TEXAS A&M AGRILIFE EXTENSION

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Residential Customer Characterization for Urban Water Conservation Planning

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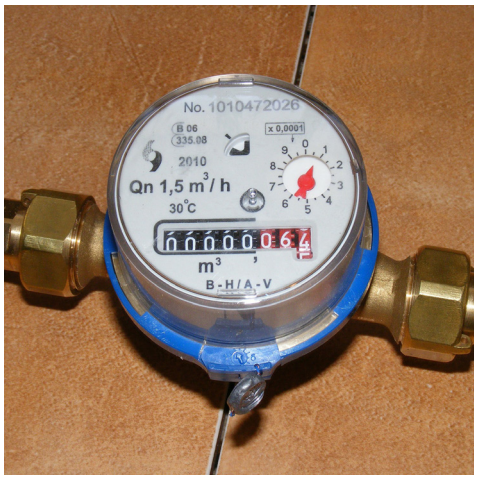

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For more information, download ESC-043 *Evaluating Customer Water Use to Create Effective Conservation Programs,* Texas A&M AgriLife Extension Service, http://www.agrilifebookstore.org, or contact Diane Boellstorff at dboellstorff@tamu.edu.

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The goal of urban water conservation planning is to save the most water at the lowest operational cost. Completing a *customer characterization* helps a utility learn how customers within the service area use water and what "normal" usage trends look like for each customer category. This information also helps direct education efforts about more efficient water-use practices to the biggest water-users.

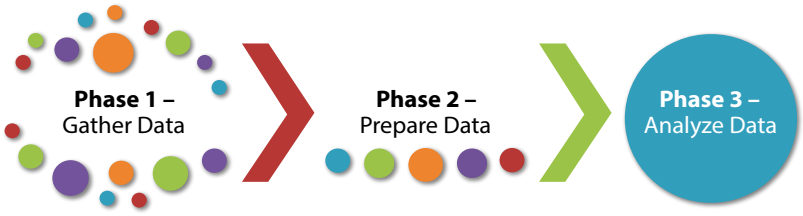
Purpose of customer characterization

Using customer characterization, utilities can effectively and efficiently meet conservation goals. While not intended to recommend specific best management practices (BMPs), this guide can help utilities better understand their customers' water use and emphasize the most appropriate conservation BMPs for the service area.

Box 1. Customer characterization: *Categorizing customer accounts by how the amount of water they are billed for indicates trends for their individual water use.*

The customer characterization process includes three phases: gather, prepare, and analyze data (Fig. 1). The complete process varies among utilities based on available information, time, and expertise.

Figure 1. Phases in the utility customer characterization process



- Know where to access needed data
- Check other helpful data

- Remove nonessential accounts
- Separate accounts by category
- Integrate property data

- Compare available data
- Identify targets for conservation

Customer characterization example

To illustrate a complete customer characterization process, we applied the three phases—gather, prepare, and analyze—to an anonymous utility usage data set. Because of data availability and time constraints, the analysis included only the single-family residential data set to identify the appropriate

audience for targeted conservation efforts. The step-by-step process completed for the sample data set outlines a single method, but is not the only procedure for completing a customer characterization. This process can stimulate discussion and creative thinking that benefits a utility and its customers by targeting water conservation BMPs.

Phase I: Gather Data

In Phase I, the quantity of available data is important; the more data collected, the better-informed decisions will be. When analyzing trends over time, 3 to 5 years of complete billed-usage data is the most beneficial. However, for a realistically manageable data set, monthly consumption data shows seasonal trends and unusually high or low usage periods. You can also estimate daily usage, if desired.

Also consider the types of available information. Gather information that helps the utility understand how water is used within the service area. Available demographic and property information integrated with billed-usage data can strongly indicate trends and predict future water use among specific customer categories (Box 2).

Box 2. Important of Gathered Data

Billed usage: Historical-usage data identifies water-use trends within a utility service area.

Property data: Property characteristics often indicate different amounts of water use, and the information is easily accessible.

> ***Example*** *– Accounts with a high winter average (billed-usage data) combined with a home built before 1992 (property data) may indicate older, high water-using appliances and fixtures inside the home—an opportunity for water savings.*

Spatial data: While not crucial for the process outlined in this guide, spatial comparisons of water-use levels (or even water-waste violations) may provide valuable information for conservation BMP decision making.

> ***Example*** *— Spatial distributions of billed-usage data may highlight consistently high water use within neighborhoods, area codes, or political districts. A utility can customize conservation BMPs to target those audiences through home water audits, education, and enforcement.*

1.1 Where to access data

Monthly-use data is the easiest to collect for all actively metered, potable connections (open accounts) in the service area. Utility billing or information systems (IT or IS) departments can provide this information to conservation staff if it is not readily accessible. Local appraisal districts can usually provide detailed, public information for each residential property if it is not already included in the billing data.

The data are usually searchable by address and sometimes downloadable for an entire county. Useful information for each property includes:

- A unique identifier
- Year built
- Most recent appraised value
- Lot or parcel size

If not already included in the billing data, this information may be challenging to integrate with the billed-usage data set, but is worth the effort for the insight it gives about characteristics of customers with the highest billed usage. The steps for integrating data are outlined later in Phase II.

1.2 Other helpful data

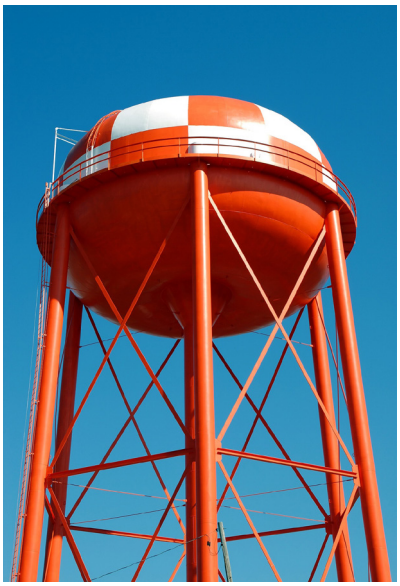
The American FactFinder database (U.S. Census Bureau, 2010) is a good resource for general demographic data such as:

- Estimates of people per household (pphh)
- Income and poverty levels
- Distribution of residential structures built by decade (if individual property build-dates are not available from an appraisal district)

The Census Bureau maintains a QuickFacts Beta database containing general demographics about people, businesses, and the geography of a city. It also compares individual cities to each other and the United States as a whole. Although general, the demographic data provides reliable information regarding the types of water-users in a particular city.

