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Prepared for

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WATER CONSERVATION SAVINGS QUANTIFICATION STUDY
Executive Summary

In 2010, the Texas Water Development Board (TWDB) contracted with a study team led by BBC Research & Consulting (BBC) to identify and evaluate potential methods (or "tools") to assist the TWDB and individual municipal water providers in evaluating the actual water savings being achieved by municipal water conservation efforts.

Study Approach

The study team conducted a series of research tasks regarding approaches to quantifying conservation savings, including:

- Reviewing existing data sources, studies, planning documents and other published information in Texas relevant to the study (see Section 2);
- Reviewing national conservation implementation studies and guidance documents developed outside of Texas (see Section 3);
- Compiling and analyzing data from the water conservation plans and annual water conservation implementation reports of nearly 100 municipal providers (see Section 4); and
- Conducting interviews with 43 selected municipal water providers (see Section 5).

Key Findings

Prior reports and planning documents in Texas demonstrate that Texas water user groups and regional planning groups are increasingly incorporating municipal water conservation as part of their strategy to meet future water needs. There has also been an increasing focus on the need to monitor the actual savings achieved by municipal conservation efforts.

Quantifying water conservation savings is not a simple task and Texas is not unique in confronting this challenge. A variety of evaluation approaches are used across the country; however, results of these approaches are often limited by data quality and availability. Some organizations have developed tools to aid in the evaluation of conservation programs, but the tools produce answers only as good as the data they incorporate.

Estimating conservation savings based on system-wide water use data must begin with some form of standardized metric of water use intensity, such as gallons per capita per day (GPCD). While comparisons of GPCD across different municipal water systems may sometimes provide useful information, there are well-known difficulties in developing "apples to apples" comparisons of this metric across different municipalities. To estimate the actual water savings achieved by conservation strategies, the key metric is the change in GPCD over time for each individual provider (and, potentially, the changes in GPCD or use per account for each customer class), not GPCD comparisons between providers.

The initial round of water conservation annual implementation reports filed with TWDB included a wide range of estimated savings from conservation programs. Many providers reported zero, or near zero, savings or left their response to this question blank. Based on subsequent interviews, municipal providers approached the problem of how to estimate their conservation savings in a variety of different ways. The interviews indicated that both top-down and bottom-up evaluation approaches are important, though over 60 percent of the providers interviewed used a top-down approach.[1] The combination of top-down approaches to evaluate overall usage with bottom-up approaches for program evaluation is likely the best method for comprehensive analysis of conservation savings, particularly for larger providers. Top-down approaches alone may be well-suited for small to medium-sized providers if other factors such as weather and economic conditions can be normalized.

Recommendations

1. Approach for developing consistent regional and statewide conservation savings estimates. The best approach for estimating overall statewide and regional water conservation savings in Texas would be for the TWDB to develop a "top-down" statistical analysis based on municipal water use data that it already collects, as well as some additional data from readily available sources. This type of analysis is known as an econometric "panel model" and attempts to control for the effects of factors such as weather and economic conditions on municipal water demand. Such a model would not produce a perfect answer regarding conservation savings – for example, it is likely to be difficult or impossible to isolate the effects of proactive conservation efforts from the effects of changes in water rates and/or rate structures and the effects from the natural replacement of older plumbing fixtures with newer, more efficient models. The conservation estimates from the model would also have a degree of statistical uncertainty. Developing and maintaining this type of model would also require additional TWDB resources.

2. Developing a potential tool to standardize and improve provider-level water use data and conservation savings estimates. The study reviewed numerous examples of "desktop" tools that have been developed to promote standardized water use reporting and analysis and facilitate evaluation of water conservation programs. The study team also gathered input from large and small municipal providers on the characteristics of an ideal tool. None of the tools reviewed are perfectly suited to meet all of the uses and objectives identified by the surveyed water providers, but many provide unique advantage(s) and attributes. It would be possible to build a new desktop tool for these purposes, but it would require additional resources to develop, test and implement such a tool. A substantial training effort would also be required for successful adoption by municipal providers.

3. Additional recommendations. Apart from the challenges of accurately compiling and analyzing water use data (particularly for smaller systems), municipal water providers face increasing reporting requirements from state, regional, and local entities, as well as their wholesale water sources. This level of reporting becomes redundant and repetitious at best; burdensome and inaccurate at worst. Developing a common data collection and reporting system that the state, regional, and local agencies would design and to which they would all have access (likely online) would streamline reporting and, over time, create a robust database of water usage data.

[1] Top-down refers to estimation approaches based on aggregate water use changes; bottom up refers to quantification based on adding up savings estimates for individual conservation measures.

SECTION 1.
Introduction

In 2010, the Texas Water Development Board (TWDB) contracted with a study team led by BBC Research & Consulting (BBC) to identify and evaluate potential methods (or "tools") to assist the TWDB and individual municipal water providers in evaluating the actual water savings being achieved by municipal water conservation efforts. Members of the study team had previously assisted the TWDB in evaluating the role of drought management in the state and regional planning process. Other, past study team work related to this project included conservation-related studies for municipal providers including the San Antonio Water System and the Lower Colorado River Authority in Texas; BBC had also conducted studies to estimate conservation savings for municipal providers such as Denver Water and the Phoenix Water Services Department.

The work plan for this study consisted of six main tasks, outlined below.

- Task 1: Project management, communications, reporting and meetings with the TWDB project manager and staff throughout the study;
- Task 2: Review existing data sources, studies, planning documents and other published information relevant to the study (see Section 2);
- Task 3: Review national conservation implementation studies and guidance documents conducted outside of Texas (see Section 3);
- Task 4: Review and analyze municipal provider conservation plans (see Section 4);
- Task 5: Conduct interviews with selected municipal water providers (see Section 5); and
- Task 6: Evaluate effectiveness of current conservation quantification practices and develop preliminary recommendations (see Section 6).

The study team met three times with TWDB staff during the course of the study. During the first meeting, near the outset of the project, the study team and TWDB staff discussed the goals of the study and refined the work plan. During the second meeting, following Task 4, the study team provided a Power Point presentation to TWDB staff reviewing progress to date and TWDB staff helped refine the plan for the interviews in Task 5. During the final meeting, the study team and TWDB staff discussed the draft recommendations resulting from the study.

Quantifying water conservation savings is not a simple task and Texas is not unique in confronting this challenge. There is also no "silver bullet" or single approach that is likely to be effective for both large and small providers, the TWDB as a whole, and the Regional Water Planning Groups. The recommendations in Section 6 do, however, provide the outline for development of tools that could provide the TWDB with a reliable and consistent approach to estimating actual conservation savings across Texas and could assist individual municipal providers with analyzing their own water use and

estimating their own conservation savings. Finally, the recommendations also address several issues related to estimating and reporting conservation savings that emerged during the course of this research.

Distinguishing Ongoing Water Conservation from Drought Management Measures

Drought management is sometimes confused with ongoing water conservation programs. Drought management can be defined as the use of temporary measures to reduce water demand during emergency conditions resulting from adverse climate circumstances or other water shortage conditions. This is often accomplished through curtailments and, in some cases, rationing that is required only while the drought or water shortage condition exists. Ongoing water conservation measures, the focus of this study, increase water use efficiency on a continual basis, thus reducing water use regardless of specific climate conditions in any particular year.

In part, this confusion may arise because some measures invoked by some providers for drought management purposes are used by other providers as part of their ongoing conservation efforts. For example, limitations on the frequency and/or time of day that customers may irrigate their landscapes are common early stage drought response strategies for many providers. Other providers, however, enact these types of restrictions on a regular, ongoing basis as part of their conservation plans. By definition, drought response measures for a particular provider must go beyond the water conservation measures that provider has already implemented as part of its ongoing conservation efforts. In general, and particularly for more severe drought conditions, drought response measures involve more aggressive efforts to limit demand than ongoing, routine conservation measures.

SECTION 2.
Published Information on Municipal Water Conservation in Texas

The first research task, (Task 2 of the study work plan) was to review information relevant to this study from existing data sources, studies and planning documents previously developed in Texas. The project team examined information regarding municipal water conservation from the last completed round of regional and state water planning (2006-2007); from several studies related to municipal conservation that have been recently completed as part of the current regional planning process; and from a number of studies and planning documents outside of the regional and state water plans. The study team also examined data currently gathered by the Texas Water Development Board (TWDB) that might be incorporated into future efforts to analyze municipal conservation savings. TWDB staff also provided draft information to the study team from the current round of regional and state water planning (2011-2012).

This task did not include review and analysis of conservation plans or studies specific to individual municipal providers. Provider-specific information was the focus of Task 4 and Task 5.

Relevant Studies Outside of the Regional and State Water Plans

To provide context regarding previous "big picture" efforts in Texas to assess municipal conservation implementation and water savings, this discussion begins with a review of several studies with a statewide perspective. Although a number of these studies were conducted for the TWDB and are relevant to regional and state water planning efforts, they were not conducted by the regional water planning groups or documented in the regional and state water plans.

Water Price Elasticities for Single-Family Homes in Texas. Commissioned by the TWDB and completed in 1999, the water price elasticity study by Stratus Consulting provided a detailed analysis of residential customers' responsiveness to changes in municipal water rates. The study focused on municipal customers served by the City of Austin, the City of Corpus Christi and the San Antonio Water System. Key findings from this study included the following:

- Customer behavior responds primarily to the total water bill amount, not to the marginal water rates for individual consumption blocks;
- The quantity of water used does decrease with increasing water prices;
- Changes in prices have the greatest effect on outdoor irrigation use;
- The overall price elasticity was estimated at -0.17 to -0.20—meaning that a ten percent increase in water rates would reduce annual residential consumption by 1.7 to 2.0 percent; and

- Price elasticity was not found to vary significantly due to differences in the age of homes or the wealth of homeowners.

The price elasticity study also noted that "there is a link between water pricing and customer interest in participating in conservation programs."[1] Increases in water prices increase the financial benefits to customers from reducing water use through conservation activities and may increase the effectiveness of other conservation efforts.

Quantifying the Effectiveness of Various Water Conservation Techniques in Texas. Completed for the TWDB in 2002 by GDS Associates, Inc. (GDS), this study was something of a precursor for the 2004 effort by the Water Conservation Implementation Task Force described later in this section. The 2002 GDS study focused on projecting typical water savings and costs associated with 16 residential and commercial conservation measures such as toilet retrofits, irrigation audits and rainwater harvesting.

The GDS study also noted that "[i]n regions with high seasonal per capita water use, water efficiency measures that target outdoor water use would be most effective, as seasonal water use is mainly attributed to outdoor water use." The study provided a number of standardized metrics intended to assist different regions in Texas in evaluating potential conservation strategies. These metrics included:

- Per capita water use by region, divided into base use, seasonal use and dry year use (additional seasonal use under low rainfall conditions);

- Comparable statistics for per capita water use in the urban areas, suburban areas and rural areas within each region (in aggregate for each category); and

- Average annual rainfall for each region based on the most centrally located (east to west) county in each region.

While the focus of the GDS study was primarily to assist Texas regions (and individual municipal water providers) in evaluating the relative merits of adopting individual conservation measures, the 2002 study also provides an example for our study by analyzing standardized data already available at the TWDB (monthly water use data by provider) or from other Texas sources (rainfall data from the Texas State Climatologist). The standardized metrics demonstrate that the monthly water use data collected by the TWDB can provide further information on the variability in water use among Texas regions and among different types of water providers. The development of standardized rainfall metrics is also a potentially useful precedent for future analyses that could attempt to more fully examine the influence of climate on municipal water use across Texas.

[1] *Water Price Elasticities for Single-Family Homes in Texas*. Stratus Consulting. August 1, 1999. Page 2-20.

Water Conservation Implementation Task Force: *Report to the 79th Legislature and Water Conservation Best Management Practices Guide*. In 2003, the Texas Legislature created a Water Conservation Implementation Task Force (WCITF) through passage of Senate Bill 1094. The work of the WCITF was documented in two reports— the Water Conservation Best Management Practices Guide and the Report to the 79th Legislature.

The *Water Conservation Best Management Practices Guide* (WCITF Guide) was, in some ways, similar to the earlier GDS study but provided considerably more extensive information regarding the benefits, costs, implementation requirements and other aspects of individual water conservation measures. The WCITF Guide included 22 measures aimed at reducing municipal water use, as well as measures targeted at industrial and agricultural use. The WCITF guide remains a very thorough, bottom-up tool for water utilities interested in developing or enhancing their conservation programs and provides considerable information for projecting the savings associated with individual conservation measures.

The *Report to the 79th Legislature* (WCITF report) contains additional information particularly relevant to our current study. The WCITF report indicates that the WCITF was tasked with several particular objectives closely related to our current effort. Task 2 for the WCITF was the evaluation of regional implementation of water conservation strategies. Task 5 for the WCITF was to develop targets and goals for per-capita water use. Task 6 for the WCITF was an evaluation of state oversight and support of conservation.

Figure 2 from the WCITF report indicated that water conservation was expected to meet 13.5 percent of statewide needs in 2010, while water reuse was anticipated to meet 5.8 percent of 2010 needs. Municipal water conservation was included as a strategy in eight of the 16 regional plans in 2001. Nineteen percent of Water User Groups (WUGs) with water supply needs by 2010 (120 WUGs in all) included water conservation as a water management strategy to help meet those needs. Ten of the 16 regions included water reuse as a management strategy and 14 percent of WUGs with anticipated needs by 2010 included reuse as a strategy.

To complete WCITF Task 2, TWDB staff conducted surveys of municipal providers on behalf of the WCITF to examine the implementation of the water conservation strategies and water reuse strategies adopted in the regional plans. Forty-nine providers were surveyed regarding the implementation of water conservation measures and 45 providers were surveyed concerning implementation of water reuse strategies.[2]

Based on the survey results, the WCITF report concluded that most of the WUGs that had included water conservation or water reuse as management strategies were at some stage of implementation for those strategies.[3] However, the WCITF report also indicated concern that only "about one in three" WUGS with needs chose water conservation or water reuse as potential strategies for meeting those needs. The WCITF report noted that approximately 26 percent of the WUGS with needs that had not selected water conservation or water reuse as a strategy were small providers serving

[2] The WUGs surveyed had expected savings of 1,000 acre feet per year or more through water conservation measures or expected to implement water reuse strategies providing 1,000 acre feet or more per year based on the 2001 Regional Plans.

[3] The survey found that 46 of 51 WUGs with conservation strategies and 68 of 85 WUGS with reuse strategies were implementing those strategies.

populations of less than 3,300. The WCITF report also found that lack of adequate funding was a significant barrier to full implementation of water conservation and reuse strategies by 2010.

The WCITF report did not provide any data regarding the estimated water savings accomplished to date through implementation of water conservation or reuse strategies adopted in the 2001 regional plans.

The WCITF report also documents the development of a standardized method for calculating system-wide gallons per capita per day (GPCD) and residential GPCD metrics. The WCITF report noted the variability in reported GPCD based on system size, climate and other characteristics. However, the WCITF also recommended that individual providers, and the state as a whole, adopt the goal of reducing municipal GPCD by 1 percent per year until overall usage reaches 140 GPCD.

The WCITF report included several other policy recommendations related to municipal water conservation:

- WUGs with needs should consider water conservation first before adopting other water management strategies to meet those needs;
- Retail water providers required to submit conservation plans should base those plans on specific targets and goals and utilize appropriate Best Management Practices (BMPs) or other conservation techniques;
- Water providers required to submit plans should also report annually to the TWDB on the progress of their conservation programs; and
- The TWDB should give priority to funding requests from entities that have demonstrated significant water conservation savings or will achieve significant conservation savings through the project proposed for funding.

The WCITF also recommended that the Texas Legislature establish a standing Water Conservation Advisory Council. The most recent work of that Council is described below.

A Report on Progress of Water Conservation in Texas (December 2010).[4] The Water Conservation Advisory Council (WCAC) was created by the 80th Texas Legislature. The WCAC is a select council with expertise in water conservation intended to serve as a resource to Texas state and local governments, as well as the public. The WCAC was also tasked with submitting a progress report on water conservation in Texas near the end of each even-numbered year. A Report on Progress of Water Conservation in Texas (WCAC report) is the current, draft version of the first of these progress reports.

The WCAC report is structured around seven charges given to the WCAC by the state legislature. Three of these charges are directly related to our current study:

- Charge 1: Monitor trends in conservation implementation;

[4] The study team reviewed the October 2010 working draft of the WCAC report.

- Charge 6: Monitor the implementation of water conservation strategies by water users included in regional water plans; and

- Charge 7: Monitor target and goal guidelines for water conservation to be considered by the Texas Commission on Environmental Quality and Texas Water Development Board.

Responding to Charge 1, the WCAC noted that the water conservation plans and conservation implementation reports that many[5] municipal water providers in Texas are now required to file create the opportunity to evaluate the implementation of municipal water conservation. However, there are several challenges associated with using these reports for this purpose, including varied quality of reporting and "enthusiasm" among the providers, variation in methods used to evaluate programs and the difficulty in sorting out the effects of year to year variations in climate and changes in the mix of uses in high growth areas.[6] The conservation implementation reports are a new source of data and are currently being analyzed by the TWDB for the first time.

