# Pre-Population and Calibration of the EZ Guide 2

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Proc. 2010 Florida Section AWWA Conference, Orlando, December

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## INTRODUCTION

The Conserve Florida Water Clearinghouse (www.conservefloridawater.org) released the first version of the EZ Guide 2 on February 2010 for beta testing by interested users. The Advisory Committee for the Clearinghouse will review the suggested refinements and recommend which ones to incorporate into the final release of EZ Guide 2. EZ Guide 2 makes use of statewide databases which include: monthly operation reports (MOR) and basic facility reports (BFR) from Florida Department of Environmental Protection (FDEP); parcel level data from Florida Department of Revenue (FDOR); and population data from the US Census Bureau. The methodology developed by the Clearinghouse uses these data to develop a bottom up water budget for the utility service area and to estimate the end use of water.

The bottom up methodology was based on detailed billing data provided by some utilities. Water use coefficients were developed to substitute for billing data that is not available for most utilities. All of these coefficients are based on the relationships between billed water and multiple attributes contained in the parcel level data from FDOR.

The process to pre-populate EZ Guide 2 with utility specific data requires precise utility service area boundaries, and water production data obtained using the utility's potable water system identification number (PWSID). After having pre-populated EZ Guide 2 for more than 20 utilities, we want to share the lessons learned regarding the importance of utility service area boundaries, the process to determine all PWSIDs associated with a given utility, and the calibration process within the EZ Guide, among others. These results help refine the EZ Guide 2 while offering guidelines on how users can get better results from this decision support tool.

As the need to implement water conservation practices in Florida becomes more important, streamlined and accountable water conservation practices must be developed. In the State of Florida, the five water management districts (WMDs) encourage the implementation of conservation practices. Each WMD has a number of rules and guidelines which utilities follow in order to obtain a Consumptive Use Permit (CUP). Water conservation plans are required as part of water supply planning and utilities may be required to track the performance of their conservation practices.

The Conserve Florida Water Clearinghouse (CFWC) developed the EZ Guide Version 2 (http://conservefloridawater.org/ez_guide.asp) to perform water conservation audits enhancing the methods in the earlier online Guide and in EZ Guide 1. This spreadsheet-based tool can assist water utilities and water management districts in performing analyses and developing water conservation plans. The purposes of these plans include consumptive use permitting, water supply planning, tracking the effectiveness of a conservation program, and inclusion in a comprehensive urban water infrastructure plan. EZ Guide 2 was developed to better address the needs of utilities to have a less-data intensive method than the original *Guide*. EZ Guide 2 has significant refinements that incorporate improved conservation analysis tools.

## EZ GUIDE 2 DATA SOURCES

A key question when using EZ Guide 1 was the validity of the underlying data. For example, the user was able to input an estimate of billed water without providing any evidence of which input data were actually measured. Most of the inputs on the EZ Guide 2 are supported by information contained in databases, technical documents, and GIS as shown in Figure 1. Thus, the EZ Guide 2 calculations are presented in summary spreadsheets that are linked to supporting data. This structure is analogous to IRS forms that provide supporting evidence for entries into the primary tax calculation. The objective of this system is to provide high quality data in a centralized location, to develop coefficients that are relevant to Florida, and to facilitate the development of conservation plans by utilities. More modules are being developed by the CFWC and will be available online as they are released for public use.