Most cities and appraisal districts have spatial data available on their website or upon request. Geographical information system (GIS) data sets may include:

- Address points
- City limits
- Extraterritorial jurisdiction (ETJ) limits
- School districts
- Watershed areas
- Land use
- Municipal utility district (MUD) jurisdictions



- Streams
- Roads
- Railroads
- Subdivisions
- Reservoirs
- Buildings

To analyze spatial trends in water use, integrate demographic and billed-usage data with available GIS data. Spatial distributions of income or appraised property value may reflect consistent usage trends across multiple customer categories. For example, to maintain a low bill, lower-income customers tend to be more efficient with their water use. However, low-income customers might not fix leaks that are difficult or costly to repair. The resulting, unusually high water-use records in concentrated low-income locations within a service area may be an indication for a utility to investigate for leaks.

Since household income is not usually included in utility billing data, separate the service area by average income within different spatial distributions, and then compare these areas to locations of any high-consumption users. Use appraised property values, typically included in appraisal district data sets, to make assumptions about income levels.

The data gathered in Phase I might not be formatted or reported in a way that is usable for comparisons or to identify trends. Phase II outlines how to combine multiple data sets into one set for analysis.

Phase II: Prepare Data

The data preparation phase takes the most time. There are several steps in this phase:

- Removing nonessential accounts
- Adding calculations for analysis
- Separating data based on customer category
- Integrating property data into the billed-usage data set

The prepared data set contains significantly fewer accounts than the original data set, but allows more accurate analysis of a sample of accounts with complete data.

2.1 Identify the types of information in the data set

Identify the amount and type of data in the billed usage before beginning any preparation or analysis. For the customer characterization process, 3 to 5 years of monthly billed-usage data is ideal. Data is usually listed in thousand-

gallons, but units of hundred-gallons, gallons, or hundred cubic feet are also common. Identify the unit in which the billed usage data is listed so the data analysis is accurate.

2.2 Remove closed accounts

Remove nonessential data so the data set is more manageable and representative of the current utility service area. Closed billing accounts may give information about historic usage trends, but from a conservation perspective, their water use no longer influences the implementation of conservation programming. Also, a closed account is no longer associated with a meter that reports water-use data. It is more effective for a utility to direct conservation efforts to account holders who will use water in the future and contribute to an aggregate reduction in water use. If there are any closed accounts (a status designated by the utility) included in the billed-usage data set, remove them from the data set.

2.3 Calculate needed data from existing billed-usage data

Because the following calculations may be compared in Phase III: Analyze Data, it is helpful to add these columns to the existing billed-usage data set for each calculation, if it is not already reported:

- Annual usage
- Annual winter (indoor) average
- Annual seasonal (outdoor) average
- Annual assumed indoor and outdoor use

(See Box 3, Step 6 for how to calculate each data type from existing data, and how to apply each one to the sample data set.)

2.4 Separate by customer category

To compare data, separate the complete data into similar customer-use categories. Do not compare a residential customer to a nonresidential customer on any scale; the characteristics of these customer categories and the nature of their water use are inherently different.

2.4.1 Residential categorization

The residential category should contain only single-family residential accounts. As outlined in Box 3, you can estimate and analyze winter average (representing monthly indoor use) and seasonal average (representing monthly outdoor use) individually for single-family accounts. Multi-family proper-

ties such as apartments and duplexes sometimes contain one billed water account for multiple residences. Consider them to be in the nonresidential category since the nature of their use is more difficult to estimate.

Box 3. Sample Utility Data Set: Step-by-Step Preparation Process

Start with the original billed-usage data set in a spreadsheet program **[33,885 accounts in the sample data set]**:

1. Before making any changes, save a separate spreadsheet with all data to use for reference or to recover information.
2. Optional — Format data into a table (Format as Table function in Excel) for easier sorting and management. If you enter a formula in the first cell of a column, the entire column will autogenerate the same formula for all cells in the same column.
3. Identify all columns of monthly-usage data for complete years.
   - Remove columns of monthly-usage data that were not included in the desired year range.
   - **Sample Data Set**—For 2009 to 2013 complete data, we used monthly usage from December 2008 to December 2013.
4. Identify units of monthly-billed usage.
   - Common units are gallons or thousand-gallons.
   - **Sample Data Set**—Monthly usage is in hundred-gallons.
5. Identify a column for service status that indicates whether the account is open or closed.
   - Designate this status by the utility; do not assume.
   - It is possible that the data set already contains only open accounts. If not apparent, confirm whether all accounts are open.
   - **Sample Data Set**—We removed all accounts that were designated as closed. **[31,548 open accounts remain]**
6. Create columns for each year for the following metrics:
   - Annual Usage [January–December summary]
   - Annual Winter (Indoor) Average [December–February Average]
   - Annual Seasonal Average [June–August Average minus Winter Average]
     - Replace negative results in this column with a zero (0) value.
   - Annual Assumed Outdoor Use [Annual Use minus (Winter Average × 12)]
     - Replace negative results in this column with a zero (0) value.
7. Identify the column containing customer categories.
   - **Sample Data Set**—We split residential and nonresidential customer-category data into separate spreadsheets so they are easier to manage. **[29,118 open residential accounts remain]**

2.4.2 Nonresidential categorization

Although nonresidential customers are more difficult to categorize (there are many different uses of water in this sector), doing so allows for an accurate comparison between the same type of water users. For example, a large-scale manufacturing customer or car wash facility will most likely have higher water-use levels than an office park. The North American Industry Classification System (NAICS) has the most complete list of categories consisting of two-to-six-digit coded categories that describe the type of use for each account.

