilities. The results are presented in Table 3.1 in terms of the breakdown of gross water use into the single family indoor and outdoor residential sectors, the multi-family sector, the commercial, industrial, and institutional sector, and the unaccounted for water. Next the mix of selected BMPs is tabulated for the 12 EZ Guide utilities and the results are shown in Table 3.3. Finally, the estimated cost effectiveness is presented in Table 3.4 in terms of costs per person and cost per kgal. of water saved for gross gpcd reductions of 5, 10, and 15 %. The results indicate that cost effective conservation options exist since the cost per kgal. saved averages about $1 per kgal.

4.2 Conclusions

1. Refinement of Water Use Estimates

Water utilities are required to report water use to their water management district (s) as part of their water use permits (WUPs for SWFWMD) and to report their water supplied from their water treatment plants (PWSIDs) to the Florida Department of Environmental Protection. It can be challenging to reconcile different values of water use and population served that come from these two sources. The Water Management Districts and Florida DEP have made major improvements in providing online access to permit information through their e-permitting sites. This access is helpful in getting a better understanding of the nature of water use by the utilities

2. Population Estimates

The parcel level estimates of present and projected populations for a utility that are available from SWFWMD and SJRWMD are very helpful in providing consistent estimates. EZ Guide is set up to use population estimating methods that are consistent with WMD approaches. Improved methods of estimating the number of dwelling units in multi-family residences are very helpful in making more accurate estimates.

3. Irrigation Using the Potable Water System

EZ Guide does not require the use of customer water billing data that are linked to parcel attribute data. However, the accuracy of the evaluations is markedly improved if such data are provided. If billing data are available, then it is relatively easy to partition water use into its indoor and outdoor components for each customer. This information is important in estimating the proportion of single family residential customers who are irrigating using the potable water system. Irrigation using private wells remains a challenge to estimate.

4. Improved Quantification of Non-residential Water Use

EZ Guide is unusual, if not unique, in providing detailed information regarding non-residential water use. By providing customer level estimates of heated area, it is possible to greatly improve the accuracy in measuring commercial, industrial, and institutional (CII) water use. The CII water use database is being expanded under an ongoing project for the Water Research Foundation and improved water use coefficients should be available later this year.

5. Adapting EZ Guide to Compile the Results of Multi-utility Analyses

Separate runs of EZ Guide were made for the 12 utilities. Selected output from these runs was extracted manually to compile the tables shown in this report. It is possible to run EZ Guide for multiple utilities at one time by using the sum of the service areas and the total present and projected population and water use. However, you lose the utility level information if you use the aggregate option. It is possible to automate this process once the users decide what information they want to see for multi-utility evaluations. It may be desirable for regional analysis to query any or all of the 64 sectors within a defined area such as a county that are contained in EZ Guide. This was done for the CII sectors in our CFWI evaluation. A limitation of this analysis is that water use information is not available.

6. Incorporation of Customer Billing Data

Water use is a function of the size of each user and their water use rate. The size of each user is estimated in EZ Guide using parcel level data. However, the water use rates are estimated using default values from benchmark utility studies. The accuracy of the water use estimates can be greatly improved if the utility billing data can be included in the analysis. SJRWMD and 34 utilities in its service area have collaborated to link the parcel and water billing data through cooperative programs. We were able to show the value added from including billing data in our recently completed study of the Sanford Water Utility (Friedman et al. 2013). Perhaps this type of effort could be undertaken for select utilities in WRWSA. The simplest way to include billing data would be to analyze the data outside of EZ Guide and include the summary results that would be useful for calibration by sector. A better long-term solution is to make the final link between the billing data and the EZ Guide parcel data. Then, EZ Guide can use the water use data directly instead of the current default estimate based on water use coefficients.

7. More Refined EZ Guide Estimates

Major advances have been made in working with large databases that allow us, for the first time, to analyze water demand for each customer in a utility and to aggregate these estimates into clusters that represent priority demand management opportunities. SWFWMD has well organized protocols for compiling and publishing annual water use reports that provide valuable information on water use by sector. It appears feasible to combine some of their data with EZ Guide results across several water use sectors if common land use categories can be used.