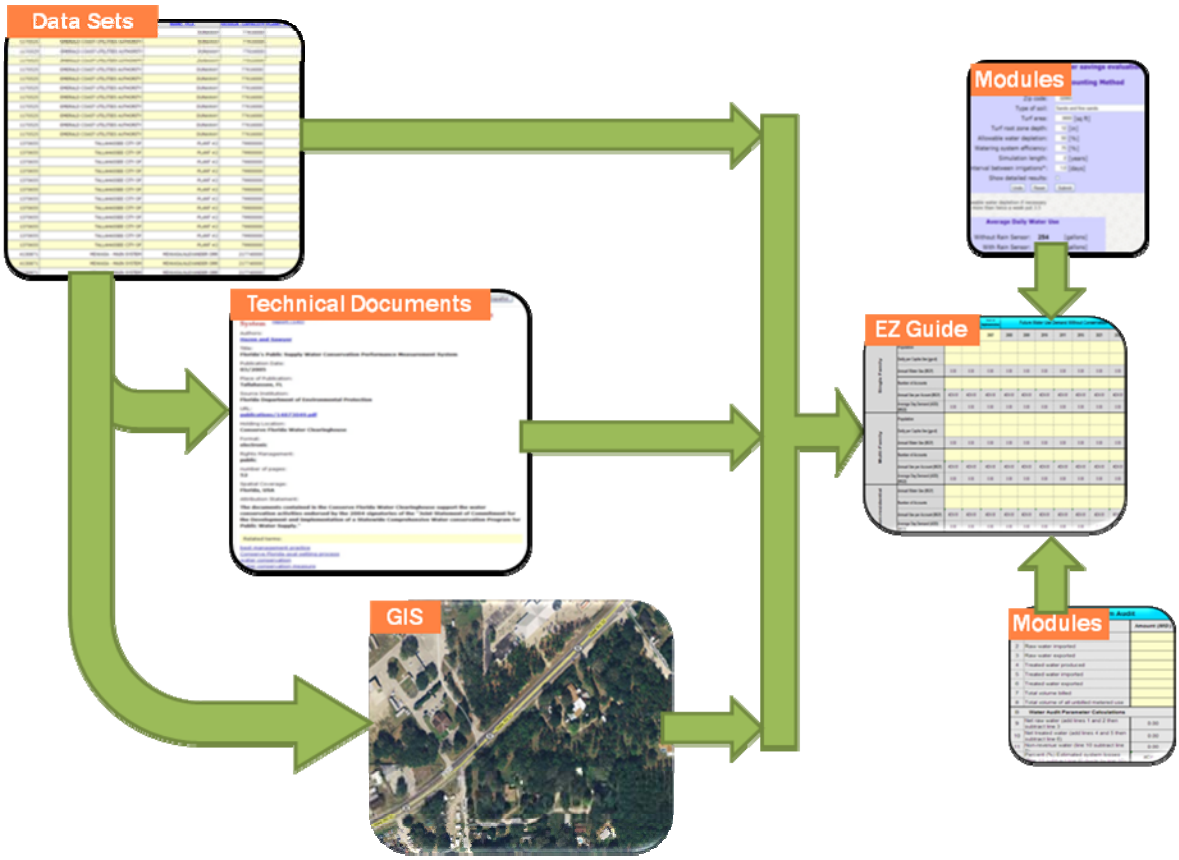


Figure 1. Data infrastructure support for the EZ Guide 2

EZ Guide 2 uses the minimum number of inputs necessary to develop a basic water conservation plan. These inputs include: monthly treated water produced, demographic data such as population served, number of accounts, and parcel data as enumerated in Table 1. Some of the required input data can be obtained online, e.g., the monthly water supplied and population served can be obtained directly from the web site of the Florida Department of Environmental Protection. U.S. Census data were used to assign a population per house estimate for each parcel in the state. This household size estimate is the average population for the Census block(s) in which the parcel is located. Parcel data was obtained from the Florida Department of Revenue (FDOR) which collects data from the individual county property appraisers.

Table 1. Data sources and features

| **Source** | **Features** |
|---|---|
| FDEP - Basic Facility Reports | PWSID, type, population served, Design capacity, number of plants |
| FDEP – Monthly Operation Reports | System name, maximum and average treated |
| U.S. Census | Block level population |
| FDOR – Parcel data | Parcel ID, land use, year built, area, number of buildings |

The CFWC group has combined the relevant features from these data sets and the database is available on the CFWC (2010) website. This data oriented approach allows for the development of water use estimates at the sector and sub-sector level. This methodology also allows analyses

at multiple scales: macro (State), meso (WMD or County), micro (Utility) and nano (parcel, water using device) as illustrated in Figure 2.