If NAICS is not available in the billed-usage data set or other data gathered, you must categorize nonresidential users manually, and this can be a tedious step. It helps to sort users from highest to lowest annual usage and isolate a specified number of users with the highest annual usage. This allows the categorization to apply to only customer accounts that may allow the utility the biggest savings, instead of the entire data set. Complete instructions for how to characterize nonresidential accounts are not included in this guide.

2.5 Remove low-use accounts

Accounts sometimes have low or even zero water use and the reason for these low bills is difficult to determine. To accurately identify the characteristics of water users in the service area, remove or hide these accounts from the usable data set.

The low-use metric can differ among utilities. It is possible for a one-person, water-efficient home to use 1,500 gallons per month, or 50 gallons per person per day, so any billed usage less than 1,000 gallons per month is a safe threshold to use for removing low-use accounts.

2.6 Integrate property data

The final step of Phase II, Preparing Data, integrates the property data set with the billed-usage data set. In this step, a unique identifier for each account property links the two data sets and allows for importing additional property data (other than the property data recommended in this guide) so the utility can make additional comparisons, if desired. Once you determine the correct unique identifiers for each property, assume that the imported property data is accurate since it is linked to the unique identifier.

For purposes of the process outlined in this guide, the property data imported into the billed-usage data, using the unique identifiers, include the property year built, and the assessed home value.

Box 4, Steps 3–4, outlines the specific steps we used with the sample utility data set to import the property data and ensure that it was complete and correct. Notice that account properties with duplicate or missing unique identifiers were first researched and then removed from the billed-usage data set.

Box 4. Sample Utility Data Set: Continued Step-by-Step Preparation Process

Start with complete, open, residential accounts in a separate spreadsheet **[29,118 accounts remain following completion of Step 7 in Box 3]**:

1. Remove low-use accounts for all monthly usage data.
   - Low-use threshold: less than 1,000 gallons per month
   - **Sample Data Set**—We filtered each column December 2008 to December 2013 to show only values greater than or equal to 10 (10 hundred-gallons = 1,000 gallons).
2. Create columns for property information:
   - A unique identifier for each account
     - **Sample Data Set**—Property ID
   - Year Built
   - Most recent *Assessed Property Value*
     - **Sample Data Set**—2014 Assessed Value
3. Import property data from downloaded appraisal district database using a query function.
   - Import unique identifiers
     - **Sample Data Set**—We used a *Lookup* formula in Excel to compare full address (street number and street name only) in both billed-usage and property data sets to import Property ID.
   - Optional—We Imported a *Property Type Code* field to ensure that the property IDs are correct (to confirm all residential properties had a *'RES'* property type code, and not a property type code associated with a nonresidential account, or land).
   - Import Years Built
     - **Sample Data Set**—We used a Lookup formula in Excel to compare *Property ID* in both billed-usage and property data sets to import Year Built.
   - Import most recent Assessed Home Values
     - **Sample Data Set**—We used a *Lookup* formula in Excel comparing *Property ID* in both billed-usage and property data sets to import *Assessed Home Value*.
4. Examine accounts without individual unique identifiers.
   - Typos or abbreviations in the full address fields can interfere with the query function in the previous step that imports the property data into the billed-usage spreadsheet and shows an error instead of the desired unique identifier.
   - **Sample Data Set**—We removed accounts with no property ID number, or accounts that shared a property ID number with another property address (may be multi-family residences or duplexes). **[17,774 accounts remain]**
5. Continue with Phase III – Conduct analyses using remaining accounts.

Phase III: Analyze Data

The analysis phase of the customer characterization process is the most important—you identify the characteristics of customers who consume the largest amount of water. The analysis can be as simple or as in-depth as the utility needs and is supported by available data (for example, the data set analyzed for this publication did not include lot size or whether an automatic sprinkler irrigation system was present).

Many characteristics can be compared to water use. For purposes of this guide, the following comparisons were made using the existing utility data set, and outlined below:

- Use distributions (by user category, year built, assessed value)
- Indoor vs. outdoor use
- Cross comparison of indoor vs. outdoor percentiles

Some water-use comparisons may not be appropriate for all customer categories. For example, because water use is the same for most single-family residential customers, it would be appropriate to compare water use on a per capita (per person) basis when comparing single-family residential accounts.

Residential water use includes indoor uses such as bathing, cleaning, cooking, and drinking, while outdoor uses can include car washing, irrigation, and outside cleaning. However, nonresidential customers use water in a different way, even when compared to each other, so normalization methods are necessary.

Normalization is as simple as comparing water usage per output. Car washes evaluate their efficiency in terms of gallons per car. Institutional, commercial, and industrial (ICI) or nonresidential customers can be analyzed based on water usage per dollar of revenue. The idea is to use terms that are comparable to each other without having to further subcategorize customers. Box 5 and Box 6 list all table calculations by table column headings.

3.1 Use distributions

Use distributions are simple comparisons that familiarize the utility with the service area. We calculated the average annual use per account as a method of normalization in order to compare individual accounts in each of the categories to each other, instead of attempting to compare aggregate usage.

The aggregate use distribution for the sample utility in Table 1 includes all open, zero, and low-use accounts, with use shown in thousand-gallons. The aggregate usage from all 5 years in the sample data set is used to compare the characteristics between the different categories as assigned by the

Box 5. Table Calculations: Tables 1–6

Listed by table column headings
*Time periods for each calculation matter—annual measures unless specifically designated by *.* [* can be annual measure OR aggregate measure of all years in the data set (as seen in the table)].