To fulfill Charge 6, the WCAC reviewed recent, region-specific studies related to water conservation (discussed later in this section) and held discussions with the chairs of a number of the regional water planning groups. The WCAC noted that 14 of the 16 regions included water conservation as a strategy for meeting future needs in the 2006/2007 regional and state water plans.[7] Based in part on discussions with the regional chairs, the WCAC noted that:

- Regional water planning statutes, rules and guidelines do not task the regional water planning groups with tracking or monitoring implementation of water conservation or other water management strategies;

- The regional water planning groups are concerned about the costs and resources required and the difficulty in measuring implementation, as well as the risk of faulty conclusions; but,

- The regional planning groups are interested in tools, methods and technical guidance that can help their members evaluate conservation implementation and savings.

The WCAC also noted that several existing reports and data collections have the potential to assist in evaluating conservation implementation and water savings on a statewide basis. These include the annual water use data analyzed by the TWDB, the annual conservation reports filed by providers, the new conservation implementation reports, and the water loss audit reports.

In responding to Charge 7, the WCAC focused primarily on the need to improve metrics and data collection to develop more useful and consistent data regarding water usage. Recommendations included adoption of more consistent methodology for both estimating provider service area

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[5] All providers serving more than 3,300 connections must file these reports, as must smaller providers that hold water rights or seek public financing. Although this group does not constitute a majority of all water providers, the reports likely cover the overwhelming majority of municipal water use.

[6] WCAC report, page 18.

[7] Though not discussed in the WCAC report, this indicates increasing reliance on water conservation as a water management strategy compared to the 2001 regional plans in which only 8 of 16 regions included water conservation as a strategy.

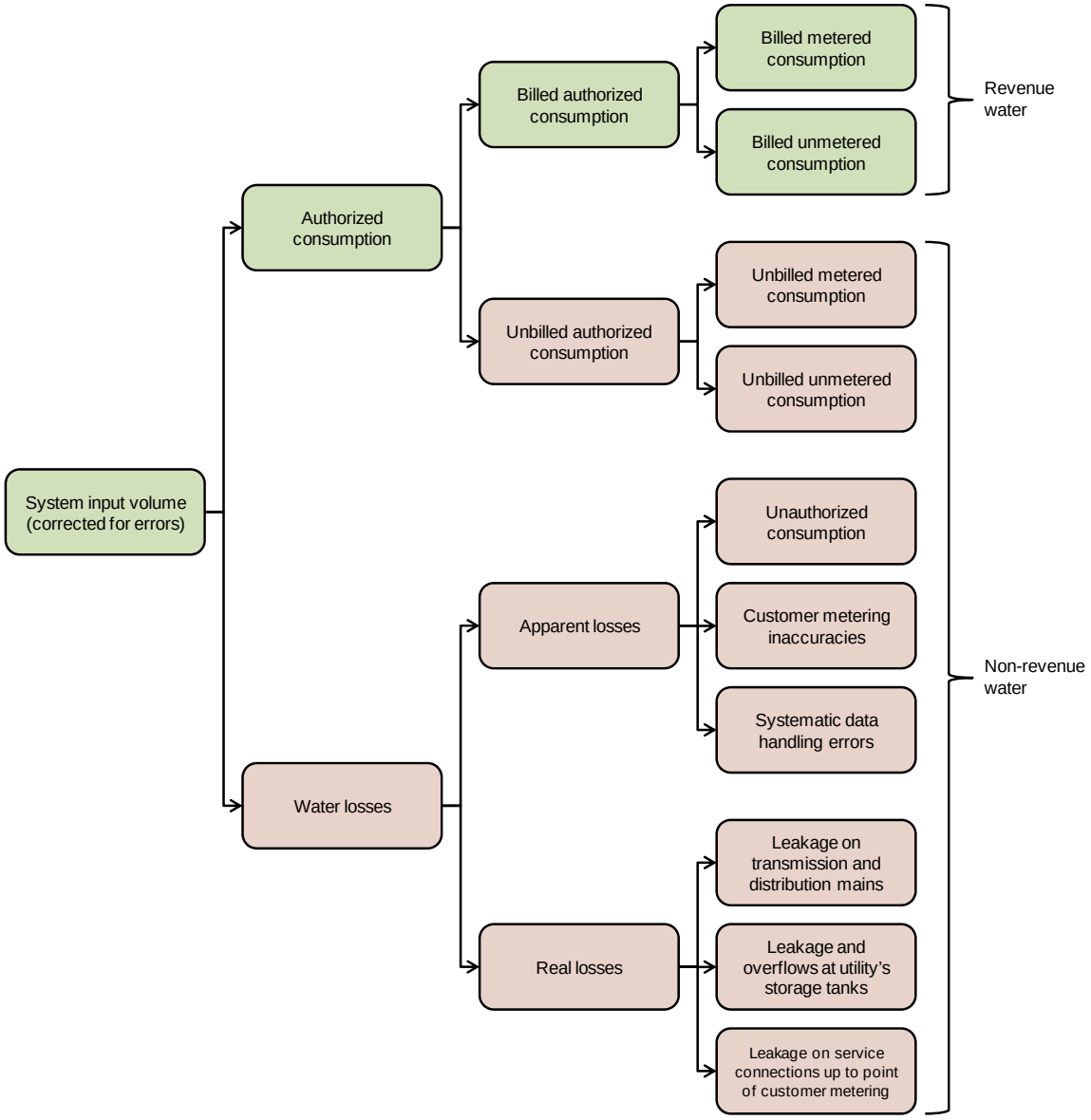
populations and calculating GPCD and development of more sector-specific usage data to assist in targeting conservation efforts. The WCAC report noted the recent development of a spreadsheet-based tool by the New Mexico State Engineers Office that is designed to improve consistency in data analysis and reporting and provide sector specific information. Such a tool, modified as appropriate for circumstances in Texas, was deemed to have considerable potential value.

Final Report – An Analysis of Water Loss as Reported by Public Water Suppliers in Texas (2007). House Bill 3338 (HB 3338), passed by the 78th Texas legislature, requires public water utilities to audit their system every five years using the methodology recommended by the American Water Works Association (AWWA) — known as the IWA/AWWA[8] Water Audit Method. Under HB 3338, the TWDB required providers to submit their first set of data by March 31, 2006. This study, completed by Alan Plummer Associates and Water Prospecting and Resource Consulting for the TWDB, used this first round of water loss data to conduct "the first broad analysis of water loss and water loss accounting for retail public utilities in Texas." The study examined the reported water loss data for consistency, errors, omissions, and other quality control issues; calculated water loss performance statistics; compared water loss performance by utility location, type, and size and made recommendations for improving the water audit reporting process.

About 50 percent of providers submitted water loss data (2,098 out of 4,295) — representing up to about 85 percent of the state population. Figure 2-1 outlines the basic data components providers needed to submit for an IWA/AWWA Water Audit to be completed.

[8] IWA stands for the International Water Association.

Figure 2-1.
IWA/AWWA Water Balance



Note: System input volume: the annual volume input to the water supply system.

Authorized consumption: the annual volume of metered and/or unmetered water taken by registered customers, the water supplier and others who are authorized to do so.

Water losses: the difference between system input volume and authorized consumption (consisting of apparent and real losses).

Apparent losses: unauthorized consumption, all types of metering inaccuracies and systematic data handling errors.

Real losses: the annual volumes lost through all types of leaks, breaks and overflows on mains, service reservoirs and service connections, up to the point of customer metering.

Revenue water: those components of system input volume which are billed and produce revenue.

Non-revenue water: the difference between system input volume and billed authorized consumption.

Source: AWWA. 2010. IWA/AWWA Water Audit Method. Available at: http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48055&navItemNumber=48162.

The study found that water loss for reporting utilities was at least 5.6 percent (or 212,221 acre-feet) of all water entering their systems and non-revenue water represented at least 8.3 percent. However, 6.7 percent of the water volume could not be assigned to one of the categories shown in Figure 2-1. This volume, referred to as the balance adjustment, represents the difference between authorized consumption and water losses. If the balance adjustment volume is assumed to be water loss, then losses could account for 12.3 percent of the water in the system and non-revenue water could account for 15 percent. The regional analysis found Regions I and J to have the highest average non-revenue water percentages (ranging from approximately 19 percent to 27 percent).

The study concluded that the balancing adjustment is too large to allow identification of trends in the water loss data and real loss appears to be underestimated. As such their recommendations generally focus on "implementing more accurate measurement and/or estimation procedures." Because this report was based on the first round of water loss data gathered from Texas municipalities, there were significant concerns about the reliability of the water loss data.

Recent reports produced by the Texas chapters of the National Wildlife Federation and Sierra Club (NWF and SC). In March 2010 and July 2010, NWF and SC released two reports entitled (respectively) *Drop by Drop: 7 Ways Texas Cities Can Conserve Water …* and *Sprayed Away: Seven Ways to Reduce Texas Outdoor Water Use*.

The first report (*Drop by Drop …*) provided a discussion of seven elements that can contribute to a successful conservation effort, including pricing (rate structures), goals, conservation funding and four types of conservation measures (toilet replacement programs, outdoor water ordinances, retrofit programs and educational efforts). The report also provided detailed summaries and evaluations of the conservation efforts (including pricing structures) of 19 cities throughout Texas. The summaries contain considerable data organized in a consistent format. These summaries facilitate comparisons of current water use per capita, GPCD targets, water rate structures and the conservation programs currently in place among these larger cities.

The second report (Sprayed Away …) focused on outdoor water conservation measures (e.g. changes in landscaping, irrigation system use, etc.) and provided an analysis of seasonal water use in 19 Texas cities. Calculations were also presented regarding the amount of water that could be saved by reducing outdoor water use by 25 percent during the July through September period in each city.

TWDB Sunset Report. Most recently (October 2010), the Sunset Advisory Commission (Sunset Commission) produced its staff report on the TWDB (Sunset Report). The Sunset Commission is tasked with reviewing each of more than 130 Texas state government agencies every 12 years. Issue 5 of the Sunset Report on the TWDB was entitled "The Board Lacks Data to Determine Whether Implementation of Conservation and Other Water Management Strategies is Meeting the State's Future Water Needs."

In this section of the report, the Sunset Commission provided a brief definition of municipal water conservation and noted that municipal water conservation measures focus on reducing GPCD. The Sunset Report also noted the requirements that larger municipal providers furnish conservation plans to the TWDB (or the TCEQ) every five years and (more recently) have begun to provide annual reports on conservation implementation progress.

In the findings section for this issue, the Sunset Report noted that the TWDB has not historically been required to track the implementation of water management strategies. The Sunset Report noted that some regions have compiled data on the implementation of conservation programs and that the TWDB has some of this data as well, particularly for WUGs that have applied for funding assistance. The report then noted the variability in GPCD across systems (and in how individual WUGs calculate GPCD in their conservation-related reports) and called for greater standardization in GPCD calculations.

In its discussion concerning the TWDB's lack of data to measure implementation of water management strategies, the Sunset Advisory Commission report focuses on the variability in GPCD across different municipal providers in Texas and the need for greater consistency in provider approaches to calculating this metric.

While comparisons of GPCD among different municipal water systems may sometimes provide useful information, the difficulty in developing "apples to apples" comparisons of this metric across different municipalities is well known. Even if two municipal water systems have achieved the same level of water conservation savings or overall water use efficiency, water use in GPCD is likely to differ between the two systems because of differences in climate, differences in the commercial and residential composition of their service areas, variations in lot sizes and the age of the housing stock, and numerous other factors. The more useful metric for evaluating actual water conservation savings achieved to date is the change in GPCD over time for each individual provider. This point was not captured in the Sunset Report.

Conservation Strategies from the 2006/2007 Regional and State Water Plans

This section provides a brief summary of the 2007 State Water Plan and the 2007 regional plans. The planning process uses a bottom-up approach — meaning each of 16 regions develops a regional water plan and the TWDB then compiles the information into the State Water Plan. The 2006/2007 plans represent the 2nd cycle of this planning process; the first being completed in 2001/2002. While the required content for regional plans was relatively extensive, the fundamental goal of the plans was to develop water demand and supply projections (out to 2060 for this planning round) and, if necessary, recommendations of water management strategies to meet identified water needs.

Senate Bill 2, passed by the 77th Texas Legislature in 2001, required that planning groups consider water conservation as a management strategy if a need was identified. The Texas Water Code §11.002(8) (1) defines conservation as "the development of water resources; and those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses." While water conservation was addressed in several sections of the regional plans, the most thorough information was presented in Chapter 4: Identification, Evaluation, Selection of Water Management Strategies; Chapter 6: Water Conservation and Drought Management Recommendations; and, for some regions, conservation-specific appendices.

The 2007 State Water Plan (State Plan). The State Plan projected water needs of 3.7 million acre-feet per year in 2010 and 8.8 million acre-feet in 2060. These needs come from about 33 percent of WUGs in 2010 and 45 percent in 2060.

In the State Plan, conservation (including municipal, agricultural, industrial and other types of water uses) accounts for nearly 23 percent of required water in 2060, a total of about 2 million acre-feet. This represents a substantial increase from the 2002 State Water Plan for which water conservation accounted for 14 percent of the water needed to meet the state's needs in 2050, a total of about 990,000 acre-feet per year.

Anticipated future agricultural conservation accounts for a large portion of the future statewide water requirements expected to be met from conservation. However, municipal water conservation strategies constituted nearly 617,000 acre-feet, or 7 percent, of estimated water generated by all recommended strategies by 2060. The State Plan notes that the municipal water conservation strategies in the regional water plans relied heavily on the WCITF Guide. Figure 2-2 shows Table 10.1 from the State Plan, which summarizes the estimated supplies from the recommended municipal water conservation management strategies for each region and the state as a whole.

Figure 2-2.
Summary of 2007State Water Plan's Recommended Municipal Water Conservation Management Strategies

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from municipal conservation (acre-feet per year)	Percentage of all new supplies from municipal conservation	Average annual unit costs per acre-foot of water* (dollars)
A	412,146	4,255	1	489
B	81,021	1,855	2	131
C	2,653,248	291,909	11	421
D	108,742	—	—	—
E	137,737	23,437	17	153
F	239,250	9,727	4	238
G	736,032	21,406	3	380
H	1,300,639	100,987	8	214
I	324,756	1,916	1	111
J	14,869	55	<1	419
K	861,930	51,315	6	209
L	732,779	72,566	10	442
M	807,587	24,412	3	141
N	149,496	2,415	2	333
O	441,511	10,424	2	863
P	32,468	—	—	—
Texas	9,034,211	616,679	7	234

Note: A dash indicates a value of zero.
*Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

2006/2007 Regional Water Plans. With the exception of the North East Texas (Region D) and Lavaca (Region P) regions, each of the regional plans from the 2006 planning cycle recommended municipal water conservation as a water management strategy. Each of these plans developed estimated projected savings from municipal water conservation in 10-year increments out to 2060. Figure 2-2, shown previously, provides the projected savings by 2060. The plans describe, with varying detail, the assumptions made to estimate future savings. In general, regions relied heavily on information available in the WCITF Guide and the 2002 GDS study to derive projected savings. These regions identified a likely menu of BMPs that could be implemented by their municipal WUGs and projected savings from each of the selected BMPs. Most regions only recommended[9] implementation of municipal water conservation as a water management strategy for WUGs with a projected need and with a GPCD projected to exceed a specified level in 2060.[10] Ultimately, each WUG has the responsibility for selecting and implementing municipal water conservation strategies. Figure 2-3 identifies the portion of each regional plan that presents the methodology used to project savings from municipal water conservation.

Figure 2-3.
Municipal Water Conservation in Regional Water Plans

Region	Municipal Conservation Savings	Estimated Projected Savings	Review of Existing Municipal Conservation
Panhandle (Region A)	✓	Section 4.3.2	
Region B	✓	Attachment 4-5	
Region C	✓	Appendix M	✓
North East Texas (Region D)			✓
Far West Texas (Region E)	✓	Section 4.4	✓
Region F	✓	Appendix 4I	
Brazos G (Region G)	✓	Section 4B.2	
Region H	✓	Appendix 4B	✓
East Texas (Region I)	✓	Chapter 4B	
Plateau (Region J)	✓	Chapter 4.5.4	
Lower Colorado (Region K)	✓	Appendix 4D	
South Central Texas (Region L)	✓	Section 4C.1	
Rio Grande (Region M)	✓	Chapter 4	
Coastal Bend (Region N)	✓	Section 4C.1	
Llano Estacado (Region O)	✓	Chapter 4.4.1	
Lavaca (Region P)			

Some of the plans discuss potential implementation challenges, including funding, enforcement, public acceptance and resources and incentives for small WUGs. Several regions also recognize the difficulty in projecting the water savings from the implementation of some measures and uncertainty surrounding the accuracy of the projections.