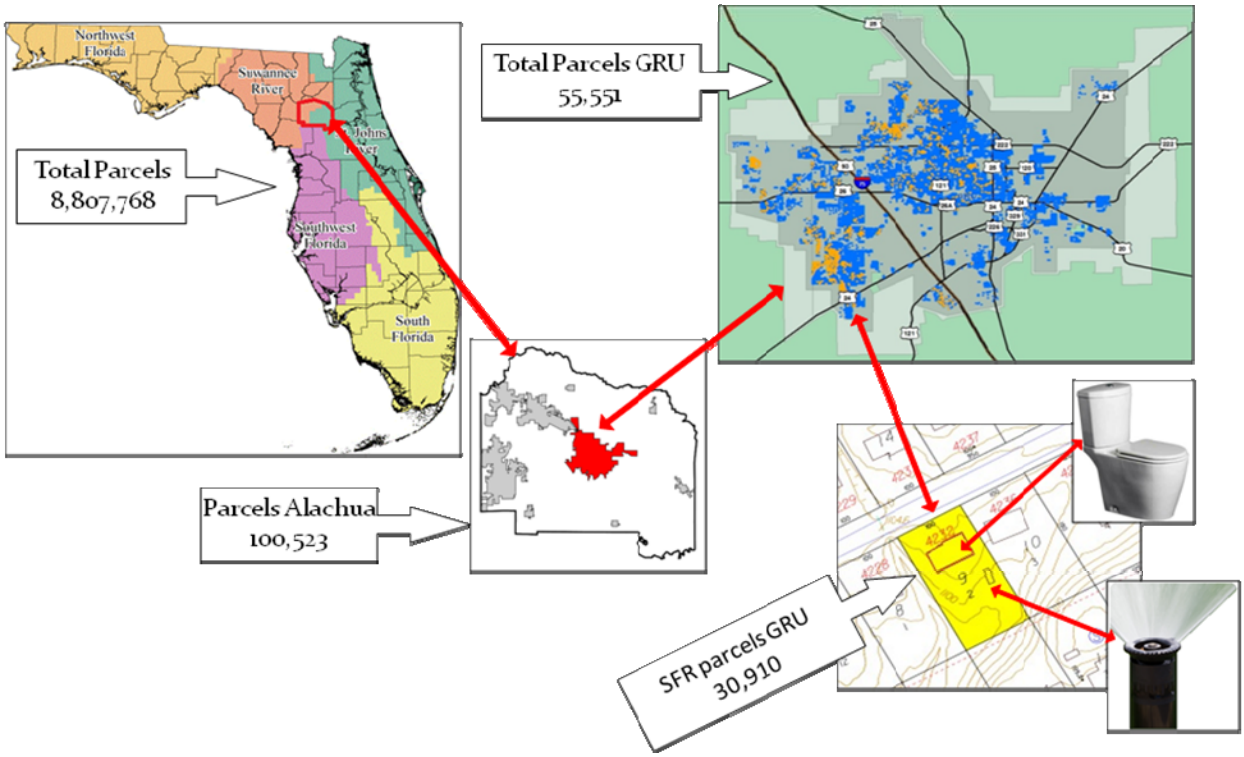


Figure 2. Data driven water conservation planning

EZ Guide 2 is organized into seven sections or modules. Each section is structured in a logical way, starting with the profile that contains basic information describing the utility and its service area. The next module is water audit. Then a water budget identifies the water used in each sector (e.g. residential, non-residential). The next two sections comprise water saving activities: BMPs (Best Management Practices) whose savings can be measured; and Measures, water conservation practices that are not quantifiable. The Analysis module provides charts and tables that summarize the results of the water conservation plan. Reports can be produced as desired by the user. Finally, BMP tracking allows the utility to track the number of BMPs that are implemented and to quantify water savings. Next we will explain how the data collected by the clearinghouse is used in the different modules of the EZ Guide 2.

## PRE-POPULATION AND CALIBRATION

To complete the EZ Guide 2 the CFWC support group requires the user to submit a list of all the public water system ID (PWSID) belonging to the utility, and a precise utility service area boundary map on a geographic information system ready format. Based on this information, the CFWC pre-populates the EZ Guide 2 for the utility.

A utility can have one or multiple PWSID's, and each ID can refer to one or more water treatment plants. The PWSID's are needed to query the FDEP data contained in the CFWC data service. EZ Guide 2 then aggregates the water production data by month and year.