Table 1 – Use Distribution: Customer Categorization	
Number of Accounts	*Number of accounts in the designated category*
Percentage of Accounts	*('Number of Accounts' in category ÷ Total 'Number of Accounts') × 100*
Aggregate Use*	*Sum of annual use for all accounts in category*
Aggregate Use Percentage	*('Aggregate Use' in category ÷ Total 'Aggregate Use') × 100*
Table 2 – Use Distribution: Year Built	
Number of Accounts	*Number of accounts in the designated range of years built*
Percentage of Accounts	*('Number of Accounts' in year range ÷ Total 'Number of Accounts') × 100*
Aggregate Use*	*Sum of annual use for all accounts in year range*
Aggregate Use Percentage	*('Aggregate Use' in year range ÷ Total 'Aggregate Use') × 100*
Average Annual Use per Account	*'Aggregate Use' in year range ÷ Number of years of data ÷ 'Number of Accounts'*
Table 3 – Use Distribution: Assessed Home Value	
Number of Properties	*Number of accounts in the designated range of home values*
Percentage of Total Properties	*('Number of Properties' in value range ÷ Total 'Number of Properties') × 100*
Aggregate Use*	*Sum of annual use for all accounts in home value range*
Aggregate Use Percentage	*('Aggregate Use' in value range ÷ Total 'Aggregate Use') × 100*
Average Annual Use per Account	*'Aggregate Use' in value range ÷ Number of years of data ÷ 'Number of Properties'*
Table 4 – Outdoor and Indoor Use	
Annual Indoor Use	*Annual winter average for all accounts × 12 [months in a year]*
Annual Outdoor Use	*Sum of annual use for all accounts — 'Annual Indoor Use'*
Seasonal Indoor Use	*Annual winter average for all accounts × 3 [months during summer season]*
Seasonal Outdoor Use	*Sum of use from June to August for all accounts — 'Seasonal Indoor Use'*
Percentages	*(Annual Indoor Use ÷ Sum of annual use for all accounts) × 100* *(Annual Outdoor Use ÷ Sum of annual use for all accounts) × 100*
Table 5 – Usage Level Designations (Use only one year of data to determine levels.)	
Seasonal Maximum	*Percentiles of seasonal use average (10th, 25th, 50th, 75th, 90th, and maximum value)*
Seasonal Minimum	*Level 1: Minimum seasonal average; Level 2+: 'Seasonal Max' in Level above + 1*
Winter Maximum	*Percentiles of winter use average (10th, 25th, 50th, 75th, 90th, & Maximum value)*
Winter Minimum	*Level 1: Minimum winter average; Level 2+: 'Winter Max' in Level above + 1*
Table 6 – Cross-Comparison of Usage Levels	
Number of Accounts	*Number of accounts in a given seasonal AND winter usage level*
Change*	*Difference in 'Number of Accounts' over time*

Box 6. Table Calculations: Tables 7–8	
Table 7 – Annual Use *(1-Year Periods)*	
Annual Use	*Sum of use for all accounts in a given seasonal AND winter usage level for the given year*
Annual Use Per Account *(1-Year Periods)*	
Annual Use per Account	*'Annual Use' in level ÷ 'Number of Accounts' in level [Table 6]*
Baseline Indoor Use (blue line)	*Persons per household × 60 gallons/person/day × 365 days/year*
Average Indoor Use (red line)	*Utility Average Winter Average × 12 months/year*
Table 8 – Aggregate Use *(5-Year Period)*	
Aggregate Use	*Sum of 'Annual Use' for all years in level [Table 7]*
Average Annual Use Per Account *(5-Year Period)*	
Average Annual Use per Account	*Average of the 'Annual Use per Account' in all years [Table 7]*
Baseline Indoor Use (blue line)	*Persons per household × 60 gallons/person/day × 365 days/year*

Table 1. Distribution of *Aggregate Use* by customer category assigned by the sample utility
**Heat mapping (gradient color scheme) provides a visual representation of low (green) to high (red) water use totals in each category.*

Description	Accounts #	Accounts %	2009–2013 Aggregate use (1,000 gal)	2009–2013 Aggregate use %
Residential	27,597	87.48%	15,695,281	47.62%
Municipal Utility District	34	0.11%	5,481,213	16.63%
Commercial	1,317	4.17%	4,494,148	13.64%
Commercial Irrigation	564	1.79%	2,841,524	8.62%
Apartment	215	0.68%	2,261,232	6.86%
County	169	0.54%	937,189	2.84%
Outside City	1,521	4.82%	882,865	2.68%
Government	76	0.24%	300,977	0.91%
Fire Hydrant (Construction)	38	0.12%	11,040	0.03%
Industrial	6	0.02%	31,720	0.10%
Residential Irrigation	11	0.03%	23,079	0.07%
Total	**31,548**		**32,960,268**	

utility. The percentage of accounts compared to the percentage of use is interesting since it illustrates the largest water users within the utility service area.

Table 2 shows the distribution of residential property year built compared to average annual use per account. The first two rows of the table show properties built before and after 1992. In that year, the Energy Policy Act of 1992 established low water-use standards for both residential and nonresidential appliances, after which building codes were required to comply with these standards. It helps to be aware of the date these standard were adopted for the location you are working with, as well as the number of properties built after the standards were established, because some specific BMPs would already be implemented.

Table 3 compares assessed home value to the average annual use per account. In the sample utility data set, it is clear that the average use per account increases when home value increases.