[9] Regions did not discourage any WUGs from implementing municipal water conservation. The term "recommended" refers to a recommended water management strategy to increase supplies to meet future needs.

[10] With the exception of the Panhandle Region (Region A) and Region B, projected GPCDs include reductions in demand from natural replacement savings.

Region I made the point, with regard to conservation pricing, that "effectiveness of this measure is in part affected by whether water conservation pricing is currently implemented." This concern could be applied to many of the conservation measures selected by regions to project savings. In fact, only four of the regional plans provided a discussion related to the current role of municipal water conservation within their region (see Figure 2-3). These discussions focused on the implementation rate of specific municipal water conservation strategies by WUGs within their region. Region C, for example, gathered this information through a survey of WUGs and also a review of available Water Conservation Plans. None of these four regions provided information on the actual cost of implementation or the estimated water savings from implementation of municipal water conservations strategies. However, there are discussions of decreasing trends of GPCD as indicators of successful implementation of conservation strategies.

None of the regions explicitly identified tools or methods for tracking water savings from municipal water conservation strategies. However, most regions point to the WCITF goal of 140 GPCD as a benchmark and general decreasing trends in GPCD as a measure that reflects successful implementation of municipal water conservation strategies.

Region-Specific Studies for the 2011/2012 Regional and State Water Planning Process

Eight of the 16 regional water planning work groups have conducted special studies related to conservation to assist in the preparation of their 2011 regional water plans. Three of these studies (conducted by Region B, Region E and Region M) focused entirely on water conservation related to irrigation (agricultural) use and are not discussed here. The following is a brief synopsis of the studies related to municipal water conservation, focusing on elements most relevant to our study.

Region C Water Conservation and Reuse Study. Prepared by a team of three consulting firms[11], the study for Region C noted that conservation and reuse are being counted on to supply about 1.3 million acre-feet per year to Region C by 2060. This study was commissioned to evaluate the performance of the region's water management strategies to date and provide insights for the region in developing its 2011 regional water plan.

Major components of this 2009 study included the effort to survey all WUGs and wholesale water providers in the region, telephone interviews with selected providers, case studies of conservation practices for different size municipalities, and detailed updates of selected reuse projects.

The survey of the WUGs had a response rate of about 50 percent. The survey found that the most commonly implemented conservation strategies included system-wide education programs, water pricing, water audits and enacting ordinances. Providers were generally found to be on-target or ahead of the schedule described in the 2006 regional plan for implementing recommended conservation strategies. Low implementation was found for rebate programs and programs targeting industrial/commercial users.

The Region C study sought to assess the quantities of water saved through the conservation measures adopted to date. The study noted that the WUG surveys provided very little information on the water savings associated with individual conservation measures due to both the lack of an established

[11] Freese and Nichols, Inc.; Alan Plummer Associates, Inc.; and CP&Y, Inc.

method to measure or estimate these savings and the difficulty of attributing water savings to individual conservation measures. Consequently, the Region C study team made an effort to assess overall water savings from conservation programs as a whole.

The Region C study team first analyzed annual water use from 2002 through 2006 for a select group of 6 WUGs. That analysis concluded that annual rainfall had more influence on water use than any other factor and found no significant trends in long term reduction in GPCD that could be associated with water conservation. The Region C study team then performed a seasonal assessment, comparing water use for five WUGS and five Wholesale Water Providers (WWPs) between two dry years: 2000 and 2006. The seasonal assessment concluded that outdoor water use had declined as a proportion of total use and that declines in outdoor use in August and September 2006 (relative to the same months in 2000) were most likely due to conservation efforts rather than weather factors. Specific estimates of these savings were not provided.

Report – Water Conservation Conference for Far West Texas Water Plan Region E. This report provides information from a conference held to share the successful experiences of El Paso Water Utilities Public Service Board (EPWU) regarding the implementation of conservation programs and incentives.

EPWU has been developing and implementing conservation programs for more than 17 years. In 1991, their objective was to reduce consumption from an initial 200 GPCD to 160 GPCD by the end of 2000. Actual 2000 consumption was reportedly 159 GPCD. EPWU's new goal of reaching 140 GPCD by 2010 was surpassed at the end of 2004 when the utility reached 139 GPCD. Last year (2008), EPWU's water consumption reached 133 GPCD. Maintaining a 140 GPCD through 2010 is EPWU's latest goal. EPWU attributed the reduction in GPCD to the implementation of best management practices such as education programs, system audits, rebates and incentives, rate structures, mandatory ordinances and supply side measures such as distribution system leak detection.

The presentation on EPWU's conservation program included a slide on GPCD trends in relation to key conservation program implementation. Other presentation topics addressed water loss, rates and reclaimed water.

Municipal Conservation Survey **(Prepared for the Region F Water Planning Group).** This study was conducted to document current conservation practices by Region F municipalities and attempt to quantify the costs and water savings associated with these practices. A mail survey was sent to 13 cities in the region and eight cities provided responses.

The survey found that the larger cities (population over 10,000) that responded had implemented several of the recommended strategies from the 2006 regional water plan, but not all of them. Only two of the four larger cities had conducted system water audit and water loss reduction efforts and only two of four had implemented water conservation pricing. The smaller cities in the region had made relatively little progress in implementing conservation measures.

The study noted that cities have great difficulty in tracking water savings from conservation practices. Only specific projects, such as pipe replacement programs and reuse, had quantified savings.

The study also provided figures comparing historical water use (GPCD) to rainfall for each city. Dates of implementation of conservation program were identified in the figures. The study also

provided "normalized" estimates of water savings from individual conservation measures for a hypothetical city of 95,000 people based on survey information and information from the WCITF BMP Guide.

***East Texas Regional Water Planning Group Study No. 3: Study of Municipal Water Uses to Improve Water Conservation Strategies and Projections* (Region I).** This report summarizes survey responses from 27 WUGs (out of 65 WUGs who were mailed the survey). The purpose of the survey was "to gain an improved understanding of current water conservation practices and to use the findings for development of conservation strategies and projections of water conservation savings in the region." Approximately half of the survey respondents had less than 2,000 connections.

Based on the survey, the study concluded that per capita water use for most WUGs participating in the survey was well below the statewide target value of 140 GPCD. The study inferred that water use in Region I appears to be relatively efficient, generally lower than in other parts of Texas, and below conservation targets set by the WCITF. Consequently, the report concluded that the water use data may not support the need for identification and development of additional, "cost-intensive" active conservation measures in Region I. The report did note, however, that water use (GPCD) based on survey responses was generally lower than indicated by the TWDB data for providers in the region.

Region L Study 3: Enhanced Water Conservation, Drought Management, and Land Stewardship. This report began by reviewing the municipal water conservation goals from the region's 2006 plan, which generally align with the 1 percent per year reduction in GPCD targeted at the statewide level. For municipal WUGs, the region has focused on accelerated plumbing fixture and clothes washer retrofits and lawn watering restrictions. The region also encourages recycled water programs and rainwater harvesting (particularly in the Hill Country). The study also noted the potential interaction between successful conservation efforts and the possible reduction in future savings available from drought management programs — a concept sometimes referred to as "demand hardening." The study did not provide any information regarding conservation implementation or water savings to date, but did discuss future conservation goals from the 2006 regional water plan.

***Coastal Bend Regional Water Planning Area Study 5: Region-specific Water Conservation Best Management Practices* (Region N).** Like the studies for Regions C, F and I described previously, this study involved a survey of the region's WUGs to identify what conservation efforts had been undertaken and to seek other information. In particular, the survey sought feedback on water savings achieved to date, conservation goals, costs, challenges to date and interest in implementing additional conservation measures. The survey was provided to 72 WUGs and WWPs and 21 responded.

The survey results provided information on the BMPs adopted by each respondent. The majority of respondents indicated that their conservation programs had reduced GPCD by between 1 percent and 5 percent, though the basis for these savings estimates is not clear. A number of the respondents indicated that cost and lack of staff were constraints in considering additional conservation measures.

Data Sources and Analytical Methods Currently Available to the TWDB

Annual Water Use Survey Data. The TWDB conducts an annual survey of ground and surface water use by municipal (and industrial) entities within the state of Texas. The Municipal Water Use Survey collects a variety of information, including the volume of water used by source, volume of water reuse, number of connections by municipal customer type (e.g., single-family, multi-family), and other

pertinent data. Failure of a municipal entity to complete and return the survey could impact their ability to receive financial assistance from the TWDB, as discussed below.

The results from the annual survey are summarized and available on the TWDB website at: http://www.twdb.state.tx.us/wrpi/wus/summary.asp, including:

- Total annual water use summarized at state, region and county levels disaggregated into sectors (i.e., municipal, manufacturing, mining, steam electric, irrigation and livestock)[12] and
- Total population and annual municipal water use for each city/place and the corresponding GPCD and residential GPCD.

It should be noted that the surveys collect more detailed information than summarized in the files provided on the TWDB's website. In particular, the survey requests water use data for each month.

Gallons Per Capita per Day (GPCD) Estimates. The TWDB uses GPCD for planning purposes. Population data comes from the Texas State Data Center – Office of the State Demographer. As explained on the TWDB's website: "In the calculation of a city or utility's water use (and ultimately, the GPCD) for regional water planning, the TWDB:

- does include the water use of residential, commercial and institutional users, as well as process-related water loss and any system water loss,
- does not include water sales to large manufacturing, mining or steam-electric power plants,
- does not include a city's water sales to retail customers who live outside of the city limits,
- does include the water use of commercial and institutional entities, and residential customers, who are within the city limits but are supplied water from another source, including a private groundwater well, another water utility or a surface water right."[13]

Starting in 2007, TWBD also began to report residential GPCD in addition to total GPCD calculated as previously described.

[12] County-level data is also broken out by source type (i.e., surface water or groundwater)

[13] See http://www.twdb.state.tx.us/wrpi/wus/faq.asp.

Natural Replacement Projections. Prior to development of the 2006 Regional Water Plans, the TWDB developed projections of the future reductions in GPCD that each municipal provider in Texas could anticipate from the replacement of older plumbing fixtures (e.g. toilets and showerheads) with the more efficient fixtures mandated under the 1991 State Water-Efficient Pluming Act. Replacement of older plumbing fixtures with efficient new models was projected to reduce a household's water use by 16 GPCD. Two percent of the existing housing stock in 1995 was projected to replace their fixtures each year, consequently all older fixtures were projected to be replaced by 2045.

These projections of water use reductions due to the natural replacement of older plumbing fixtures have been incorporated in the TWDB's demand projections for municipal providers (so they are not part of the anticipated water use savings from municipal conservation as a water management strategy in the regional and state water plans). However, the projections could also be used to develop an estimate of change in each municipal provider's actual GPCD that may be attributable to natural replacement rather than proactive conservation efforts.

Ranking of Financial Assistance Applications. Through the Water Infrastructure Fund (WIF), the TWDB provides "affordable financing for water conservation and development projects for the implementation of recommended strategies in the state water plan" (TWDB, September 2010). Applications for funding are prioritized annually by the TWDB using two criteria: demonstration of conservation and need. "Demonstration of conservation is based on the highest rolling five year average gallons per capita per day since 1980 compared to the average gallons per capita per day for the most recent four year period" (TWDB, September 2010).

Conservation Plans and Implementation Reports. The TWDB compiles the municipal water conservation plans and, beginning with 2009, the annual conservation implementation reports, for municipal providers required to submit these materials. Further information regarding these plans and reports, and analysis of a sample of these documents, is provided in the Task 4 portion of this report.

Summary

A number of important observations can be drawn from the preceding review of published reports, planning documents and data sources in Texas.

Texas water user groups and regional planning groups are increasingly relying on water conservation in general, and municipal water conservation in particular, as a strategy to meet future water needs. The number of regions that included municipal water conservation as a water management strategy increased from eight in the 2001 planning cycle to 14 in the 2006 planning cycle. Overall water conservation (including agricultural, industrial and other types of water use, as well as municipal) was anticipated to meet 23 percent of long-term (2060) water needs in the 2007 regional plans, compared to 14 percent of long-term (2050) needs in the 2002 State Water Plan.

Along with the increasing reliance on municipal water conservation to meet future water needs, there has been growing concern about the lack of information on actual progress towards achieving the anticipated water savings. As early as 2003, the Texas Legislature charged the WCITF with evaluating the regional implementation of water conservation strategies. That charge was repeated in the 80th Texas Legislature's directives to the WCAC in 2007. Most recently, the 2010 Sunset Advisory Commission Staff Report for the TWDB has identified the lack of data to determine whether

implementation of water conservation is meeting the state's water needs as one of six key issue areas for the TWDB.

Conceptually, there are two potential approaches to assessing progress towards achieving municipal conservation goals:

- The first approach could be described as being based on indicators of "effort" and is reflected in the implementation of conservation measures and the resources dedicated to them;
- The second approach would reflect actual "achievement" in terms of water use reductions specifically attributable to proactive conservation measures.

To date, most assessments of municipal conservation progress have focused on the first assessment approach. The WCITF (using TWDB staff) conducted a survey in 2004 that found that most WUGs that had municipal water conservation identified as a water management strategy in the 2001 regional plans were at some stage of implementing water conservation measures. Four of the 16 Texas Regional Water Planning Groups (RWPGs) provided some information regarding the extent of municipal conservation efforts in their 2006 regional water plans. Although the RWPGs are not required to evaluate the implementation of previously recommended water management strategies, a number of them have undertaken special studies to evaluate municipal water conservation implementation since the last round of regional planning. Primarily, these studies have focused on surveying WUGs to ascertain the extent to which they have adopted conservation measures and BMPs.

The predominant focus in the literature on the first approach toward assessing conservation progress based on the adoption of specific conservation measures (and, to a much lesser extent, on funding dedicated to conservation programs) can likely be attributed to the greater difficulty in identifying actual water savings achieved by conservation programs. While the *Water Conservation Best Management Practices Guide* developed by the WCITF provides methods for projecting the potential savings associated with individual conservation measures, neither the WCITF nor the WCAC provided any estimates of actual water savings achieved by conservation efforts to date.

Though none of the studies or data sources reviewed in this section provide estimates of actual water conservation savings achieved to date, most of them ultimately gravitate towards discussions regarding aggregate water use in terms of GPCD (or residential GPCD in some cases). The WCITF provided initial direction regarding the standardized calculation of this metric, and established statewide goals for reducing municipal GPCD over time. The WCITF sought to improve on GPCD calculations and standardization. The TWDB's method for assessing conservation progress in evaluating funding applications is based on comparisons of GPCD over time.

There appears to be general agreement that the analysis of actual conservation savings must begin with some form of standardized GPCD metric. However, some of the challenges associated with this type of evaluation are also well recognized. Variability in GPCD based on climate (rainfall), region and customer base (e.g. urban, suburban, and rural) was documented as early as the 2002 GDS study. The WCITF noted similar concerns, but nonetheless adopted a common statewide goal of reducing municipal use to 140 GPCD. The WCAC report reiterated the challenge in sorting out the various factors influencing GPCD.

To some extent, the potential use of some form of GPCD metric to assess conservation progress is also confounded by the ways in which GPCD is evaluated in the reports and studies described in this section. In its discussion concerning the TWDB's lack of data to measure implementation of water management strategies, the Sunset Advisory Commission report focuses on the variability in GPCD across different municipal providers in Texas and the need for greater consistency in provider approaches to calculating this metric. The recent NWF and SC reports also focus, in part, on comparative GPCD across providers.

While comparisons of GPCD among different municipal water systems may sometimes provide useful information, the difficulty in developing "apples to apples" comparisons of this metric across different municipalities are well known. For purposes of estimating the actual water savings achieved by conservation strategies, such comparisons of GPCD between providers are also essentially irrelevant. In this context, the key metric is comparative GPCD over time for each individual provider (and consistency in how each provider measures its own GPCD over time). This inter-temporal comparison, with appropriate adjustments for the other factors influencing year to year water use, holds greater promise for estimating actual water conservation savings achieved to date.

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SECTION 3.
National Conservation Studies and Guidance

Introduction

To provide further perspective on key issues and identify other potential methods for estimating water savings as a result of water conservation programs, the BBC team reviewed guidance documents and studies conducted outside of Texas, including those conducted by professional organizations, national conservation-focused organizations, other states, and major municipal water providers known for their conservation programs. Numerous national conservation studies and guidance manuals were reviewed, including those published by the following entities:

- Alliance for Water Efficiency (AWE)
- American Water Works Association (AWWA)
- California Department of Water Resources (CDWR)
- California Urban Water Agencies (CUWA)
- California Urban Water Conservation Council (CUWCC)
- Conserve Florida Water Clearinghouse
- Denver Water
- Georgia Department of Natural Resources, Environmental Protection Division
- New Mexico Office of the State Engineer
- Pacific Institute
- Phoenix Water Services Department
- Seattle Water Utilities
- South Florida Water Management District
- Water Conservation Alliance of Southern Arizona (Water CASA)
- U.S. Environmental Protection Agency

The primary focus of the research was to identify methods for evaluating effectiveness of conservation programs after implementation; however, approaches and planning tools for estimating water savings during plan development are also discussed as they may have some applicability for evaluating effectiveness.