The utility service area boundary is used to select the parcels that fall within the area served by the utility. Special care is needed during this step of the process. If the boundary includes areas not covered by the utility, like projected service areas, or "donuts" that are self served the number of parcels could be over estimated. On the contrary, if areas served by the utility are not included in the boundaries the numbers of parcels could be under estimated. Both issues will distort the results of the baseline water budget estimated by the EZ Guide 2. The pre-population of EZ Guide 2 can be done easily for utilities of varying size. EZ Guide evaluations have been created for utilities ranging from a few hundred to over 150,000 parcels. Details on how the EZ Guide 2 uses the information from the different data sources, and the calibration methods are described for each module:

**Profile**

The Profile section requires information on system design, capacity, etc. This information is available from the FDEP web site (http://www.dep.state.fl.us/water/drinkingwater/download.htm).

**Table 1.1.4 FDEP Basic Facility Report**

| FDEP Basic Facility Report | |
|---|---|
| Analysis Year | 2009 |
| Design Capacity (gal./day) | 350,375 |
| Number of Plants | 1 |
| Number of Service Connections | 206 |
| Population Serverd | 721 |
| Population Sold to | 50 |

**Table 1.1.5 Utility Treated Water Imports and Exports**

| Reported Year | Million Gallons per Month |
|---|---|
| Treated water imported | 0.000 |
| Treated water exported | 0.198 |

Figure 3. Profile information extracted from FDEP Basic Facility Reports

Additionally, this module requires monthly water supplied data. The database maintained by CFWC contains monthly data starting on January 1999. This information can be used to determine any long term trends on water production, as well as seasonal variability of water production.

EZ Guide bases its analysis on a single year of monthly data. Water production data presented in the Profile section can be used to select an appropriate analysis year based on local conditions. Once the analysis year has been determined, treated water imports and exports as well as adjustments to basic facility report data for that year can be done based on local data.

**Water Audit**

The second module in EZ Guide 2 is the Water Audit. There is not a single and uniform data source that could be used to complete a comprehensive water audit. For this section, each utility

needs to enter the required information. EZ Guide 2 provides links to five methodologies that can be used to complete this section, allowing for the reuse of results from external water audits. A default of 15% water loss is assumed if no water audit is performed. Users can calibrate this value for the analysis year if an audit was performed.

**Water Budget**

This module is the more detailed and data intensive of the EZ Guide 2 modules; however, the data input required by the end user is minimal. A complete water budget is fundamental to obtain a baseline of the current water use by sector. The water budget uses parcel level data from FDOR and population from U.S. Census. Additionally, the CFWC developed water use coefficients for multiple commercial, industrial and institutional (CII) users based on utility billing and county property appraiser data from various utilities. These coefficients are used to calculate water use based on the area of the building (Morales and Heaney 2010). Ultimately, all the estimates are summarized on total number of accounts, population served, and total water use. These estimates are compared to FDEP flow data from the profile section shown in Figure 5. If accurate, the estimates should match the reported values. Discrepancies can be resolved by refining default assumptions to calibrate the model such that the difference between estimates and reported values is minimized.

**Table 3.2.2 Initial Comparison to Reported Data**

| | FDEP Data | CFWC Estimate | % Differe |
|---|---|---|---|
| Total Number of Accounts | 206 | 206 | 0.0% |
| Population Served | 721 | 646 | -10.4% |
| Total Water Use (MGY) | 30.50 | 41.14 | 34.9% |

Figure 5. Summary table that compares FDEP data and CFWC estimates

**BMP Optimization**

Once the water budget has been calibrated, water conservation best management practices (BMPs) can be identified. EZ Guide 2 uses linear programming to select the most cost-effective BMPs to reach a specified gpcd savings or budget constraint. These goals can be specified by the user, depending on the desired outcome. Default BMP options, retrofit costs, and production cost savings are provided in the model and can be changed to reflect local conditions. Currently the BMP optimization focuses on indoor retrofits although other sectors can be evaluated in a similar fashion.