Table 2. Distribution of available property *Year Built* compared to *Aggregate Use,* and the *Average Annual Use per Account* both before and after 1992, and in each decade for residential accounts (17,739)
**Heat mapping (gradient color scheme) provides a visual representation of low (green) to high (red) use per account.*

Year Built	Accounts #	Accounts %	2009–2013 Aggregate use (gallons)	2009–2013 Aggregate use %	Average annual use per account (gallons)
1992 and prior	5,569	33.16%	3,265,906,200	27.62%	103,412
After 1992	12,170	72.46%	8,558,430,100	72.38%	126,830
Total	**17,739**		**11,824,336,300**		
≤1900	3	0.02%	2,281,700	0.02%	152,113
1901–1910	6	0.04%	4,636,900	0.04%	154,563
1911–1920	5	0.03%	2,576,900	0.02%	103,076
1921–1930	11	0.07%	6,013,800	0.05%	109,342
1931–1940	33	0.20%	14,051,000	0.12%	85,158
1941–1950	34	0.20%	14,675,300	0.12%	86,325
1951–1960	27	0.16%	14,623,000	0.12%	108,319
1961–1970	56	0.33%	32,074,400	0.27%	114,551
1971–1980	2,006	11.94%	1,217,849,600	10.30%	121,421
1981–1990	2,810	16.73%	1,559,606,400	13.19%	111,004
1991–2000	6,396	38.08%	4,362,166,200	36.89%	136,403
2001–2010	6,343	37.77%	4,583,876,700	38.77%	144,533
≥2011	9	0.05%	9,904,400	0.08%	220,098
Total	**17,739**		**11,824,336,300**		

3.2 Indoor use compared to outdoor use

Using information in Box 3, we calculated the assumed winter average of all residential accounts to determine the indoor use, and then subtracted indoor use from annual use to determine the outdoor use (Table 4).

The seasonal use portion of Table 4 is of particular interest because it fairly compares outdoor and indoor use for residential accounts in summer months (June to August) where outdoor use is assumed to occur more frequently. Although outdoor and indoor annual use helps determine maximum-use trends, it inaccurately compares the two. Outdoor use does not occur year-round, but indoor use is assumed to be year-round and shows a larger percentage of use (Fig. 2). It is interesting that the geographical location of the example utility experienced drought conditions in 2011, leading to higher outdoor use, especially in the summer months.

Table 3. Distribution of available property *Assessed Value* compared to *Aggregate Use* and the *Average Annual Use per Account* in each home value range for residential accounts (17,768)

**Heat mapping (gradient color scheme) provides a visual representation of low (green) to high (red) use per account.*

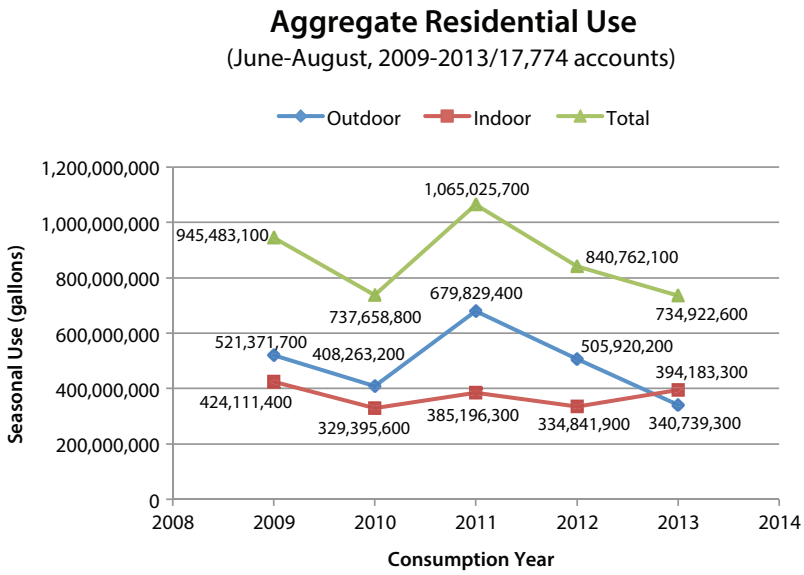
2014 Assessed Home Value	Properties #	Total properties %	2009–2013 Aggregate use (gallons)	2009–2013 Aggregate use %	Average annual use per account (gallons)
Less than $50,000	13	0.07	5,536,800	0.05	85,182
$50,000 to $99,999	202	1.14	81,023,900	0.68	80,222
$100,000 to $149,999	5,002	28.15	2,272,199,800	19.19	90,852
$150,000 to $199,999	5,485	30.87	3,017,862,300	25.49	110,041
$200,000 to $299,999	4,361	24.54	3,330,586,600	28.13	152,744
$300,000 to $499,999	2,579	14.51	2,913,352,300	24.61	225,929
$500,000 to $999,999	125	0.70	221,251,800	1.87	354,003
$1,000,000 or more	1	0.01	2,673,000	0.02	534,600
Mean Value	**$207,601**	**Total**	**11,844,486,500**		

Table 4. Assumed annual outdoor and indoor use for all residential accounts (17,774)

Aggregate assumed distribution	Annual use (gallons)
2009 Outdoor	748,223,700
2009 Indoor	1,618,737,000
2010 Outdoor	911,023,800
2010 Indoor	1,267,888,100
2011 Outdoor	1,328,372,100
2011 Indoor	1,500,144,300
2012 Outdoor	1,049,008,100
2012 Indoor	1,300,963,600
2013 Outdoor	624,016,400
2013 Indoor	1,499,686,400

Aggregate assumed distribution	Seasonal use Jun–Aug (gallons)	Percentage
2009 Outdoor	521,371,700	55.14%
2009 Indoor	424,111,400	44.86%
2010 Outdoor	408,263,200	55.35%
2010 Indoor	329,395,600	44.65%
2011 Outdoor	679,829,400	63.83%
2011 Indoor	385,196,300	36.17%
2012 Outdoor	505,920,200	60.17%
2012 Indoor	334,841,900	39.83%
2013 Outdoor	340,739,300	46.36%
2013 Indoor	394,183,300	53.64%

Figure 2. Graphical representation of the data in Table 4, Seasonal Use section only



3.3 Cross-comparison of indoor and outdoor use levels

To categorize residential accounts into groups of similar use, we determined usage levels by calculating percentiles of seasonal (outdoor) and winter (indoor) use from residential billed usage in 2009. For the sample data set, 2009 was the baseline year because it was the first year billed-usage data was gathered, and it was the first year that the utility participated in conservation programming. Table 5 shows the levels of use that was used for analysis. The maximum seasonal use for the 10th percentile was 300 gallons, meaning 10 percent of accounts in the 2009 data set used 300 gallons or less, outdoors, during the summer months. These ranges were used to compare data for the subsequent years in the data set.