Estimating Potential Conservation Savings

The vast majority of national studies and guides address estimating potential water savings likely to result from conservation practices and programs (i.e., estimating savings that will occur in the future) rather than the effectiveness of implemented programs (i.e., evaluating savings that have occurred in the past). One of the first guides for estimating potential savings related to water conservation practices, the 1992 Evaluation of Urban Water Conservation Programs: A Procedures Manual produced by the CUWA, provides step by step instructions to develop a conservation program. The manual was developed because the authors believed there were important information gaps in implementing water conservation programs: lack of reliable knowledge of actual water savings, market penetration, and interaction effects among conservation measures. Existing, empirical studies were producing widely divergent results for the same type of measures and/or programs. The authors believed there was a need for greater focus and standardization in procedures for estimating water savings.

When the 1992 manual was developed, the recommended procedures drew heavily from the program evaluation experience of the energy industry, as energy conservation programs predated those for water conservation. The experience of the energy industry has shown that conservation program evaluation must be viewed as an integral part of the design and implementation of all water conservation programs. Experience in implementing water conservation programs in the 18 years since the study was developed has only reinforced this point, as has review of other studies and guides from across the nation.

Elements to be considered during initial planning and program initiation that are key to post-implementation evaluation include establishing data needs and collection methods, developing evaluation approaches (e.g. bottom-up or top-down) and monitoring usage trends. The 1992 manual summarizes the data needs clearly (CUWA 1992):

> *"The need for early planning cannot be overstated with respect to the process evaluation. The sources of information for the process evaluation must be determined well in advance of program implementation. In most cases, selected data parameters for the process evaluation are gathered during delivery of the services. Therefore, data collection forms and procedures must be prepared prior to program implementation, and program implementation staff must be trained in the data collection methods."*

Data Requirements. Accurate data are important to both estimating potential savings and evaluating program effectiveness. There are numerous methods used to calculate and compare water conservation savings. Each of these methods requires data inputs that are not always readily available. In the AWWA Manual 52 (2006), the method suggested for calculation of water use reduction is expressed as:

Water savings (GPD) =
No. of accounts targeted * market penetration (%) * unit water savings (GPCD)

According to the manual, the unit water savings can be expressed in many ways, including gallons per fixture replaced and percent of end use reduced. The data necessary to forecast water savings resulting from conservation measures include baseline water use, end uses of water, demographics, market penetration, and unit water savings. Another important factor in evaluation of water use reduction is the persistence of savings over time. The savings resulting from the effects of plumbing

codes can be estimated given assumptions about unit water savings and rate of natural replacement of old fixtures with new, efficient fixtures. The anticipated customer response should also be included in the calculation. The baseline water use can then be apportioned into end uses using seasonal patterns and other relevant research (i.e., end-use studies). Unit water savings can describe individual product units or groups of products; a unit estimate may not be appropriate for each conservation measure. Service area population; total number, type (e.g., single-family or multi-family) and age of dwelling units; and residential and nonresidential demand are the primary demographic-related information used to evaluate measures. Market penetration is the estimated percentage of customers that will be participating in the measure when implemented. Errors in market penetration estimates for each measure can be significant but can be corrected through reevaluation of the measure once implementation begins.

Similarly, the manual developed for the CUWA (1992) identifies data collection and analysis as the first step in estimating conservation savings. The results of this step include:

- Disaggregation of total urban water use by major water sectors;
- Estimation of seasonal and outdoor components of water use in each sector;
- Identification of significant end uses of water in each user sector;
- Assessment of the existing conservation practices among various users; and
- Assessment of user motivations to implement conservation practices.

The CUWA manual goes on the say that knowledge of current water use and historical trends is required, as is knowledge of existing conservation practices resulting from passive programs (e.g., plumbing fixture codes) or market trends. Data on housing stock, household characteristics, business establishments, and other demographic statistics are also important for proper design and implementation of a water conservation program.

As discussed previously, one of the critical data needs for estimating potential water conservation savings is a baseline water demand with which to compare the reduction in water use. Step two of the 1992 manual's eight step process used to develop and implement a conservation program involves developing a disaggregated (both use sectors and end uses) forecast of future water demand without conservation for comparison with future effects of proposed conservation programs.

As identified in the University of Florida's EZ Urban Water Conservation Guide, data to be considered in evaluating potential savings from a water conservation plan include:

- Climactic considerations, such as rainfall and evapotranspiration, that affect outdoor water use;
- Housing data such as age of housing stock, lot size, irrigated versus non-irrigated areas, and mix of single-family and multi-family units;
- Existing water use regulations (e.g., outdoor watering restrictions);
- Existing conservation measures, whether quantifiable or not;

- Methods for reducing unaccounted-for water; and
- Actual or estimated historical water use on a monthly basis, disaggregated by residential and non-residential customer classes.

The recommended level of detail for various data sets is commensurate with the size of the utility and the complexity of the water distribution system.

Estimating Savings by Best Management Practice or "Bottom-Up" Approach

A common method for estimating potential savings relies on calculating water use reductions resulting from specific individual conservation measures. In most of the national studies reviewed, total anticipated water conservation savings were determined by aggregating the estimated savings from each best management practice to be implemented. For example, savings from toilet replacement programs were estimated and then added to calculated savings from showerhead replacements to determine overall savings potential. Most relied heavily on end-use studies the authors deemed most appropriate. Estimated costs were also based on various end-use and market studies deemed appropriate for a particular area or utility.

In the 2005 study, CUWCC set out to supplement existing guidelines by explicitly linking conservation costs and savings to a specific set of best management practices using the "best available information." The document was intended for use by water suppliers in both "forward-looking planning analyses (prospective) or backward-looking evaluations (retrospective analysis)."A set of best management practices was provided with a description, cost estimates, and water savings calculation formulas. Questions to ask of the water supplier's program related to these best management practices were also provided, as were potential persistence of savings, limitations, confidence in the estimates, factors to consider, and sources available for more information.

The US Environmental Protection Agency has a substantial number of publications regarding water conservation, including guidelines for planning and developing conservation programs. The guidelines provide approaches that states can take to monitor and track water use and conservation practices, but not methods for evaluating performance. Additionally, the WaterSense program conducts research on methods for reducing water use, as well as specific water-saving technologies (USEPA, 1998 and 2009).

Estimating Savings Using an Aggregated or "Top-Down" Approach

Using a "top-down" approach to estimate potential savings from water conservation on a statewide basis, the Pacific Institute conducted an urban water use analysis in California. Essentially, the analysis calculated urban water use data throughout the state in four major categories: residential, commercial, institutional and industrial. For each sector, water consumption was allocated by end use through application of percentages garnered from detailed end-use studies. For example, total residential use was split between indoor and outdoor use. Indoor water consumption was then allocated among uses such as toilet-flushing, showers, faucets and so on. Calculations were then performed to project potential statewide savings if water-efficient technologies were employed. Similar methodologies were applied for residential outdoor irrigation, as well as for other sectors. Further, for each water conservation measure, implementation costs were estimated.

The analysis resulted in a cumulative estimate of potential water savings for the state of approximately 2.3 million acre-feet per year. The financial analysis concluded that 85 percent of the estimated savings would be less costly than developing new sources of supply (Pacific Institute 2003). The potential for urban conservation savings was updated in 2010 with potential savings being allocated among specific water-efficient fixtures. Additional policies, financial incentives and regulations to support retrofit of water-efficient devises were also identified.

Monitoring Usage Trends. Before water conservation programs were common, electric utilities had demonstrated the usefulness of program monitoring after implementation. The most important benefit of monitoring is the ability to assess progress toward reaching the goals of a given conservation program. Without it, water suppliers may not have the information or justification to adjust their long-term water management plans when necessary. Implementation of a long-term monitoring program also allows analysis of the cost-effectiveness of specific components within a conservation program.

In the 1992 CUWA study, eight steps were defined as the keys to a successful water conservation program. The final step listed was the development of a long-term monitoring program. According to the manual, the following are the steps recommended when developing a monitoring program:

1. Analyze total water consumption and standard deviations within selected user groups, which allows for the determination of sample sizes that result in a statistically significant representation of the user group as a whole.

2. Conduct periodic surveys of the sample customers that represent the various user groups.

3. Couple survey data of each sampled customer with its corresponding historical water use record.

Even if a water supplier does not have extensive historical water use records at the initiation of the monitoring program, the results, at the least, provide valuable descriptive information such as:

- Identification of general water use characteristics of each customer class as a baseline for the monitoring program (e.g., seasonal water use patterns, process water use, cooling water use);

- Identification of the major factors that affect water use and conservation behavior;

- Determination of the market penetration of existing conservation programs;

- Identification of the characteristics of conservers versus non conservers; and

- Identification of the potential for conservation program improvement.

To fully benefit from a monitoring program, the water supplier must update the database on a relatively regular basis.

Evaluating Actual Conservation Savings

While end-use studies enable a water supplier to estimate conservation savings, and are especially helpful in the planning stages, more accurate methods of calculating actual conservation savings are available. These methods are typically more expensive and data intensive than the estimation methods described previously; however, the results provide much better information that can be used to

evaluate and adjust, if necessary, a water conservation program. The following paragraphs describe some of the ways in which actual savings are calculated across the country.

Conservation Targets and Evaluation Using a "Bottom-Up" Approach

In addition to providing guidance on how to estimate savings during development of a conservation plan, the 1992 manual (CUWA) also includes a component on evaluating the effectiveness of a conservation program. The manual emphasizes the need to develop an evaluation plan prior to plan implementation and provides steps to generate estimates of reliable water savings, program costs, and other conservation parameters that are used to evaluate demand reduction measures. The analytical steps of program evaluation presented include:

- Design of a plan for evaluating the implementation process of a conservation program;
- Design of an evaluation plan for determining the impacts of a water conservation program (i.e., the water savings); and
- Development of a long-term program for monitoring water use and conservation.

The manual acknowledges the cost of evaluation programs can be "very high," thus the expenditure must be justified by the knowledge acquired through the evaluation. For example, evaluation can establish the cost-effectiveness of water conservation programs so that a water supplier is able to define those investments that have been beneficial. An adequate evaluation enables conservation planners to determine the least-cost programs for achieving various levels of water savings and focus on those that are cost-effective. Evaluations can be interim, to provide information during implementation; final, which follow completion of a program (or at least its implementation); process, to address all elements and effects of the program other than its impact on water use; and impact, the measurement of savings in water use.

Methods included in the 1992 manual address how to evaluate conservation program effectiveness. The recommended evaluation process includes extensive surveys of the customer base or other water-user populations. Such surveys can provide a utility with information on the rates of adoption and retention of conservation measures. The objective of the surveys is to obtain feedback regarding the program, assess market penetration, and provide input for the impact evaluation. Three types of sample surveys of the target population are recommended for consideration:

1. Surveys of the target population;
2. Surveys of program participants; and
3. Surveys of program nonparticipants.

Mail surveys tend to be the least costly, but response rates can be very low, creating a greater chance for non-respondent bias. Telephone surveys typically allow the fastest results, but are more costly than mail surveys and, due to time constraints, can limit the number and complexity of questions asked. Personal interviews are the most costly of the three types of surveys, but there is much greater control over the selection of respondents and response rates tend to be the highest of the methods. A baseline survey provides the ability to compare results and may help refine conservation program goals and processes.

Finally, according to the authors of the 1992 manual, utilities must have estimates of reliable water savings, as well as potential benefits and costs of implementing a conservation program; thus, there is a need for greater focus and standardization in procedures for estimating water savings itself. It is often useful to design a water use modeling study prior to implementing a program to ensure data collection needs are accounted for. Several methods for estimating water conservation savings are available, and each has its advantages and disadvantages. The section entitled *Challenges to Estimating Water Conservation Savings* describes several items to consider when selecting a method.

The manual also recommends a long-term water use and conservation monitoring program, as described in *Monitoring Usage Trends*.

In addition to evaluation via surveys and monitoring water use, water savings are also calculated on a program by program basis and aggregated. Seattle Public Utilities has a rigorous evaluation process for its water conservation program. Consistent with the regional goal of reducing water use by 1 percent per year, Seattle has established a goal to reduce total water use by 1 percent annually. The utility examines the degree to which overall water use has declined each year as the overall measure of effectiveness. The analysis normalizes for the affects of weather and other external forces that could affect water use. On an annual basis they also complete "bottom-up" assessments, calculating water saving from programs that replace water using fixtures, as well as those that influence behavior (e.g., education). The sum of the savings from individual programs is the calculated overall savings volume. This calculation is confirmed through "backcasting", or comparing current use with what water use would have been in the absence of conservation programs (Saving Water Partnership, 2010).

A major effort to estimate actual water savings from specific individual conservation measures was undertaken by Water CASA from 2002 to 2005. The Water CASA study, *Evaluation and Cost Benefit Analysis of Municipal Water Conservation Programs*, was funded by the U.S. Bureau of Reclamation, the University of Arizona and other sources and involved extensive data and cooperation from 30 water utilities of varying size across the western U.S. The study set out to address the following issues:

- "…actual water savings for a given conservation measure was almost impossible to find."
- "With a few exceptions, after-the-fact assessment of water conservation measures is rarely done."
- "Estimating potential levels of water savings has often proved to be inaccurate."

The Water CASA study was based on comparative evaluations of water use for each of several measures, including water use audits, give-away programs, rebate programs, landscape conversions, rates and others. In each case (and for each utility involved in each of the specific programs evaluated), water use was compared between program participants and a control group (generally all other single-family water users for the utility). Participant water use was also compared before and after participation. Among the key findings from this study was that program savings differ widely from utility to utility and that savings were often (though not always) less than originally projected during program development. The results also appeared to demonstrate that the costs per acre-foot conserved tended to be greater for larger water systems and lower for smaller systems, potentially because larger providers were more likely to have already captured the easier (and less costly) conservation savings prior to the study period.

Conservation Targets and Evaluation Using a "Top-Down" Approach

In November 2009, the California legislature enacted Senate Bill X7-7, establishing a state-wide target to reduce urban per capita water use by 20 percent by 2020. Subsequently, the CDWR issued the 20 X 2020 Conservation Plan (February 2010) that established state-wide average per capita goals, as well as goals for each of 10 hydrologic regions within the state. The statewide per capita goal for 2015 is 173 gallons per person per day, and the 2020 goal is 152 gallons per person per day. The hydrologic regions reflect existing boundaries for integrated resource planning and state funding and not necessarily climactic regions. Each region has a unique target that considers baseline water use and other factors, including:

- Previous conservation efforts and additional best management practices that could be implemented;
- Community characteristics such as land use, condition of water distribution systems, socio-economic factors, and other utility profile elements; and
- Climate differences.

The plan does not establish goals for individual water suppliers, thus leaving some flexibility for water suppliers to establish specific per capita goals or use water budgets for determining supply-specific targets. However, similar to the existing requirement in Texas, each water supplier must establish 2015 and 2020 water use targets and report progress on achieving those targets either individually or on a regional basis. Key data determined to be necessary for evaluating achievement of the conservation targets are required to be collected and submitted. The appropriate state agencies are developing a streamlined data collection, storage and analysis protocol.

The plan identifies a three-phase implementation period to allow for interagency coordination and program "ramp up" and data collection. 20 X 2020 identifies a number of implementation strategies and actions designed to achieve the reduction goals. Evaluation processes will include monitoring implementation of the strategies and best management practices, as well as attainment or progress toward the per capita water use targets. Monitoring per capita goals will span multiple years to allow for normalization of external factors such as weather, economic conditions, etc.

The state of California will require implementation of conservation measures to receive state financial assistance for implementation of water resource management projects (e.g., new supplies and other strategies in the integrated water resource plans).

Senate Bill X7-7 identifies four ways in which to be compliant with the water use reduction targets. These include:

- Reduction to 80 percent of the supplier's baseline use;
- The sum of 55 gallons per day indoor residential use; efficient landscape irrigation standards applied to irrigated acreage within a provider's service area; and 10 percent reduction in industrial, commercial and institutional uses;
- Reduction to 95 percent of the regional target; and
- A "reasonable use" method developed by the CDWR.

The fourth compliance method, known as Target Method 4, is intended to provide flexibility in determining water use targets, while still establishing a consistent method for determining if individual water agencies and the state as a whole are meeting target 2015 and 2020 savings. This last compliance method was released in February 2011 as part of the *Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use* (CDWR 2011). In this document, CDWR provides technical methodologies and criteria to urban retail water suppliers for developing baseline and compliance water use. The methodologies adopted incorporate stakeholder input.