## SOUTH FLORIDA CASE STUDY

A South Florida case study utility (SFU), for which the EZ Guide pre-population and calibration procedures have been completed, will be used to illustrate these procedures. CFWC was contacted by SFU and South Florida Water Management District (SFWMD) personnel explaining that SFU needed to create a conservation plan for their upcoming permit since per

capita usage was nearing 250. SFU wanted to reduce their per capita usage by 20% from 250 to 200 gpcd. They provided CFWC with their PWSID, and their utility boundary was obtained by spatially querying the SFWMD utility boundary GIS coverage, which included boundaries for all utilities in the district.

Given the SFU PWSID, the FDEP basic facility report and monthly treatment plant production data could be queried from the CFWC database. The FDOR parcel level data for SFU was obtained using a spatial query by selecting the parcels that fall within the SFU utility boundary from the statewide CFWC parcel database. This data was then used to pre-populate the SFU EZ Guide 2. Once the data was loaded into EZ GUIDE 2, CFWC performed a preliminary QA/QC to check the validity of the reported MOR basic facility report and flow data as well as selected parcel data from the spatial query.

The QA/QC procedure showed that the number of selected parcels was almost 50% less than the number of connections reported to FDEP in the MOR data. CFWC felt the error was due to the utility boundary obtained from SFWMD not being accurate. CFWC then sent a map containing the suspect boundary to SFU personnel explaining the possible error. Several discussions between CFWC and SFU revealed that two served areas of the utility were not included in the previous boundary and that one area in the previous boundary was no longer served by SFU. CFWC then adjusted the SFU utility boundary to query the currently served parcels. After this procedure, the number of accounts was only 6% less than the reported number of connections reported to FDEP in the MOR data. However, water usage and population were being significantly underestimated compared to reported values in the basic facility report. Additionally, CFWC noticed that MOR usage for 2008-2009 was much higher than the other years reported, shown in Figure 6. An initial analysis year of 2006 was proposed by CFWC, to avoid this recent increase in water usage.

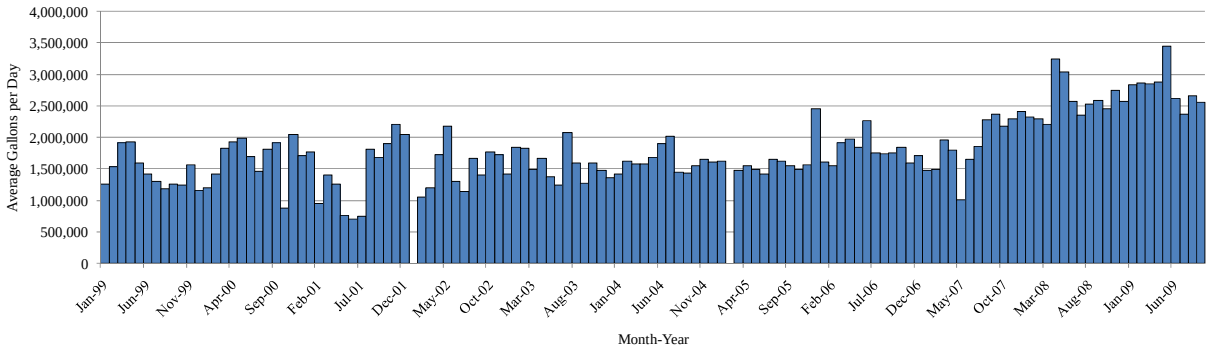


Figure 6. Monthly treated water produced as reported by SFU to FDEP

Next, CFWC set up a conference call with SFU and SFWMD to discuss possible explanations for the treated water time series as well as discuss calibration for the rest of the EZ Guide 2. SFU explained that 2008 and 2009 usage was higher because they used to import water to a section of their area which they now supply with their treated water. Adjustments to the profile section, shown in Figure 7, were then decided upon as follows:

- 2008 was chosen to be the analysis year, since it was most representative of typical current conditions
- Population served was changed from 15,500 to 12,427 based on their records
- SFU entered a water exported of 0.825 MG/mo. based on their records

| FDEP Basic Facility Report | |
|---|---|
| Analysis Year | 2006 |
| Design Capacity (gal./day) | 5,130,000 |
| Number of Plants | 2 |
| Number of Service Connections | 4,747 |
| Population Serverd | 15,500 |
| Population Sold to | 300 |

a

| Reported Year | Million Gallons per Month |
|---|---|
| Treated water imported | 0.000 |
| Treated water exported | 0.000 |

a

| FDEP Basic Facility Report | |
|---|---|
| Analysis Year | 2008 |
| Design Capacity (gal./day) | 5,130,000 |
| Number of Plants | 2 |
| Number of Service Connections | 4,747 |
| Population Serverd | 12,427 |
| Population Sold to | 300 |

b

| Reported Year | Million Gallons per Month |
|---|---|
| Treated water imported | 0.000 |
| Treated water exported | 0.825 |

b

Figure 7. Basic facility report data for SFU: a) before calibration, and b) after calibration

The next step was to adjust the water audit section. SFU explained that they perform an annual water audit, and report the results to SFWMD. No standard procedure was used to perform the water audit, but based on their method; they had 9.9% water loss for 2008, which was then entered into the EZ Guide 2.

The water budget section was then calibrated. The initial number of accounts was very close to the FDEP value, with a 6% error. This error was low since the utility boundary had previously been corrected. However, population was underestimated by 35% and water usage was underestimated by 42%. The following corrections were made to calibrate the model:

- The number of Commercial accounts was increased from 102 to 190 to increase the CII account estimate from 268 to 356, which is what SFU's records indicated
- Based on SFU data on multi-family irrigation, 0.22 in/month with 100% of multi-family accounts irrigating on the system was input. CFWC initially estimated that multi-family irrigation is minimal
- The default savings of a 15% reduction in irrigation for two days/week watering restrictions was increased to 20% based on local studies
- The remaining error was calibrated by adjusting single family irrigation parameters, although no direct local data was available. SFU increased the irrigation application rate

for single family homes with sprinklers from two to three in./mo. SFU also increased the percent of single family homes with sprinklers to 90/90/95%, and increased the percent of accounts on the system from 50% to 75/75/75%. The single family irrigation changes are summarized in Figure 8.

| Watering Restrictions (Days/Week) | 2 |
|---|---|

| Irrigable Area Application Rates | |
|---|---|
| With Sprinkler, in./month | Without Sprinkler, in./month |
| 2.00 | 1.25 |

| | Pre-1983 | 1983-1994 | Post-1994 | **Overall** |
|---|---|---|---|---|
| Total number of SFR accounts | 618 | 594 | 2,653 | 3,865 |
| % of accounts automatic sprinklers | 9% | 23% | 61% | 47% |
| Number of SFR accounts with automatic sprinklers | 56 | 137 | 1,618 | 1,811 |
| % of SFR accounts with sprinklers that irrigate from the potable system | 50% | 50% | 50% | 50% |
| Number of SFR accounts not having automatic sprinklers | 562 | 457 | 1,035 | 2,054 |
| % of SFR accounts not having automatic sprinklers that irrigate regularly from the potable system | 25% | 25% | 25% | 25% |

a

| Watering Restrictions (Days/Week) | 2 |
|---|---|

| Irrigable Area Application Rates | |
|---|---|
| With Sprinkler, in./month | Without Sprinkler, in./month |
| 3.00 | 1.25 |

| | Pre-1983 | 1983-1994 | Post-1994 | **Overall** |
|---|---|---|---|---|
| Total number of SFR accounts | 618 | 594 | 2,653 | 3,865 |
| % of accounts automatic sprinklers | 90% | 90% | 95% | 93% |
| Number of SFR accounts with automatic sprinklers | 556 | 535 | 2,520 | 3,611 |
| % of SFR accounts with sprinklers that irrigate from the potable system | 75% | 75% | 75% | 75% |
| Number of SFR accounts not having automatic sprinklers | 62 | 59 | 133 | 254 |
| % of SFR accounts not having automatic sprinklers that irrigate regularly from the potable system | 25% | 25% | 25% | 25% |

b

Figure 8. Single family irrigation parameters: a) before calibration, and b) after calibration