Table 5. Residential levels of use, in gallons, calculated from seasonal and winter percentiles for all accounts in 2009. Seasonal and winter use is assumed to represent outdoor and indoor use, respectively

	Monthly Usage Levels (gallons)				
Levels	**Seasonal minimum**	**Seasonal maximum**	**Winter minimum**	**Winter maximum**	**Data set percentile**
1	0	300	1,101	3,267	10th
2	301	2,742	3,268	4,542	25th
3	2,743	7,367	4,543	6,400	50th
4	7,368	13,933	6,401	9,367	75th
5	13,934	22,633	9,368	14,100	90th
6	22,634	183,467	14,101	98,333	MAX

Table 6 is a cross-comparison of the levels from ranges of use in Table 5. The set of tables in the left column shows the number of accounts in each group. In 2009, 1,257 accounts had seasonal use between 2,743 and 7367 gallons, and winter use between 4,543 and 6,400 gallons.

The set of tables in the right column illustrates the cumulative 5-year change in the number of accounts, as well as the 1-year changes between each of the 5 years in the data set. A positive change in the direction of level 1 for both seasonal and winter use indicates that accounts are reporting lower water use, as seen more predominantly in the 1-year change in 2009–2010, and 2011–2012.

Table 7, the final piece of Phase III, helps the utility determine which audience to target with conservation BMPs. The

Table 6. *Number of Accounts,* and *Change in Number of Accounts* categorized by cross-comparison of seasonal and winter use levels

Heat mapping (gradient color schemes) provide a visual representation of low (green) to high (red) number of accounts in each category, and an increase (red) and decrease (blue) in number of accounts between each year.

Number of Accounts

2009 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	149	224	348	383	280	401
2	478	514	739	558	233	137
3	549	840	1257	1062	506	244
4	366	616	1203	1223	708	316
5	161	315	582	763	540	303
6	83	148	334	457	381	372

2010 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	365	461	681	704	399	255
2	779	929	1072	723	225	66
3	662	985	1299	948	294	82
4	496	737	1096	828	262	79
5	260	378	687	494	174	66
6	135	221	355	333	167	76

2011 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	188	247	350	342	232	222
2	424	475	597	446	170	68
3	553	694	1006	761	350	144
4	457	739	1136	1055	488	198
5	283	548	902	909	529	189
6	170	341	690	871	574	424

5-Year Change 2009–2013

2009 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	335	370	413	366	166	14
2	283	377	340	268	113	2
3	-6	-54	-79	24	42	-8
4	-88	-126	-402	-347	-127	-74
5	-29	-112	-174	-271	-169	-111
6	-58	-63	-173	-250	-202	-190

1-Year Change 2009–2010

2010 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	216	237	333	321	119	-146
2	301	415	333	165	-8	-71
3	113	145	42	-114	-212	-162
4	130	121	-107	-395	-446	-237
5	99	63	105	-269	-366	-237
6	52	73	21	-124	-214	-296

1-Year Change 2010–2011

2011 — *Winter*

Seasonal \ Levels	1	2	3	4	5	6
1	-177	-214	-331	-362	-167	-33
2	-355	-454	-475	-277	-55	2
3	-109	-291	-293	-187	56	62
4	-39	2	40	227	226	119
5	23	170	215	415	355	123
6	35	120	335	538	407	348

Table 6 continued

2012 *Winter*

Seasonal Levels	1	2	3	4	5	6
1	321	357	515	450	237	206
2	676	757	846	509	169	51
3	735	960	1216	864	331	104
4	564	810	1230	934	428	114
5	347	515	765	641	286	111
6	150	282	478	436	233	146

1-Year Change 2011–2012

2012 *Winter*

Seasonal Levels	1	2	3	4	5	6
1	133	110	165	108	5	-16
2	252	282	249	63	-1	-17
3	182	266	210	103	-19	-40
4	107	71	94	-121	-60	-84
5	64	-33	-137	-268	-243	-78
6	-20	-59	-212	-435	-341	-278

2013 *Winter*

Seasonal Levels	1	2	3	4	5	6
1	484	594	761	749	446	415
2	761	891	1079	826	346	139
3	543	786	1178	1086	548	236
4	278	490	801	876	581	242
5	132	203	408	492	371	192
6	25	85	161	207	179	182

1-Year Change 2012–2013

2013 *Winter*

Seasonal Levels	1	2	3	4	5	6
1	163	237	246	299	209	209
2	85	134	233	317	177	88
3	-192	-174	-38	222	217	132
4	-286	-320	-429	-58	153	128
5	-215	-312	-357	-149	85	81
6	-125	-197	-317	-229	-54	36

table shows the summary of annual usage for all account groups that were categorized in Table 6. The account group in Level 4 of both seasonal and winter use tends to show the largest use, especially when looking at the aggregate use for all 5 years in Table 8. This group represents the largest user of water within the residential category. Evaluate the characteristics of this group and use the integrated billed-usage and property data set to determine which BMPs will best encourage the group to reduce their water use. You can include other high water-consuming groups in the BMP implementation or identify more appropriate BMPs for differing characteristics.

Table 7 and Table 8 show a baseline metric (blue line) that represents a defining level of efficient water use in the sample utility service area. The goal is for the water-use amount for a larger number of accounts to stay below this line. To calculate individual utility baseline metrics, use the number of persons per household determined on an individual service area basis and the national median indoor use per person, 60 gpcd, determined by a residential water-use study funded by the Water Research Foundation.

Table 7 also offers an average indoor use metric (red line) to compare actual (red line) to desired (blue line) indoor usage. Calculate the average indoor usage by using the average of the winter average of each account in the billed-usage data set.