For Target Method 4, water savings are assumed between the baseline period, which is selected by the urban retail water supplier, and 2020 due to metering of unmetered water connections and achieving water conservation measures in three water use sectors: residential indoor; commercial, industrial, and institutional (CII); and landscape water use, water loss, and other unaccounted-for water. Water use in these three sectors is combined to estimate base daily per capita water use. Total possible savings is estimated by combining anticipated metering, indoor residential, CII, and landscape and water loss savings. Base daily per capita water use minus total savings is then the urban water use target. A Target Method 4 Calculator (Calculator), which employs an Excel spreadsheet, was developed for use with this method. The Calculator is required for some of the Target Method 4 calculations; other procedures may be accomplished without it but have been incorporated into the Calculator for the purpose of ease.

Indoor residential savings can be calculated using the Calculator or by using a default savings of 15 GPCD. CII savings is assumed to be 10 percent of baseline CII water use, and landscape water use and water loss savings are based on a 21.6 percent reduction in that sector for all water suppliers. Note that, because accurate methods are not generally available to estimate the water use in each of these three sectors, a standard of 70 GPCD was selected for current residential indoor water use. Further, CII water use does not include landscape irrigation use served by dedicated landscape irrigation meters; that is accounted for in the third sector. Only irrigation water use served by mixed use water meters is included in the CII estimate.

CDWR is required to update Target Method 4 by December 31, 2014. This requirement is based on the assumption that new data and improved analytical techniques will be available at that time (CDWR 2011).

Members of the study team have been previously involved in "top-down" evaluations of changes in municipal water use that sought to uncover the varied factors contributing to such changes. Both Denver Water and the Phoenix Water Services Department have experienced substantial, and persistent, reductions in water use per account and water use per capita over the past decade, and each utility commissioned research to better understand these changes for purposes of long-term planning.

From 1996 through 2001 (prior to a severe, two-year drought event), Denver Water customers used an average of 780 gallons of water per account per day. Since watering restrictions were lifted in August of 2004 ("post-drought"), Denver Water's customers have used an average of 636 gallons of water per account per day. Based upon econometric models involving individual, single-family customer water user records; assessor records for individual properties; monthly water use data for other customer classes; and service levels and other data sources spanning more than a decade, the study team developed estimates of the factors leading to the 18 percent reduction in water use. A

combination of price (rate) increases and natural replacement accounted for nearly half of the reduction in water use, while proactive conservation programs and changes in customer behavior resulting from the drought experience accounted for the remainder. These findings are summarized in Figure 3-1.

Figure 3-1.
Estimated Contribution of Alternative Factors to Post-Drought Reductions in Denver Water Usage per Account (2005-2008 versus 1996-2001)

Factors affecting use per account	Estimated ranges of possible effects	Best estimate*
Weather	2% to 3%	2%
Increased conservation and behavioral changes from drought	-7% to -14%	-11%
Price increases	-8%	-6%
Natural replacement	-2% to -3%	-3%
Total effect on use per account	**-15% to -22%**	**-18%**

Note: *The best estimates of savings from each factor reflect the reallocation of some savings attributed in the models to conservation and price increases to natural replacement and behavioral changes from drought (which are not explicitly modeled). It is also important to note that some factors likely interact with each other. For example, the recent drought experience of Denver Water's customers has likely enhanced the effectiveness of conservation public information efforts.

Source: BBC Research & Consulting, 2009.

The Phoenix study focused entirely on residential water use, which had declined by about 12 percent per account from the period of 1999 through 2002 to the period of 2004 through 2006. Contributing factors to the changes in water use in that city were statistically attributed to a combination of the rapid development of new homes with smaller lots and landscape areas, changes in landscaping preferences, reduced incidence of pools among newer homes, and increases in water prices, among other factors.

Challenges to Estimating Water Conservation Savings. Estimating actual savings from water conservation programs is challenging due to several factors, including external conditions, interactions among conservation measures, transferability of savings estimates from one program or end user group to another, and overall cost-effectiveness of a particular measure (i.e., the "water footprint").

External Conditions Affecting Program Evaluation. To determine program effectiveness from external factors, agencies that regulate electric utilities often require that the evaluation program design meets distinct requirements related to internal and external validity. Internal validity entails calculating program effectiveness while excluding the confounding effects of external factors (e.g., weather, price changes, etc.). External validity ensures the findings of the evaluation process can be generalized to similar conservation programs within the service area. Evaluation designs are often customized to particular programs rather than standardized to conform to current designs for similar programs.

Further, a number of factors can affect the validity of the evaluation process and conclusions about the effectiveness of conservation programs. Factors that threaten validity include (CUWA 1992):

- History or changes in the environment surrounding the program;
- Maturation caused by change in participant attitude over time;

- The "Hawthorne effect", or the act of sensitizing program participants to behave differently;
- Instrumentation or the effect of changing the calibration of the measuring instrument (e.g., "non-blind" data collectors);
- Regression-to-the-mean caused by choosing the participants on the basis of extreme measurements;
- Self-selection bias when program participation is voluntary; and
- Experimental mortality when program participants drop out of the program.

To control for the effects of the passage of time, the evaluation procedure should be designed to monitor nonparticipants, as well as program participants, both before implementation and after completion of the program.

The potential influence of external conditions was echoed in a January 2010, AWWA Water Conservation Division Subcommittee "Guidance Report" titled *Water Conservation Measurement Metrics*. The study suggests a utility seeking to develop a conservation program define benchmark values, or a value of a metric that denotes a specific level of performance intended for comparison purposes. Development of benchmark values for the level typically used in water conservation calculations (e.g., system-wide or sector-wide water use) is difficult since the aggregate metrics capture "other than efficiency" effects. Even though these values tend to be interpreted as an indicator of efficiency in water use, they are also reflective of the influence of other determinants of water use that are unrelated to efficiency. Climate and water rates are examples of externalities commonly encountered.

Interactions Among Conservation Measures. An additional challenge to understanding the effectiveness of a particular conservation measure involves the potential interactions among conservation measures. The combined conservation savings of two or more measures can be calculated as a fractional reduction in water use for each water use sector and dimension. There are three types of interaction effects: competitive, independent, and synergistic. The first results in water savings less than the sum of water savings from each measure when implemented alone. For example, a rebate program for installation of water-efficient irrigation systems may be expected to save a certain volume of water. When coupled with passage of outdoor water restrictions; however, savings from the efficient systems may be lower than they would otherwise be (e.g., watering occurs once per week rather than twice, thus overall savings are reduced). The second effect indicates their savings are strictly additive, such as water use efficiency from a cooling tower retrofit and installation of waterless urinals in a commercial facility. The third interaction occurs when two measures result in a combined savings that is greater than the sum of savings if the measures were implemented individually, such as might occur with installation of drought-tolerant plant materials and education on irrigation techniques. These effects should be estimated for an accurate program evaluation.

Transferability Among Communities. Water savings rates are not consistent across communities and time periods for many best management practices, as the typical planning practices and guidelines may indicate. In a 2005 study completed for the CUWCC, the authors suggest that careful thought should be given to factors that may limit the "applicability or generalizability" of cost and savings estimates developed by the studies used for conservation savings per measure. The ability to generalize the findings of a particular evaluation to other programs and consumer groups depends on whether the

evaluation design was capable of isolating and controlling for factors that could affect the magnitude of water savings. For example, the following elements may be area or utility specific (CUWA 1992):

- Characteristics of the evaluated program that could significantly influence the results of the evaluation;
- Characteristics of the customer groups targeted by the program that could also influence the results; and
- Characteristics that are external to both the program design and the targeted customer groups (e.g., weather, price, general economic conditions, etc.).

It is very difficult to determine which characteristics of the conservation program will preclude generalization of the evaluation findings.

Generally, one would expect metrics based on disaggregated demands (i.e., water use separated into sectors or user groups) to provide a better comparison of usage rates over time and a better means for evaluating actual savings from implementation of a particular conservation practice. However, in comparing single-family residential use across seven case studies, the AWWA 2010 report described large differences across the utilities, which reflect the effects of local climatic conditions and the influence of other factors, such as housing makeup, price of water, income, etc. Different utility definitions of multifamily structures and variations in the types of multifamily properties lead to large differences within this sector across utilities. Because the composition of user types in the nonresidential sector will differ greatly across utilities, the cross-utility comparison of these usage rates is likely not a valid evaluation method. Such differences are also likely to occur with respect to commercial, institutional and other water use sectors served by municipal providers.

Cost-effectiveness Considerations. The "perspective of analysis" (i.e., from whose perspective one is evaluating success or value) is one of several key factors that influence the evaluation of costs and water savings resulting from a water conservation program. Is the evaluation designed to determine savings for a particular end user, the utility, the region's water supply or the total "water footprint" of a conservation program? For example, measures that reduce water use but result in increased energy consumption could actually increase water use if water used for power generation is considered. Costs and savings could include those to customers, capital and operation and maintenance expenditures for conservation programs and utility delivery systems, program administration and implementation costs, as well as environmental costs. The evaluation could also include the energy savings from the costs of the conservation programs on a case by case basis (CUWCC 2005).

Chapter 246-290 of the Washington Administrative Code, known as the Municipal Water Law, establishes that water suppliers must implement water use efficiency measures. In addition to requiring suppliers to set goals, establish universal metering, and develop leak standards, the statute requires evaluation of the cost-effectiveness of conservation measures. Specifically, the analysis must evaluate the cost to the water system, customers and to society as a whole.

Metrics for Evaluating Conservation Program Effectiveness. The 2010 AWWA study presented various metrics to track water use and progress toward efficiency goals. Almost all metrics were determined to be best suited for making comparisons of water use within a single utility over time, rather than across utilities.

Several different metrics of aggregated water use can be defined by a utility. However, measures of system size, typically used to standardize these metrics, do not fully convey information on the intensity or average rate of water use. Possibly the most popular metric of aggregate use is use per person, usually expressed in gallons per capita per day (GPCD). When calculating per capita use, the volumes of water produced should be matched with the population served in the retail service area. Total population served is typically total year-round resident population within the retail service area, but different utilities use different definitions of population, accounting for seasonal or institutional populations in a variety of ways.

The Florida Department of Environmental Protection has established uniform methods for calculating per capita water use: Uniform Gross Per Capita and Uniform Residential Per Capita. These metrics of water use are used at the state, district, county and utility levels for water supply planning, water use permitting, financial assistance for conservation projects and annual reporting on water use by the five water management districts in Florida that regulate consumptive water use. These standardized measures address some of the utility profile (demographic and water use sector) differences among utilities; however, other differences such as use of domestic irrigation wells are not fully addressed.

Uniform Gross Per Capita is defined as:

$$\frac{\text{Utility Service Area Finished Water Use}}{\text{Utility Service Area Residential Population}}$$[1]

Uniform Residential Per Capita is defined as:

$$\frac{\text{Utility Service Area Finished Water Used by Dwelling Units}}{\text{Utility Service Area Residential Population}}$$

The districts use the standard conservation planning and savings calculation methodology and tool housed by the Water Conservation Clearinghouse, discussed in the "Available Conservation Calculation Tools" section (Walker, et al, 2009). (Note that Florida includes only treated or finished water in their calculations while many state include total water withdrawn from the source in their GPCD calculations.)

Using the number of water service connections is another measure of system size that can be used in lieu of population served; the advantage is that the data are available on a billing period and annual basis. The 2010 AWWA study determined this metric can be used for comparing year-to-year changes within a single utility, but is also inappropriate for inter-utility comparisons. One improvement to this value would be standardizing the definition to only include water deliveries to the retail area, which

[1] Utility Service Area Finished Water Use is the sum of finished water (withdrawals + imports –exports – treatment losses) used by all sectors served by a utility. Utility Service Area Residential Population is the number of dwelling units served, multiplied by an estimate of persons by household)

would exclude any wholesale sales and remove the effect of non-revenue water; further, wholesale deliveries and agricultural sales can be removed from total metered sales relatively easily. Another possible improvement would be to convert the total number of connections or accounts into the number of "equivalent connections" of single-family accounts. A weighting system for each sector is defined and converted. When comparing seven case studies in the report, the customer class definitions varied significantly between utilities, though, indicating another source of difficulty for comparison purposes. A conversion based on meter size could provide a more standard measure of equivalent accounts for systems with universal metering and if meter-sizing requirements are comparable.

In addition to population or water service connections, effectiveness of conservation could also be measured using other "units" or scaling variables, including number of housing units, number of employees, acreage of irrigated areas, square footage of nonresidential buildings, and other measures of size for specific sectors of water users.

Seasonal and non-seasonal use is another way to assess water use trends. In the residential sector, nearly all seasonal use is outdoor use; non-seasonal use is assumed to be relatively constant throughout the year, even though that may not the case (e.g., water for cooling the interior for a building during summer or cleaning concrete with water in the winter). Metrics of seasonal and non-seasonal use could indicate a reduction of discretionary water uses for landscaping and other outdoor uses, although seasonal population changes should be factored into the calculation.

Utilities consider other metrics for determining program effectiveness, as well. Georgia's Water Conservation Implementation Plan suggests several ways to measure effectiveness of water conservation plans. Acknowledging the difficulty in calculating water used for landscape irrigation, the Implementation Plan suggests using a peak to average use ratio to gauge the effectiveness of education, watering restrictions and other non-quantifiable conservation practices. For industrial and commercial users, they suggest developing a "water intensity" measure such as gallons per unit produced (e.g., gallons per square foot of carpet dyed). Other metrics of program effectiveness include those identified in the Lower Colorado River Authority Strategic Conservation Report, such as the number of program participants, seasonal reduction, training sessions attended, cost per gallon saved and other metrics in addition to aggregate or per capita water savings.

In addition to establishing metrics for evaluating conservation savings, standard calculations that normalize external factors would ensure water use metrics are comparable at different time periods for a single utility (or potentially across utilities). For single utility comparisons, normalizing factors would incorporate weather and socio-economic conditions; further, the elasticities that are used should reflect the responsiveness of water use to changes in the values of determinants of water use. Elasticities will vary by sector and should be obtained from studies conducted within the service area; generalized values are available in literature if necessary. Metrics for cross-utility comparison would need to ensure all external factors that influence the quantity of water used, but are outside the control of water users, are somehow accounted. Normalizing for weather and other factors across different utilities is problematic; the best approach may be to derive a benchmark value of a metric for each utility and divide the weather-normalized value of the metric by a theoretical value of the benchmark.

Thus, a practical approach to developing metrics for comparing water use efficiency across utilities would be to use metered account-level information for homogeneous groups of customers and the same dimensions of water use (i.e., total annual, seasonal, non-seasonal), then convert the values of the calculated metrics into ratio benchmarks for each utility before making a comparison. Benchmarks include water loss indices, indoor conservation indices, and outdoor conservation indices.

Further Research Recommended. The recommendations resulting from the AWWA study (2010) include the adoption of a standard set of customer types and customer classification procedures, and these would be enhanced further with the acquisition and maintenance of data typically not collected for each customer.

In the study done for the CUWCC (2005), the following list was developed by the authors to emphasize the subjects requiring further research:

- Savings decay over time;
- "Free rider" and "spillover" effects;
- Discount rates;
- Natural replacement rates;
- Device saturation rates;
- The effects of key program design variables like timing, scale, and targeting;
- The types and amounts of costs utilities avoid by implementing conservation programs; and
- Expressing program benefits in dollar terms.

Available Conservation Calculation Tools

A number of entities have developed tools to estimate water use reduction as a result of conservation programs (for both planning and evaluation purposes) for widespread use. This section describes some recently developed tools available to the public.

New Mexico's Gallons Per Capita Per Day Calculator. In 2009, the New Mexico Office of the State Engineer developed a standardized methodology for calculating water use per person per day to be used for reporting purposes. The methodology was intended to track municipal water use over time and to provide the utility with a categorized baseline of historical and current water use. The methodology is required as part of certain applications and mandated water use reporting. The methodology is called the Gallons Per Capita Per Day Calculator, and can be found on the New Mexico Office of the State Engineer website.

New Mexico's method uses specific attributes pulled from the most recent U.S. Census and data provided by the utility using the tool. Data from the U.S. Census required includes number of persons per household, vacancy rates, and group quarters' population. This is combined with the utility's data on the number of single-family residential connections and multi-family residential units

to determine a population served. The utility also provides the total volume of water diverted and the volume delivered to specific sectors. Sector gallons per capita per day are calculated by dividing that sector's use by that sector's population (e.g., single-family residential populations into single-family residential gallons delivered). Sectors without a defined population (e.g., industrial) use the system total population. The system total gallons per capita per day value is calculated by dividing total supplied to the system by total population.

The following is a list of data that the utility will need to collect to use the Calculator. Not all data will be required for each case; the user manual provides information on default values and other model responses to incomplete data.

- Total gallons of water diverted to the system.
- Volume of water imported and/or exported by system.
- Total gallons of water delivered to sectors: single-family residential; multi-family residential; industrial, commercial and institutional; and other metered.
- Number of single-family connections (total or active) served by drinking water supplier.
- Number of multi-family units served by drinking water supplier.
- Data retrieved from the most recent US Census.
  - Number of persons per household for area of state serviced by supplier.
  - Occupied status of housing units (Occupied and Vacant).
  - Group Quarters' population.
  - Total gallons of water reused.