The calibration procedure resulted in a water usage error of less than 1% as shown in Figure 9.

| Sector | % of Total Water Use | Breakdown of Gross gpcd | Breakdown of Gal/Htd. Sq. Ft. |
|---|---|---|---|
| Single Family | 58.0% | 91 | 3.21 |
| Single Family Indoor | 36.9% | 58 | 2.04 |
| Single Family Outdoor | 21.1% | 33 | 1.17 |
| Multi-Family | 3.0% | 5 | 2.61 |
| Commercial | 12.9% | 20 | 5.46 |
| Industrial | 0.1% | 0 | 4.88 |
| Institutional | 11.0% | 17 | 4.40 |
| Unaccounted For | 15.0% | 24 | 0.62 |
| **TOTAL** | 100.0% | 157 | 4.15 |

| | FDEP Data | CFWC Estimate | % Differen |
|---|---|---|---|
| Total Number of Accounts | 4,747 | 4,468 | -5.9% |
| Population Served | 15,500 | 10,114 | -34.8% |
| Total Water Use (MGY) | 655.30 | 581.66 | -11.2% |

a

| Sector | % of Total Water Use | Breakdown of Gross gpcd | Breakdown of Gal/Htd. Sq. Ft. |
|---|---|---|---|
| Single Family | 65.9% | 166 | 5.84 |
| Single Family Indoor | 23.1% | 58 | 2.05 |
| Single Family Outdoor | 42.8% | 108 | 3.79 |
| Multi-Family | 2.2% | 6 | 3.03 |
| Commercial | 15.0% | 38 | 5.46 |
| Industrial | 0.1% | 0 | 4.88 |
| Institutional | 6.9% | 17 | 4.40 |
| Unaccounted For | 9.9% | 25 | 0.61 |
| **TOTAL** | 100.0% | 252 | 6.12 |

| | FDEP Data | CFWC Estimate | % Differen |
|---|---|---|---|
| Total Number of Accounts | 4,747 | 4,556 | -4.0% |
| Population Served | 12,427 | 10,114 | -18.6% |
| Total Water Use (MGY) | 932.94 | 930.62 | -0.2% |

b

Figure 9. Water budget sectoral breakdown: a) before calibration, and b) after calibration.

The population served was still being under estimated by 18.6%. However, this was deemed acceptable since population served is typically over reported in basic facility reports. The estimated gross per capita usage of 252 gpcd was also very close to the initial 250 gpcd estimate for the system. Gross per capita water use ignores the influence of the non-residential sectors and unaccounted for water on per capita water use. As shown in Figure 9, the per capita water use for SFU is partitioned into its components. Single family residential indoor water use is 58 gpcd, a relatively low number. Single family outdoor water use accounts for 108 out a total of 166 gpcd. The remaining components of gpcd are 6 gpcd for multi-family, 55 gpcd for commercial and institutional, and 25 gpcd for unaccounted. This water budget provides important insights as the sectors with the most potential savings.

Once the budget was calibrated, the indoor BMP optimization program was run. Although SFU wanted to develop a program to reduce their gpcd down to 200, the maximum achievable savings via indoor retrofits was only 29 gpcd. A target gpcd of 230, which would result in a savings of 22 gpcd, was input into the model. After the optimization program was run, a blend of 24,750 toilets, clothes washers, faucets, and showerheads was selected for retrofit to meet the goal for a cost of roughly 4 million dollars. Outdoor retrofits were thought to be a potential option to further reduce per capita usage down to 200.

## CONCLUSIONS

The pre-population and calibration procedures to create a utility specific EZ Guide 2 provide a quick and detailed water supply and water conservation analysis for a utility. CFWC has developed statewide datasets of publically available data which can be queried by utility

providing the PWSID and utility GIS boundary are provided. Default coefficients based on case studies and literature are used to supplement statewide data when necessary. These coefficients can be adjusted by users based on local data to calibrate usage estimates and develop more accurate predictions. The South Florida case study utility shows how detailed data and local knowledge can be used to adjust assumptions and calibrate EZ Guide 2. The case study also shows that accurate source data is required for meaningful analysis.

## REFERENCES

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