5.0 Acknowledgements

Our group at the University of Florida was selected in 2007 to host the Conserve Florida Water Clearinghouse. The original team included Professor James Heaney as principal investigator, Randy Switt as information technology coordinator, and Kristen Riley as project manager. Early graduate student investigators included Ken Friedman (indoor water use and water loss management) and John Palenchar (outdoor water use) who prepared masters theses on these topics in 2009. One year later they were joined by Miguel Morales who prepared his masters thesis on non-residential water use. Based on the early success of this research program, Ken Friedman and Miguel Morales were awarded doctoral fellowships that provided about one half of their support for pursuing Ph.D.'s. Ken Friedman received his Ph.D. in 2013 and Miguel Morales is expected to complete his Ph.D. in 2014. We are grateful to the University of Florida for providing this valuable support that has permitted these students to pursue this new research area. Thanks to continuing funding from the Florida Department of Environmental Protection, St. Johns River, South, and Southwest Florida Water Management Districts, the City of Sanford, the U.S. Geological Survey, and the Florida Energy Systems Consortium, we have been able to keep this core group intact and help build an effective foundation in this new field.

6.0 References

Cardno. 2013. Water demand projections for the WRWSA (2015-2035)-Draft.

Friedman, K. 2009. *Evaluation of Indoor Urban Water Use and Water Loss Management as Conservation Options in Florida.* M.E. Thesis, Dept. of Environmental Engineering Sciences, U. of Florida, Gainesville, FL

Friedman, K. and J. Heaney. 2009. Water Loss Management: Conservation Option in Florida's Urban Water Systems. *Florida Water Resources Journal*, August.

Friedman, K. 2013. Simulation/Optimization of Alternative Water Supply Planning Using Parcel Level Demand Estimation and Management Strategies**.** Ph.D. Dissertation, Dept. of Environmental Engineering Sciences, U. of Florida, Gainesville, FL

Friedman, K., Heaney, J., Morales, M. and J. Palenchar. 2011. Water Demand Management Optimization Methodology. *Jour. American Water Works Assoc.*, Vol. 103, No. 9.

Friedman, K., Heaney, J. Morales, M. and J. Palenchar. 2013. Predicting and Managing Residential Potable Irrigation Using Parcel Level Databases. *Jour. American Water Works Assn.*, Vol. 105, No. 7.

Friedman, K., Heaney, J., and M. Morales. 2013. Water Loss Control for Sanford, Florida. Final Report to the City of Sanford, December

Friedman, K. , Heaney, J., Morales, M., and J. Palenchar. 2014. Estimation of Single Family Residential Irrigation Demand Management Effectiveness. *Jour. American Water Works Assn*, accepted for publication

Heaney, J. 2014. Evolution of Urban Water Systems Analysis. *Jour. of Water Res. Planning and Management*, accepted for publication.

Heaney, J., Switt, R., Friedman, K., Morales, M., and K. Riley. 2011. Overview of EZ Guide for Water Conservation Evaluations. *Florida Water Resources Journal*, September.

Morales, M. 2010. *Parcel Level Methodology for Estimating Commercial, Industrial,*

and Institutional Water Use. M.E. Thesis, Dept. of Environmental Engineering Sciences, U. of Florida, Gainesville, FL

Morales, M., and J. Heaney. 2010. Predominant Commercial Sectors in Florida and Their Water Use Patterns. *Florida Water Resources Journal*, August.

Morales, M., Heaney, J., Friedman, K., and Martin J. 2011. "Estimating Commercial, Industrial, and Institutional Water Use on the Basis of Heated Building Area." *Jour. American Water Works Assoc.*, Vol. 103, No. 6.

Morales, M., Heaney, J., Friedman, K. and J. Martin .2013. Parcel-level Model of Water and Energy End Use. *Jour. American Water Works Assn.,* Vol. 105, No. 8

Morales, M, Martin, J., Heaney, J. and K. Friedman. 2013. Parcel Level Modeling of Seven End Use Water Demands in 64 Public Supply Land Use Sectors. *Jour. American Water Works Assn.,* Vol. 105, No. 9.

Nancy H. Smith, Inc. 2014. Regional Irrigation System Evaluation Pilot Program; 2011-2014. Draft Final Report to SWFWMD.

Palenchar, J. 2009. *Trends in Irrigation Use of Potable Water by the Single Family Residential Sector in Alachua County, Florida.* M.E. Thesis, Dept. of Environmental Engineering Sciences, U. of Florida, Gainesville, FL

SWFWMD. 2011. 2010 Estimated Water Use in the SWFWMD. Brooksville, FL

Switt, R., Heaney, J.P., Friedman, K.R., Morales, M.A. and K.J. Riley. 2013. EZ Guide Online User's Guide.