With the results, trends can be identified to estimate upper and lower boundaries for each sector; these boundaries provide goals for both annual and monthly water use. In addition to tracking water conservation programs, the baseline boundaries provide information for water use projections. The baseline information can be used in combination with localized population projections to project water needs by sector and by season.

IWR-MAIN. The IWR-MAIN, or the Institute for Water Resources – Municipal and Industrial Needs, water use forecasting system employs a computerized forecasting model. The model was developed in 1988 by the U.S. Army Corps of Engineers. While the model is generally used for water demand forecasting and economic impact analyses, it can be used by a water supplier to estimate water use with and without conservation.

In the model the average daily water use is a function of the price of water and sewer service, market values of housing units (in residential categories), persons per housing unit (in residential categories), weather conditions or climate (in residential categories), the type of conservation program to be examined, the number of users, and the number of employees (in nonresidential categories).

Residential water use is estimated using equations that utilize a combination of price, housing unit value (a surrogate for income and the stock of water-using appliances), household size, and weather conditions as explanatory variables. The estimating equations were selected after reviewing more than 50 empirical studies of residential water demand.

Non-residential uses are disaggregated into as many as 280 categories within the three major sectors (i.e., industrial, commercial/institutional, and public/unaccounted). Different values of price elasticities derived from the literature are applied to manufacturing and commercial/ institutional sectors. Water use coefficients representing average use rates were derived from a nationwide survey. The model contains a procedure for estimating the effectiveness of up to 18 different conservation measures; conservation parameters were obtained from literature.

The preparation of an IWR-MAIN water use forecast requires verification of the empirical equations and coefficients for estimating water use and projection of the future values of determinants of water use. Model verification is accomplished by preparing independent estimates of water use for one or more historical years and comparing these estimates with actual water use conditions.

Alliance for Water Efficiency Water Conservation Tracking Tool. In 2010, the Alliance for Water Efficiency developed an Excel-based spreadsheet tool for evaluation water savings, costs, and benefits resulting from a water conservation program. The tool provides users a standardized methodology for water savings and benefit-cost accounting. The tool includes a library of predefined, fully parameterized conservation activities from which users can construct their own conservation programs; the library was developed from end-use studies developed by numerous entities, compiled for this purpose.

According to the user manual, "It was the Alliance's intention to provide a tool that utilities could adapt to a wide variety of user situations, regardless of geographic location, water system size, or extent of previous conservation program experience…This generic framework utilizes several key assumptions and simplifications…" Note there are currently three North American editions of the tool: the standard North American, a CalTex version (the tool is geared to Texas and California based on these states' specific regulatory requirements), and a Georgia version.

The tool evaluates conservation program costs and benefits from three perspectives: a utility, a program participant, and society. The tool also disaggregates water savings three different ways: by water user classification, between system peak and off-peak periods, and between program-related and code-related water savings. The tool is user-input intensive, with a great deal of data required.

Conserve Florida Clearinghouse EZ Urban Water Conservation Guide. The University of Florida serves as a clearinghouse for conservation resources in Florida. In 2009, they updated a conservation planning tool (the "EZ Guide") and published a users' guide, which is available to utilities throughout the state. The tool provides a means for utilities to calculate potential water savings and evaluate best management practices for inclusion in conservation plans. The tool provides an easy framework to input utility profile information, water production and use data (e.g., billing information), and historical and projected population data. It produces results of gross and residential per capita data that serve as the baseline against which to measure the potential effectiveness of future conservation measures.

In addition to the utility profile, the EZ Guide provides the means for a utility to perform a desktop audit of water use. If an independent audit has been conducted, results can be input into the tool.

The tool distinguishes conservation practices into non-quantifiable "measures" and quantified "best management practices". Conservation measures include factors such as universal metering, having a conservation coordinator, conservation rate structures and other similar measures. Best management practices include those practices that have quantifiable savings, such as replacing toilets, washing machines and other water-using fixtures. Estimated savings and costs per retrofit are provided in the tool from end-use studies. The savings potential is driven by the utility profile and annual investment in the best management practice. The tool allows the utility to develop various scenarios and combinations of practices and measures that would result in the desired savings goal, measured as reductions in per capita usage.

ECoBA Interactive Calculator. In addition to the *Evaluation and Cost Benefit Analysis of Municipal Water Conservation Programs* report described earlier in this section, the 2002 to 2005 Water CASA study produced an Excel workbook designed to assist utilities in evaluating the actual water savings, costs and cost-effectiveness of individual water conservation measures. The workbook, however, requires the user to perform extensive data collection and analysis prior to its use.

Required inputs for the water savings component of the workbook include:

- Participant average annual water use two years before through two years after the measure was implemented.
- Control group average annual water use two years before through two years after.
- Lifespan of the conservation measure (from a standard list in the workbook or as specified by the user).
- Number of participants being analyzed.

Required inputs for the cost effectiveness component of the ECoBA Interactive Calculator include:

- Discount rate (from a list or as specified by the user).
- Rate of inflation (from a table of consumer price index values or as specified by the user).
- Cost for the year (exact cost for the number of participants included).
- Average water rates over time (per 1,000 gallons).

The workbook provides some standardized data to assist users in evaluating cost effectiveness, including estimated lifespans for conservation savings from a number of different conservation measures; Office of Management and Budget discount rates to assist in present value calculations; and a table of consumer price index values to help adjust for inflation. These factors can also be specified by the user.

Target Method 4 Calculator. As discussed in the "Conservation Targets and Evaluation Using a 'Top-Down' Approach" section, CDWR has developed the Target Method 4 Calculator to implement the fourth method available to entities in defining water use reduction targets. The calculator is Excel-spreadsheet-based and estimates savings that would result from retrofit of

inefficient indoor residential fixtures; from increased efficiency in the commercial, industrial, and institutional sector; and from conversion of unmetered connections to metered connections.

Entities can find the information required to populate the calculator's data input fields from state-mandated reporting requirements (best management practice and demand management measure reports, urban water management plans, and public water supply survey records), the California Department of Finance and the Bureau of the Census. *Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use* provides the methodology to be used in developing baseline water use (both a five-year and 10-15-year continuous period), expressed in GPCD; total service area population; and baseline use by commercial, industrial, and institutional accounts.

The calculator uses natural turnover and historical retrofit data to estimate the saturation level of high-efficiency indoor residential fixtures at the midpoint of a supplier's baseline. The calculator then estimates how much water would be saved if the high-efficiency fixture saturation rate was increased to certain specified saturation goals. Entities that already have a high percentage of high-efficiency fixtures would be required to install fewer efficient fixtures to reach the saturation goal (thus will have a smaller savings requirement) than those that do not.

Savings as a result of metering non-metered accounts are based on the CUWCC estimate of savings, estimated to be 20 percent of deliveries to unmetered connections. Savings available through commercial, industrial and institutional accounts are set to 10 percent of the associated baseline use, a standard that comes from Target Method 2, specified in SBx7-7.

Summary

The team's review of guidance documents and studies conducted outside of Texas confirms the challenges involved in evaluating water conservation programs that were identified in previous reports and studies within the state. Data requirements and survey needs required to develop valid results for evaluating specific conservation measures are extensive. Funding for such evaluations is typically a lower priority than funding for the conservation program itself. Both top-down and bottom-up approaches can be limited by data needs. Numerous other challenges exist to obtaining valid data to use in an evaluation, even when funding is available. Some organizations have developed tools to aid in the evaluation of conservation programs, but the tools produce answers only as good as the data used to develop those answers. Water suppliers should incorporate data collection and evaluation efforts into their conservation program at the planning stage, when funding is secured, not only to demonstrate the cost effectiveness of their programs, but to also provide empirical data to improve actual water savings from conservation practices as a whole.

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SECTION 4.
Analysis of Municipal Provider Conservation Plans and Annual Conservation Implementation Reports

Wholesale water providers and retail providers serving more than 3,300 connections are required to file water conservation plans (WCPs) with the TWDB. Beginning in 2010, the providers are also required to submit an annual water conservation implementation report (AR). During Task 4, the study team reviewed a sample of the WCPs filed by retail providers and the initial round of ARs filed by the same providers.

Working with the TWDB, the study team identified a target sample of 100 providers for this task. The sample included a stratified selection of small, medium and large municipal water providers across Texas. We obtained electronic copies of provider WCPs and ARs from the TWDB, analyzed their content, and created databases that identified the providers' water conservation measures, water savings estimation methods and data sources, and the specific water savings estimates for each provider (where available).

The analysis of WCPs and ARs allowed a systematic examination of how different water providers throughout Texas assessed conservation. This analysis also provided information to assist the study team in identifying specific providers for additional research in Task 5.

This section of the report describes the selection of the sample of water providers studied and the analysis of the conservation plans and annual reports.

Sample Selection

The following steps were used to select the providers for the target sample.

- The study team obtained a list of all municipal retail providers that had filed WCPs and ARs with the TWDB.

- We included in the sample all large providers that served a population of over 100,000 and had filed a WCP or an AR with the TWDB, as well all providers that were among the 10 largest municipal water providers in the state (even if the TWDB did not have a current WCP or AR on file for them).[1] As a result, a total of 25 large providers were included in the sample.

- The study team also selected a roughly equal balance of medium-sized providers (serving 25,000 to 99,000 residents) and small providers (serving fewer than 25,000 residents) to

[1] Although some of the largest utilities did not have ARs or WCPs on file, we included them to allow for the possibility of conducting interviews with them during Task 5.

fill out the rest of the sample. Where possible, we randomly selected two providers from each of these size categories in each region. In some cases the regions had only one (or no) providers in one of these size categories.

- To complete the sample, the study team randomly selected additional medium-sized and small providers across the state.

Figure 4-1 summarizes the characteristics of the sample of WCPs reviewed during Task 4. Two of the largest municipal providers that were included in the target sample did not have a WCP on file with the TWDB. The relatively large number of providers sampled from Region C reflects the numerous municipal water systems in that region. (Overall, 64 of the total of 193 WCPs across Texas contained in the TWDB's records were from Region C providers.) Only one provider each was included from regions B, J and P because only one retail municipal provider in each of those regions had filed a WCP with the TWDB.

Figure 4-1. Characteristics of Provider Sample

Note:

Two of the 100 providers in the target sample did not have a WCP on file with the TWDB.

Region	Number of Providers
A	3
B	1
C	35
D	5
E	2
F	4
G	10
H	15
I	3
J	1
K	3
L	8
M	2
N	2
O	3
P	1
Total	**98**

Service Area Population	Number of Providers
Under 10,000	8
10,000-24,999	30
25,000-99,999	37
100,000+	23
Total	**98**

Figure 4-2, on the following page, provides a list of all of the providers included in the sample for review of WCPs and ARs. This sample also provided the basis for selecting providers for telephone interviews and data collection in the following task (Task 5).

Figure 4-2.
Providers Studied in Task 4

Municipal Water Providers		
Abilene	Flower Mound	Marshall
Addison	Forney	Mesquite
Amarillo	Fort Bend	Midland
Andrews	Fort Worth	Military Highway
Aqua WSC	Frisco	Mineral Wells
Arlington	Garland	Murphy
Austin	Georgetown	Nederland
Bay City	Grand Prairie	Odessa
Bexar Metropolitan	Green Valley	Palestine
Boerne	Harker Heights	Paris
Borger	Harris Co. MUD #55	Pasadena
Brownfield	Harris Co. WCID #36	Pearland
Brownwood	Hewitt	Plano
Burkburnett	Highland Park	Port Arthur
Burleson	Horizon Regional MUD	Portland
Canyon	Houston	Rockett SUD
Carrollton	Humble	Rockwall
Cash SUD	Huntsville	Rosenberg
Cedar Hill	Hurst	Rowlett
Cedar Park	Kerrville	San Antonio
Coppell	Kilgore	San Benito
Copperas Cove	Killeen	San Marcos
Corpus Christi	Lake Cities	Schertz
Dallas Co. WCID #6	Lake Jackson	Sherman
Dallas Water Utilities	Lakeway MUD	South Houston
Deer Park	League City	Southern Utilities
Denton	Levelland	Springs Hill Water Supply Corp.
De Soto	Lewisville	Stephenville
Duncanville	Little Elm	Texas City
East Central SUD	Livingston	Waco
El Campo	Longview	Waxahachie
El Paso	Lubbock	Wylie
Euless	Mansfield	

Analysis of Information from Provider WCPs

The water conservation plans describe existing and planned conservation measures, and provide basic information on how providers intend to track the effectiveness of their conservation programs over time.

Conservation Measures. The WCPs vary in terms of how clearly they distinguish between existing conservation measures and measures that the providers plan to implement in the future. All of the providers in the sample metered their customers' water use, and all had some form of leak detection program for their transmission and distribution systems. Each provider in the survey also had some form of education and outreach program, although the focus and intensity of these programs varied.

Adoption of other types of conservation measures differed substantially from provider to provider. Eighty percent of the providers in the survey have implemented (or intend to implement) water conservation-related ordinances, such as prohibitions on wasting water or time-of-day watering restrictions. More than one-third of the providers had some type of water reuse system. About a quarter of the surveyed providers conduct irrigation audits, either by targeting high water users or upon customer request. Eighteen percent of the providers offered some type of rebate program, with toilet rebates being the most common.

Figure 4-3 summarizes the conservation measures identified in the WCPs of the sample providers.[2] Although water rates and rate structures are not shown in the figure, most of the WCPs (90 of 97) discussed the provider's existing rate structure and 62 of the 97 providers (64 percent) had adopted a conservation-oriented, inclining block-rate structure.

[2] Note that the City of Humble's WCP did not contain information on conservation measures, only a utility profile.

Figure 4-3.
Summary of Conservation Measures from Provider WCPs

Conservation Measures	Number of Plans	Percent of Total (97)
Metered use	97	100%
Leak detection	97	100%
Education and Outreach		
School programs	63	65%
Public Service Annoucements	68	70%
Bill inserts	75	77%
Conservation web page	61	63%
Other	82	85%
Any education/outreach	97	100%
Rebates		
Washing machine	8	8%
Toilet	13	13%
Other plumbing fixtures	10	10%
ET controllers	4	4%
Rain gauge	2	2%
Other	9	9%
Any rebate	17	18%
Irrigation Audits		
Identify customers	18	19%
On request	6	6%
Any irrigation audit	22	23%
Conservation ordinances	78	80%
Reuse		
Industrial	23	24%
Landscape	28	29%
Rainwater	1	1%
Any reuse program	34	35%

Note: City of Humble WCP did not include conservation measure information.
Source: Sample of Water Conservation Plans on file with the TWDB, 2010.

Tracking Conservation Effectiveness. Almost 80 percent of the WCPs directly discuss tracking the effectiveness of their conservation programs. About two-thirds of the providers examined in this task plan to measure effectiveness through quantitative methods. Most commonly, providers discuss this issue as part of their "record management system."

In many cases, plans to track conservation effectiveness are not very specific. Typically, provider plans indicate they intend to track GPCD, unaccounted-for water and other system-wide statistics. Plans often reference annual reporting requirements, and their intention to complete annual implementation forms.

A handful of the plans qualify this approach to measuring the effectiveness of their program only during periods of "normal" weather. The WCPs do not discuss how to account for weather, natural replacement and other factors that might lead to differences in GPCD over time.

Analysis of Information from Provider ARs

In 2009, for the first time, municipal providers required to submit WCPs were also required to submit an AR. The ARs, along with the WCPs, provide important data for evaluating municipal conservation efforts.

The AR requests basic data from the providers, including their most recent estimates of water use, population and water losses. It also requests information focused on the providers' conservation programs. Providers are asked to rate the effectiveness of their conservation programs, to specify an estimate of the amount of water and dollar value they saved in the most recent reporting period, to state the five- and ten-year goals for their conservation program and to document their spending on conservation activities.

Self-evaluation. Over 80 percent of providers rated their conservation programs as "effective" or "somewhat effective." Most others indicated they "do not know." These results varied by provider size, with larger providers being more likely to give their conservation programs an effective or somewhat effective rating, and smaller providers more likely to indicate they did not know (or to leave the answer blank).

Conservation Savings Estimates. The ARs also provide estimates of water savings in the "most recent period" due to conservation. Generally, this was interpreted to mean savings during 2009. During subsequent interviews in Task 5, there was some variation in terms of the baseline year used for comparison and there was considerable variation in terms of what types of savings were included in response to this question (discussed further in the Task 5 report section).