Table 7. A*nnual Use* and *Annual Use per Account* (gallons) for residential accounts in Table 6
Baseline indoor use (blue line) = 2.96 pphh*60 gpcd*365 d/yr = 64,824 gal/acct/year; average indoor use (red line) = Avg, Winter Avg [gal/m]*12 m/yr
**Heat mapping (gradient color scheme) provides a visual representation of low (green) to high (red) water use totals in each category.*

2009 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	4,667,400	9,915,900	21,059,800	30,857,100	31,202,600	78,958,900
2	30,296,300	28,264,100	53,387,500	53,585,800	30,283,400	28,158,900
3	30,047,000	59,356,300	109,990,400	118,632,300	75,135,600	54,706,700
4	29,508,600	58,129,500	134,664,600	166,685,100	120,909,300	78,967,100
5	18,717,200	41,203,800	85,205,600	127,335,600	110,520,300	85,754,700
6	15,906,200	28,612,000	70,197,800	107,982,400	105,258,800	144,429,200

2009 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	31,325	44,267	60,517	80,567	111,438	196,905
2	63,381	54,989	72,243	96,032	129,972	205,539
3	54,730	70,662	87,502	111,706	148,489	224,208
4	80,625	94,366	111,941	136,292	170,776	249,896
5	116,256	130,806	146,401	166,888	204,667	283,019
6	191,641	193,324	210,173	236,285	276,270	388,251

Average Indoor Use: 95,445 gal/acct/yr

2010 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	11,714,800	21,467,400	41,328,400	59,565,500	44,718,600	45,661,000
2	32,714,000	53,803,700	80,189,400	72,243,200	30,888,200	13,588,400
3	41,996,300	77,457,200	124,883,600	116,394,100	46,845,800	18,196,000
4	49,021,900	84,572,000	144,122,200	130,550,600	51,893,500	21,832,600
5	37,801,900	60,884,600	123,867,300	100,825,900	43,412,000	21,213,100
6	30,725,700	55,113,700	93,419,600	99,802,100	59,656,700	36,464,100

2010 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	32,095	46,567	60,688	84,610	112,077	179,063
2	41,995	57,916	74,804	99,921	137,281	205,885
3	63,439	78,637	96,138	122,779	159,339	221,902
4	98,834	114,752	131,498	157,670	198,067	276,362
5	145,392	161,070	180,302	204,101	249,494	321,411
6	227,598	249,383	263,154	299,706	357,226	479,791

Average Indoor Use: 74,130 gal/acct/yr *(same line as blue Baseline)*

2011 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	6,044,300	11,115,200	21,586,800	27,891,600	25,734,500	41,370,800
2	17,703,800	27,144,800	44,281,200	44,546,800	23,014,100	14,928,100
3	34,826,200	52,834,300	94,666,100	90,739,800	54,683,600	33,948,200
4	43,054,400	79,628,200	143,786,300	159,745,200	93,143,600	54,383,200
5	39,000,600	84,638,900	154,995,100	178,676,600	125,043,700	60,183,300
6	37,530,700	80,107,800	179,913,500	253,485,400	196,470,400	197,493,700

2011 — *Winter*

Seasonal Level	1	2	3	4	5	6
1	32,151	45,001	61,677	81,554	110,925	186,355
2	41,754	57,147	74,173	99,881	135,377	219,531
3	62,977	76,130	94,101	119,238	156,239	235,751
4	94,211	107,751	126,572	151,417	190,868	274,663
5	137,811	154,451	171,835	196,564	236,378	318,430
6	220,769	234,920	260,744	291,028	342,283	465,787

Average Indoor Use: 86,688 gal/acct/yr

Table 7 continued

2012 *Winter*

Seasonal Level	1	2	3	4	5	6
1	9,877,600	16,017,100	31,210,100	37,247,900	25,818,100	37,379,400
2	26,694,100	42,297,000	61,631,500	50,344,600	22,864,400	11,262,900
3	43,797,100	71,894,600	113,267,000	103,251,400	52,901,000	25,108,000
4	53,566,100	90,218,500	158,021,200	145,943,400	83,193,700	31,118,900
5	48,899,600	82,167,000	135,471,000	128,993,700	68,942,000	37,105,600
6	33,059,100	68,129,200	126,606,500	126,310,000	81,294,200	68,068,200

2012 *Winter*

Seasonal Level	1	2	3	4	5	6
1	30,771	44,866	60,602	82,773	108,937	181,453
2	39,488	55,875	72,850	98,909	135,292	220,841
3	59,588	74,890	93,147	119,504	159,822	241,423
4	94,975	111,381	128,473	156,256	194,378	272,973
5	140,921	159,548	177,086	201,238	241,056	334,285
6	220,394	241,593	264,867	289,702	348,902	466,221

Average Indoor Use: 75,355 gal/acct/yr

2013 *Winter*

Seasonal Level	1	2	3	4	5	6
1	14,400,900	26,678,900	45,294,100	60,124,200	47,914,500	82,645,500
2	29,985,900	49,557,600	78,222,400	79,672,800	46,230,300	31,522,800
3	31,871,100	58,116,100	107,236,700	126,380,500	83,996,100	53,928,300
4	24,881,300	50,992,100	97,072,500	130,092,700	107,181,000	64,924,700
5	17,296,800	29,781,600	67,667,200	92,881,600	82,806,100	57,714,500
6	5,050,700	18,129,200	38,515,200	54,879,000	55,328,300	74,695,100

2013 *Winter*

Seasonal Level	1	2	3	4	5	6
1	29,754	44,914	59,519	80,273	107,432	199,146
2	39,403	55,620	72,495	96,456	133,614	226,783
3	58,694	73,939	91,033	116,372	153,278	228,510
4	89,501	104,066	121,189	148,508	184,477	268,284
5	131,036	146,707	165,851	188,784	223,197	300,596
6	202,028	213,285	239,225	265,116	309,097	410,413