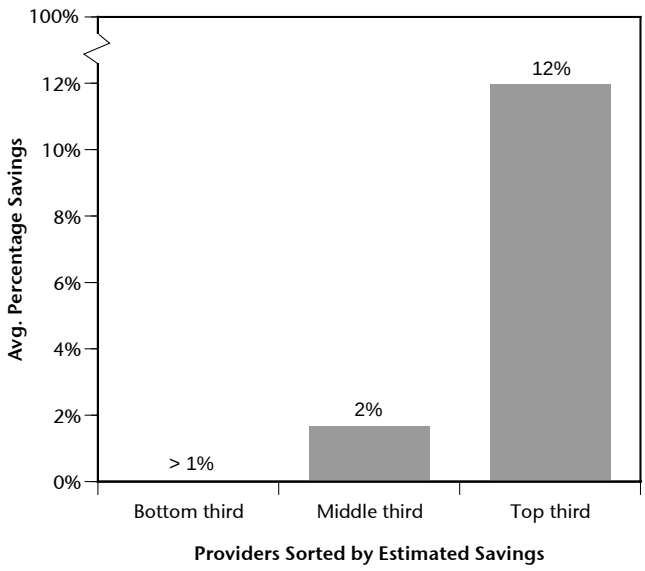
More than two-thirds of the ARs for the water providers in the study sample (67 out of 95 providers in the sample completed an AR) provided an estimate of their conservation savings. In some cases, the reported savings were zero. The mean estimated savings from conservation (for the 67 providers that answered this question) was 4.9 percent of total treated or diverted water supply in 2009. The median savings for these providers was lower, at 2.1 percent.

There was a large amount of variation in estimated water savings due to conservation. The top one-third of the providers (in terms of estimated percentage savings) reported savings that averaged nearly 12 percent of 2009 water use. The middle one-third reported savings that averaged less than 2 percent, while the bottom one-third reported savings of 0 percent, or nearly 0 percent, of annual water use. Figure 4-4 summarizes these results. There was no discernable correlation between the size of the provider's water systems and the magnitude of the estimated percentage savings due to conservation.

Figure 4-4.
Percentage Water Savings Due to Conservation (For 67 providers that Answered this Question)

Source:

Sample of 2009 Annual Water Conservation Implementation reports on file with the TWDB.



Conservation Goals. The ARs also request a summary of the five- and 10-year conservation goals for the providers in per capita (GPCD) terms. The study team compared the reported conservation goals to water use over the most recent five-year period from the providers' utility profiles in the ARs or to their historic use from their WCPs. For 65 of the 95 providers who submitted a complete AR in 2009, the 10-year goal in GPCD is lower than their historic, five-year average use. Among those 65 providers, the 10-year goal will require, on average, an 11 percent reduction from their historic use (in terms of GPCD).

Figure 4-5 depicts the providers' water conservation goals relative to their historic use. Mid-sized providers (serving 25,000 to 99,999 residents) appear to have the most aggressive conservation goals relative to their historic use. Negative numbers in Figure 4-5 indicate that the average future GPCD goals for the group are lower than their actual use over the most recent five year period, positive numbers indicate that the average GPCD use over the most recent five year period is lower than the future GPCD goal.

Figure 4-5.
Water Conservation Goals Relative to Historic Use

System Size (Population)	All 95 Providers Change in GPCD*			10-yr Goal < Historic Use Change in GPCD*		
	Number	5-yr Goal	10-yr Goal	Number	5-yr Goal	10-yr Goal
100,000+	20	1%	-2%	13	-5%	-8%
25,000-99,999	40	-1%	-4%	26	-10%	-13%
Less than 25,000	35	4%	0%	26	-6%	-10%
Overall	**95**	**1%**	**-2%**	**65**	**-7%**	**-11%**

Note: *Based on GPCD goals relative to average over most recent five year period from utility profiles.

Conservation Spending. Of the 95 providers with a complete AR on file, 59 responded to the question regarding conservation spending during 2009. For purposes of analysis, the study team converted these estimates into spending per capita based on system size.

The average (mean) spending on conservation in 2009 was $6.23 per resident served by the water system. Weighted by system size, the average was $4.39 per capita. However, these mean estimates of spending per capita are heavily influenced by a few utilities reporting large conservation expenditures. Median expenditures on conservation were much lower ($0.23 per capita).

Figure 4-6 depicts the annual water conservation spending per capita among the 59 providers responding to this AR question. In general, providers that spend more (per capita) on their conservation programs appear more likely to consider them to be "effective."

Figure 4-5.
Annual Water Conservation Expenditures per Capita Served

Source:
Sample of 2009 Annual Water Conservation Implementation reports on file with the TWDB.

		Spending per Capita	
Program Self Evaluation	**Number**	**Mean**	**Median**
Effective	22	$14.09	$0.48
Somewhat Effective	31	$1.64	$0.10
Less than Effective	1	$0.16	$0.16
Not Effective	0		
Do Not Know	5	$1.26	$0.13
Overall	**59**	**$6.23**	**$0.23**

Summary

During Task 4 the study team identified a target sample of 100 retail municipal water providers based on system size and region and reviewed the providers' WCPs and ARs. The analysis helps identify the most commonly selected types of conservation measures and provides limited insight into how providers are tracking (or intend to track) the effectiveness of their conservation efforts. Based on the initial round of AR filings, at least 80 percent of municipal providers consider their conservation programs to be either "effective" or "somewhat effective." Smaller providers are more likely than larger ones to indicate they do not know how effective their programs are.

The initial round of AR filings includes a wide range of estimated savings from conservation programs. The average estimate of water saved due to conservation programs during the reporting period (2009) was almost 5 percent of total water use; the median was about 2 percent. Many providers reported zero, or near zero, savings or left their response to this question blank. Based on subsequent interviews with many of the providers (described in the following section), AR respondents interpreted this question, and approached the problem of how to estimate their conservation savings, in a variety of different ways.

SECTION 5.
Interviews and Additional Data Collection from Municipal Water Providers in Texas

During Task 5, the study team conducted interviews with 43 municipal water providers across Texas to gather further information regarding their approaches, and the challenges they face, in seeking to estimate the savings achieved by their conservation efforts.

Interview Guide

The study team developed an interview guide to help structure the interviews with the municipal providers. The draft guide was reviewed by the TWDB and the municipal representative to the Water Conservation Advisory Council and modified based on their comments. The interview guide was used to provide general direction during the interviews. It was not, however, treated as a strict "survey" and the discussions with the providers varied in terms of the level of detail devoted to each topic and sometimes ventured into other, related topics of interest.

The interview guide essentially covered three major topic areas:

- **Estimating water conservation savings achieved to date** — providers were asked how they had responded to the first question in the TWDB's Water Conservation Annual Report (AR) questionnaire. That question requested the amount of water the entity estimated to have saved during the reporting period (2009) due to their overall conservation program. This portion of the provider interviews sought to determine the methods used by the providers to estimate savings, what types of conservation savings were (and were not) included in their estimates, what data the providers were using as a benchmark for comparison, and how confident they felt about their estimates.

- **Five- and 10-year conservation goals** — in the second segment of the interviews, providers were asked how they had established their conservation goals and whether they were on track to meet those goals. They were also asked about the overall importance of conservation savings for their utility and whether they had developed projections of future savings based on specific planned conservation measures. Finally, they were asked whether they felt that development of standardized approaches to estimate savings and track progress was an important and worthwhile objective.

- **Ideas for potential TWDB tools and methods** — in the final portion of the interviews, the providers were asked for their ideas concerning potential tools and approaches to track and estimate conservation savings. In particular, they were asked whether they felt that "top-down" approaches (based on total water use or GPCD, with appropriate adjustments) or "bottom-up" approaches (based on evaluations of individual conservation measures) were most appropriate for the purpose of tracking and estimating savings. They were also asked what factors, other than conservation efforts,

affected their customers' water use and should be taken into account in developing appropriate tools and methods for quantifying conservation savings.

At the conclusion of each interview, the providers were asked whether they would be willing to serve as part of a stakeholder review group and provide feedback on the draft version of this report. All providers interviewed indicated willingness to assist in that capacity.

A copy of the complete interview guide is provided in Appendix A.

Sample of Providers Interviewed

As discussed in Section 4 of this report, the initial sample of municipal providers selected for interviews was identified using information contained in the provider Water Conservation Plans (WCPs) and ARs. The initial target sample included providers that had provided a quantitative response to the AR question regarding estimated conservation savings discussed previously (even if that response was an estimate of zero savings) and that had a 10-year water use goal (in GPCD) that was lower than their historic average use. The latter criterion was considered an indicator of providers that might have more active water conservation programs. Forty-six of the 95 water providers whose WCPs and ARs were analyzed in Task 4 met both of these criteria.

The study team was able to contact and interview 36 of the 46 entities initially targeted for interviews. To increase our interview sample, we subsequently contacted and interviewed an additional seven water providers. These providers were also selected because they reported a quantitative estimate of conservation savings in their AR, but generally did not have 10-year water use goals less than their historic average.

The providers interviewed in Task 5 included the following entities:

Municipal Water Provider	Municipal Water Provider	Municipal Water Provider
Abilene	East Central SUD	Lewisville
Addison	El Paso	Longview
Amarillo	Fort Worth	Midland
Aqua WSC	Frisco	Mineral Wells
Arlington	Garland	Murphy
Austin	Georgetown	Odessa
Borger	Grand Prairie	Pasadena
Brownwood	Harker Heights	Plano
Canyon	Horizon Regional MUD	Portland
Cash SUD	Huntsville	San Antonio
Cedar Park	Kerrville	San Benito
Corpus Christi	Lake Jackson	San Marcos
Dallas Water Utilities	Lakeway MUD	Schertz
Deer Park	League City	Springs Hill Water Supply Corp.
Denton		

Figure 5-1 provides descriptive statistics for the sample of municipal providers interviewed by the study team. The sample included providers from 12 of the 16 planning regions in Texas. The interview sample included the majority of the large water providers (serving over 100,000 people) whose WCPs and ARs were analyzed in Section 4. (17 out of 23 providers). The interview sample also included 16 of the 37 medium size providers (serving between 25,000 and 99,000 people) whose WCPs and ARs were analyzed. A relatively small proportion of the smallest providers (utilities serving less than 25,000 people) was interviewed during Task 5 because most of the smaller providers did not provide estimates of their conservation savings in their ARs. However, the study team did complete interviews with 10 small providers.

Relative to the overall sample of utilities whose ARs and WCPs were reviewed in Section 4, the providers interviewed by the study team were more likely to have evaluated their conservation programs in their ARs as "effective" or "somewhat effective" and less likely to have evaluated them as "less than effective" or to indicate that they did not know. Likely this result reflects the fact that providers who indicated they did not know whether their conservation programs were effective were also likely to have not attempted to report estimated conservation savings from those programs in their ARs (and consequently were not targeted for the interviews).

Figure 5-1.
Overview of Sample of Municipal Water Providers Interviewed

	Number of Providers		
		Interviews	
Region	Overall	Target	Completed
A	3	2	3
B	1		
C	35	16	13
D	5	3	1
E	2	1	2
F	4	2	3
G	10	2	5
H	15	7	5
I	3		
J	1	1	1
K	3	2	2
L	8	6	5
M	2	2	1
N	2	1	2
O	3	1	
P	1		
Total	**98**	**46**	**43**

	Number of Providers		
		Interviews	
Service Area Population	Overall	Target	Completed
100,000+	23	13	17
25,000-99,999	37	20	16
Under 25,000	38	13	10
Total	**98**	**46**	**43**

	Number of Providers		
Conservation Self		Interviews	
Evaluation	Overall	Target	Completed
Effective	28	17	14
Somewhat Effective	50	25	24
Less than Effective	4	1	0
Do Not Know	13	3	2
No Data			3
Total	**95**	**46**	**43**

Note: There was no data regarding the self-evaluation of conservation program effectiveness for Corpus Christi or El Paso because they did not file ARs in 2009. Mineral Wells did not provide a response to that question in their 2009 AR.

Source: BBC Research & Consulting, 2011.

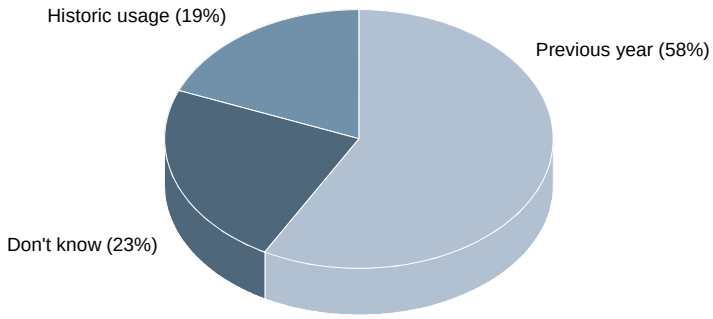
Analysis of Interview Responses

The study team analyzed responses for each of the three main topic areas covered in the water provider interviews.

Estimating Water Conservation Savings Achieved to Date. About 60 percent of providers estimated annual conservation savings using the previous year (2008) as a baseline. About 20 percent used broader historic usage as a baseline. Examples of historic usage included comparison to five-year GPCD trends, comparison to a similar recent weather year, comparison to 10-year averages of water usage prior to conservation plan implementation, and a 30-year time series econometric model. The remaining 20 percent of interviewees reported that they were unsure of the baseline used for estimating savings from conservation. Figure 5-2 illustrates these results.

Figure 5-2.
Baseline year for conservation savings

Source:
BBC Research & Consulting interviews with water providers, May-June 2011.



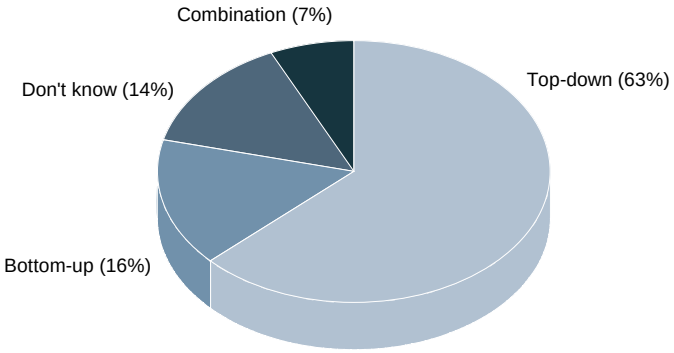
Over 60 percent of providers used a top-down approach to arrive at annual conservation savings. Top-down approaches generally compared annual GPCD or annual water loss totals to the providers' chosen baseline. While most water providers noted that weather, population growth, and economic activity were important factors in annual water usage, few providers attempted to account for these factors when estimating conservation savings using top-down approaches. Approximately 25 percent of the providers interviewed simply compared GPCD from the current year to GPCD in the previous year to estimate their conservation savings. Another 15 percent of the respondents just compared total water sales or production (or recycled water sales) from the current year to the previous year to estimate conservation savings.

Approximately 16 percent of providers took a bottom-up approach to arrive at annual conservation savings. These water providers attributed water conservation to certain conservation measures and aggregated these values to arrive at a total amount saved for the year. Rebate programs, tiered rates, irrigation restrictions, reused water, and system loss aversion were examples of conservation measures included in bottom-up approaches to estimating annual conservation savings.

Less than 10 percent of providers used a combination of bottom-up and top-down approaches to arrive at a final estimate of conservation savings with the remaining 14 percent unsure of the approach used to estimate annual conservation savings. Figure 5-3 presents these results.

Figure 5-3.
Approach for savings estimation

Source:
BBC Research & Consulting interviews with water providers, May-June 2011.

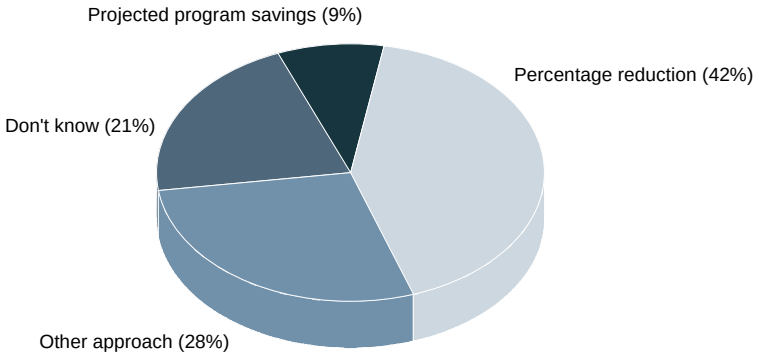


About half of the interviewees said that their annual conservation estimate was reasonably or very accurate. One quarter said that the estimate was the best guess possible given available data. The remaining 25 percent either did not have much confidence in the estimate or did not know how the estimate was calculated.

Five- and 10-Year Conservation Goals — Over 40 percent of interviewees reported that their organization set conservation goals for the future by using a certain percentage reduction per year. Most of the entities using this approach followed the 2003-2004 Water Conservation Implementation Task Force recommendation, which suggested a 1 percent per year decrease in GPCD as a conservation goal. In contrast to this top-down approach, about 10 percent of water providers studied or projected savings attributable to individual programs as they set five- and 10-year conservation goals. As illustrated in Figure 5-4, the remaining half either used some other unique approach or did not know how the conservation goals were set. Half of the providers interviewed stated that they were on track to meet their conservation goals.