Average Indoor Use: 88,710 gal/acct/yr

Table 8. ***Aggregate Use*** **and** ***Average Annual Use per Account*** **(gallons) for residential accounts in Table 6.**
Heat mapping (gradient color scheme) provides a visual representation of low (green) to high (red) water use totals in each category

Aggregate Use 2009–2013
Winter

Seasonal Level	1	2	3	4	5	6
1	46,705,000	85,194,500	160,479,200	215,686,300	175,388,300	286,015,600
2	137,394,100	201,067,200	317,712,000	300,393,200	153,280,400	99,461,100
3	182,537,700	319,658,500	550,043,800	555,398,100	313,562,100	185,887,200
4	200,032,300	363,540,300	677,666,800	733,017,000	456,321,100	251,226,500
5	161,716,100	298,675,900	567,206,200	628,713,400	430,724,100	261,971,200
6	122,272,400	250,091,900	508,652,600	642,458,900	498,008,400	521,150,300

Average Annual Use per Account 2009–2013
Winter

Seasonal Level	1	2	3	4	5	6
1	31,219	45,123	60,600	81,955	110,162	188,584
2	45,204	56,309	73,313	98,240	134,307	215,716
3	59,886	74,852	92,384	117,920	155,433	230,359
4	91,629	106,463	123,935	150,029	187,713	268,435
5	134,283	150,516	168,295	191,515	230,958	311,548
6	212,486	226,501	247,633	276,367	326,755	442,092

Baseline Indoor Use = 2.96 pphh*60 gpcd*365 d/yr = 64,824 gal/acct/year

Recommendations

Frequency of analysis

The utility or utility conservation program should conduct a utility customer characterization on a regular basis. Annual customer characterizations produce more accurate and informative water-usage trends within different customer categories. Managers will become familiar with normal usage trends and better able to recognize anomalous and consistent high-usage levels. An annual program evaluation process also helps managers target BMPs accordingly and recognize when specific BMPs are no longer needed among different groups.

Outliers, or customers with significantly higher annual usage than other similar users in their category, may be apparent and indicate the need for inquiry. If a customer has a significant increase in annual usage, an examination would benefit both the customer and the utility. If customers have unusually high usage as a result of inefficient practices, the utility has an opportunity to work with that user to identify ways to reduce water use.

Computer analysis

Where utility and conservation managers benefit from looking at data trends, they may also benefit from computer analysis within information technology and GIS departments. Technicians trained in data manipulation and analysis may be able to prepare and sort data sets more efficiently, and present them in a way that is useful to managers who make decisions about conservation programming.

BMP selection

After identifying the characteristics of high-consumption users, the utility chooses which BMPs to promote. For conservation programs for residential customers, separate indoor and outdoor programs, focusing more on indoor programs. Often, it is easier for customers to make changes to fixtures and appliances inside the home rather than change their water-use behavior.

For example, it is common for utilities to adopt toilet replacement programs early in the planning process because replacing older, high-flow toilets with low-flow toilets saves a considerable amount of water. However, the Energy Policy Act of 1992 passed national efficiency standards stating that toilets may not be installed in new development if they do not meet a 1.6 gallon per flush or less requirement. As a result, manufacturers no longer produce toilets with flow rates higher than 1.6 gallons per flush, and all development must meet this stan-

dard. So, the customer characterization process is important in identifying whether or not a toilet replacement program would result in water savings at a reasonable cost to the utility.

National efficiency standards and specifications

Along with standards for water use in toilet fixtures, the Alliance for Water Efficiency publishes an updated matrix that outlines efficient standards for all residential and commercial fixtures and appliances in terms of the Energy Policy Act of 1992, the U.S. Environmental Protection Agency WaterSense program, and the Consortium for Energy Efficiency.

North American Industrial Classification System (NAICS)

As mentioned in Phase II: Prepare Data, the NAICS is a helpful way to standardize the categorization of nonresidential customers. In 2015, the City of Garland, Texas identified an existing, unused field within their billing system that they used to input the six-digit NAICS code for each nonresidential customer. This standardization will make it easier and faster for the utility to create a consistent customer characterization.

Program evaluation

In addition to an annual customer characterization, the best way to ensure that chosen conservation BMPs continue to reduce water use and target the correct audience is to conduct BMP evaluations before and after implementation. Consistent program evaluations indicate when a BMP is no longer producing a significant amount of water savings and gives the utility an opportunity to make adjustments.

Maintain relationships

Successful water conservation planning requires a cooperative culture from all groups of home and business owners in the utility service area. Maintaining positive relationships with local landscape companies, building-management companies, and homeowners associations establishes buy-in for conservation programs and positively promotes associated BMPs.

Transient populations

In water conservation planning, it helps to be aware that transient populations such as customers affiliated with a large military or higher education presence make implementing conservation efforts a challenge. Transient populations have a higher turnover of customers who are sometimes new to the

geographic region and unfamiliar with existing conservation efforts. As a result, transient populations require more education and outreach programs.

Conclusion

Adopting the customer characterization process makes targeted conservation programming easier and quicker. This familiarity with the customer base allows the utility to leverage available resources to their fullest potential, realize the greatest water savings at the least cost, and achieve conservation goals.

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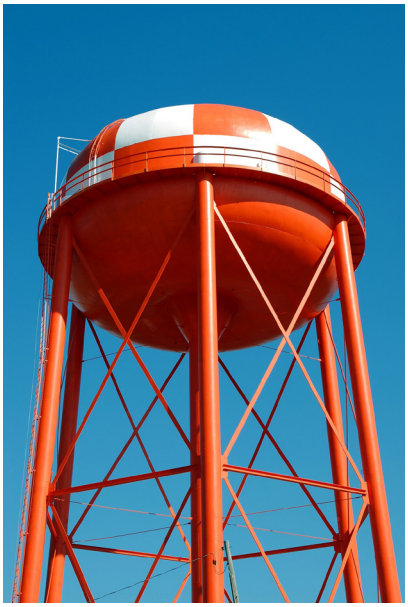

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