Figure 5-4.
Approach for setting conservation goals

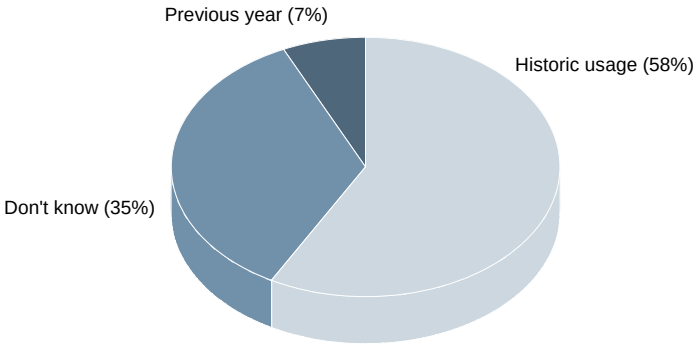
Source:
BBC Research & Consulting interviews with water providers, May-June 2011.



Approximately 60 percent of water providers used historic water usage as the baseline for their conservation goal-setting. A small percentage (7 percent) used 2008, the previous year, as the baseline for conservation goal-setting. The remaining interviewees were unsure of what was used as a baseline for setting conservation goals (Figure 5-5).

Figure 5-5.
Baseline for setting conservation goals

Source:
BBC Research & Consulting interviews with water providers, May-June 2011.



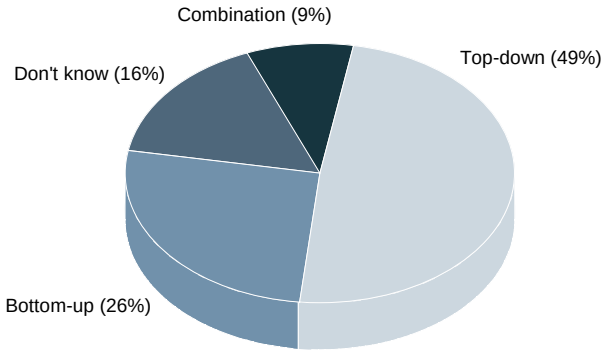
Three-quarters of interviewees stated that conservation was an important or a somewhat important aspect of their organizations' planning for the future. Of those who did not see conservation as an important resource for meeting future demand, the most common reason cited was that water conservation would harm the financial health of the provider. Several of the municipal water providers interviewed reported to operate under "take or pay" long-term purchase contracts, where the municipal provider agrees to purchase a certain amount of water in a certain time period. If the provider sells less water to residential, commercial, and industrial customers than the volume they have contracted to purchase from suppliers, the municipal providers experience a shortfall in revenue required to offset the fixed cost.

Ideas for Potential TWDB Tools and Methods — Roughly 75 percent of water providers stated that standardized tools or methods for estimating annual conservation savings and for setting future conservation goals would be useful. Many of these providers stated that there are limited resources available to create estimates and report them to various agencies. Interviewees noted that a set of tools that would help municipal water providers compare usage and conservation from year to year would be useful, especially to providers with limited budget or limited staff available for this kind of analysis and reporting. Many providers noted that regional climate and population differences make comparison across individual providers difficult. Several suggested that regional reporting approaches or systems could create cooperation among similar providers.

Half of the providers preferred that the TWDB focus on top-down approaches when developing standardized tools and methods. One quarter suggested that a bottom-up approach would be preferable. The remaining 25 percent of respondents either suggested a combination of top-down and bottom-up approaches or did not offer an opinion on their preferred approach. These results are illustrated in Figure 5-6 below. Nearly all of the interviewees noted that weather is an important factor in water usage and that it should be accounted for when developing tools and methods. Water providers also noted economic conditions and socioeconomic status of retail customers as important factors that affect water use.

Figure 5-6.
Preferred approaches for TWDB development

Source:
BBC Research & Consulting interviews with water providers, May-June 2011.



Recommendations and suggestions for the TWDB often included comments that the TWDB needs to understand that not all water providers are alike. More specifically, comments stressed that smaller water providers find this kind of reporting onerous at times; they agree with the intent of the effort, however. A recurring concern among municipal water providers was that the TWDB, Texas Commission on Environmental Quality (TCEQ), other state agencies, and wholesale water providers (from whom these entities purchase the water they sell) each require reporting regarding conservation efforts. Reporting requirements to these various organizations and agencies are often largely redundant but just different enough to require analysis of data many different ways and for different time periods (often according to the different fiscal year definitions of the various organizations or agencies). According to those water providers interviewed, a standardized methodology with standardized reporting would benefit smaller and larger providers alike, as would a single report that could be used by multiple agencies.

Summary and Interpretation of Interview Results

Water providers were generally cooperative and willing to share the tools and methods they used to estimate water conservation savings and conservation goals. Interviewees also offered recommendations and suggestions for how the TWDB can develop future tools and methods. The following themes stood out from the interview effort.

Tools and methods must be useful to and usable by different providers. The tools and methods developed by the TWDB should assist providers both with data collection and with analysis. The standardization of data collection across providers benefits both providers and the TWDB as it allows for easier comparison between communities. Data collection tools should include bottom-up approaches that may also be used for conservation measure program evaluation.

Water providers want to streamline their reporting. Water providers prefer a single data collection report in collaboration with TCEQ, other state agencies, regional organizations, and/or the wholesale water providers from whom they purchase water. The various agencies and organizations often request similar data for different time periods, duplicating work for providers.

Both top-down and bottom-up approaches are important. GPCD is a useful measure to evaluate water usage as a whole. Providers suggested that GPCD is most useful for residential use; commercial and industrial users should be evaluated with different measures. Bottom-up approaches are useful for evaluating individual conservation programs, and individual savings can be aggregated to a total savings for different conservation measures. This combination of top-down approaches to evaluate overall usage with bottom-up approaches for program evaluation is likely the best method for

comprehensive analysis of conservation savings. This is particularly the case for medium to larger utilities with multiple conservation measures, larger financial investment in conservation and staff dedicated solely to conservation.

Analyses of GPCD should focus on changes over time rather than comparisons across providers. Rather than comparing water usage of different providers in a given time period, the focus should be on trends and changes in GPCD for the same providers from year to year. This allows for evaluation of a specific water provider's programs and also recognizes fundamental differences between water providers. This could also be expanded to a regional analysis where certain providers are grouped together. Analyses of changes in water use over time are less valid, however, if providers or the TWDB are not controlling for factors like weather, economic conditions, or changes in the socioeconomic makeup of the service area.

Overall, focusing on long-term trends and ease of reporting should be the foundation of the TWDB tools and methods for estimating conservation savings and setting conservation goals.

Case Studies of Selected Providers

Specific examples of how selected individual providers endeavor to evaluate and quantify conservation effectiveness and water savings provide further illustration of varied ways of approaching this challenge. Except where specified, these data and information are based on the interviews conducted for this study and the utilities' 2009 Water Conservation Program Annual Reports to the TWDB.

Large Water Providers (Water User Groups). Large water providers in Texas shared some similarities. Most have staff specifically dedicated to water conservation. These providers incorporated a "bottom-up" approach to water conservation savings estimation more often than the small or mid-sized providers. The following case studies provide approaches to water savings estimation that should prove beneficial to other water providers.

Austin. The City of Austin is located in the Lower Colorado (Region K) water planning area and served an estimated population of approximately 873,000 people in 2009. The city reported saving approximately 2.5 billion gallons or 8 gpcd during 2009.

Estimated water savings reflect a combination of reclaimed water sales, leak detection and repair, public education efforts, retrofit and new plumbing fixture distribution and rebate programs, a tiered rate structure, water use audits and landscape-related ordinances. The estimated savings do not include passive savings resulting from natural replacement of older fixtures. Outdoor water use is one of the key opportunities for water conservation in Austin; regulations on water use and regulations for new development related to irrigation/landscape standards, soil depth and requirements for annual audits for commercial/industrial use are anticipated to be the primary way to reduce water usage in the future.

Evaluation Method. Austin incorporates several methods in estimating water savings. Examples include:

- For rebates, they multiply the actual number of participants by an estimated savings per fixture using data from a variety of sources (e.g., the Alliance for Water Efficiency tracking tool, an end-use survey conducted in 1999, and other sources as appropriate).
- They estimate the impact of their water ordinance (e.g., a maximum of two times per week watering) using a comparison of previous years' irrigation water use and what would have been used absent the ordinance. They use the same formula to assess the effects of building and development codes.
- They meter recycled water use.

The City incorporates bottom-up and top-down approaches in their estimates; the top-down estimates are used to monitor total changes to GPCD and water use. The difference between the estimates derived from their bottom-up and top-down approaches is used to qualitatively account for education and rate impacts.

Dallas. The City of Dallas Water Utilities (DWU) is located in the Region C water planning area. DWU provided retail service to about 1.3 million residents in 2009 (similar to the population served by SAWS), but also provided wholesale water supplies to utilities serving another 1.4 million people. Overall, DWU is the largest water provider surveyed in this study.

DWU adopted a water conservation plan in 1999 and initial conservation efforts included mandatory water requirements, time-of-day restrictions and a four tier increasing block water rate structure. In 2005, DWU developed a five-year water conservation plan that identified and implemented additional conservation measures based on benefit-cost analyses and other evaluations. DWU currently spends about $3.6 million per year on water conservation efforts. DWU considers water conservation to be an important element of meeting the City's (and metropolitan area's) long range water supply needs.

Evaluation Method. DWU primarily evaluates citywide water conservation savings using a time-series econometric model based on annual retail consumption. The time-series model indicates that — apart from DWU's conservation efforts — annual rainfall, the number of high temperature days and economic conditions are significant factors affecting water use. Netting out these effects, DWU estimates that its conservation efforts have saved about 98 billion gallons over the eight-year period of 2002-2009. In their 2009 Water Conservation Program Annual Report, DWU estimated their conservation savings (relative to pre-conservation program use) at about 20 billion gallons, or 19 percent of retail consumption.

DWU also uses a "bottom-up" approach to estimate water savings for its individual conservation programs. These include retrofit and new plumbing fixture distribution and rebate programs, water use audit programs, and targeted education and outreach programs.

City of El Paso. The City of El Paso is located in the Far West Texas (Region E) water planning area and served an estimated population of just under 775,000 people in 2008; the estimated population in 2010 is just under 650,000 people. The decline (and/or incorrect estimation[s]) is attributed to recent violence in nearby Mexican border towns (City of El Paso 2011).

While the City did not submit a 2009 Water Conservation Program Annual Report to the TWDB, they have had an active conservation effort since 1990. By implementing innovative water

conservation, the El Paso Water Utilities Public Service Board (EPWU-PSB) sought to reduce per capita use by 20 percent, from the 200 GPCD used in 1989 to 160 GPCD by the year 2000. Subsequently, the 2005 Water Conservation Plan outlined a goal of achieving water use of less than 140 GPCD by 2010. This goal was met before the year 2010, and, while the current goal is to maintain 140 GPCD in 2020, the staff intends to revise this goal to be more aggressive.

Evaluation Method. The City of El Paso estimates water savings due to conservation efforts using two approaches:

Simple Approach. When the City's water conservation efforts began in 1990, usage was approximately 200 GPCD. They can multiply the currently population by 200 GPCD and compare that with actual current use (currently estimated at 133 GPCD); the difference is attributed to water conservation efforts. This is also the method used to provide information to the TWDB in their reporting requirements.

Complex Approach. The City also uses econometric modeling to estimate how effective each individual conservation measure is. They are able to show the impact of pricing, rebates, and other measures. Due to challenges in attributing savings to one program over another when they are initiated at the same time, they also incorporate end-use studies in their estimations. These numbers can also be verified using wastewater flows and even by tracking water use patterns of participants in specific programs over a period of time (i.e., a "before and after" analysis).

Each conservation measure implemented must be approved by the Board, and approval is predicated on staff demonstrating that the cost of a certain measure is less than the cost of generating a new water source.

San Antonio Water System. The San Antonio Water System (SAWS) is located in the South Central Texas (Region L) water planning area. SAWS provided water service to about 1.3 million residents in 2009, making SAWS the second largest water provider surveyed in this study (after Dallas).

SAWS has a long history of water conservation programs and was required to undertake aggressive water conservation efforts in response to regulation of the Edwards Aquifer. The Edwards Aquifer has historically provided SAWS with virtually all of its water supplies until recent years. SAWS conservation programs include a comprehensive array of indoor, outdoor and public education programs, as well as a recycled water system.

Evaluation Method. Overall, SAWS' efforts are intended to answer two questions: how much water did their efforts save and what is the cost of the savings per acre-foot? SAWS estimates the savings from its conservation programs based on a bottom-up, program-by-program approach. Indoor program savings estimates are based primarily on the types and numbers of fixtures replaced or rebated (e.g., number of low-flow toilets provided). Outdoor savings estimates are derived from "rules of thumb" developed by analyzing customer water use records before and after participation in irrigation audits and similar programs. SAWS also compares similar properties to further refine the estimated savings from participation in outdoor conservation programs.

SAWS believes their conservation savings estimates are conservative. They assume a 10-year life for indoor conservation measures (e.g., fixture replacement) and only a one-year life for outdoor conservation savings (e.g., irrigation audits). They do not include any estimated savings from public education efforts; they do, however, track the number of customers that they reach through

workshops and outreach programs. They also do not estimate any savings that may result from changes in their rates or rate structure. They recently implemented a stronger conservation rate structure that they expect to drive additional interest in participating in their indoor and outdoor conservation programs.

SAWS is frustrated with the emphasis on the GPCD metric in evaluating water use and conservation in Texas. They noted a number of problems with this metric, including errors in population estimates and annual variability in use due to weather variation and other factors. In their view, there need to be improvements in the measurement of GPCD — perhaps by modifying and implementing available tools such as the New Mexico GPCD calculator. However, they believe there would also be considerable value in updated guidance for estimating unit savings from specific types of conservation programs. This could possibly be accomplished through updating the most recent work conducted by the Water Advisory Task Force and/or adapting the Alliance for Water Efficiency's tracking tool to meet the needs of Texas municipal water providers.

SAWS also noted that it would be useful if the TWDB's annual reporting requirements included metrics to measure the scale of outreach and education programs. Without requiring such metrics, there is a risk that these types of foundational conservation programs will become undervalued or be under-emphasized. They also suggested that the TWDB should seek information on whether providers have implemented reasonable rules and regulations to prohibit water waste, such as time of day restrictions and other common measures.

Mid-Sized Water Providers. The mid-sized water providers varied significantly with respect to approaches used to evaluate the effectiveness of their water conservation programs. Generally, they used either easily-quantifiable data such as metered reclaimed water sales or multi-year water use trends. However, some of these water providers had approaches to measuring actual water savings that could serve as models for other water providers across the state. These methods are highlighted in the following discussion.

Denton. The City of Denton Water Utilities is located in the Region C water planning area. The City served an estimated population of 110,000 in 2009 and obtains water from Lewisville Lake and Lake Ray Roberts. Denton reported saving 385 million gallons (9.5 GPCD) through conservation efforts during 2009.

The City of Denton estimates water conservation by comparing water usage from the current year to historic usage, controlling for weather. A comparison to a comparable weather year in the past allows the City to attribute differences in usage to conservation.

Denton relies on price signals to control usage. The City models expected seasonal water usage, controlling for factors such as weather and soil moisture. These models inform the City when setting seasonal, blocked rates for both residential and commercial customers. Joel Nickerson, Water Utilities Coordinator for the City of Denton, stated, "If you set the right price, you shouldn't have to worry about supply [issues]."

Evaluation Method. Denton's conservation efforts reflect a top-down focus on daily per-capita usage. Although the City estimates water savings attributable to different measures, staff believes that different programs do not necessarily save unique amounts of water. Savings attributed to different programs are also not necessarily additive, according to the City. Denton finds that the trend in

GPCD over time is a useful indicator of the total performance of conservation efforts considered together. The City can also model usage by residential, commercial, and industrial customers.

Estimated conservation includes passive savings resulting from natural replacement of older fixtures and from new development. Denton also enforces water loss control ordinances and offers irrigation audits and meter checks. The most important conservation tool, however, is the tiered rate structure.

Georgetown. The City of Georgetown, located in the Brazos (Region G) water planning area, serves approximately 50,000 people in the rapidly growing I-35 corridor. The city reported saving approximately 90,000,000 gallons or 5 GPCD during 2009. Because the city has a relatively new housing stock (approximately 75 percent of the homes were built after 1995), they do not offer rebates for plumbing or appliance replacement.

Estimated water savings reflect a combination of reclaimed water sales, leak detection and repair, and landscape water use reductions. Public education and rates are also thought to be strong contributors to the city's water use savings; however, these are not quantified in the annual report. Outdoor water use reduction is a central component of their water conservation program.

Evaluation Method. Georgetown has developed a model that compares expected versus actual water use on an individual customer basis. Geospatial data such as lot size, permeable and impermeable cover, and other site characteristics have been assembled for each water customer. Assuming an average application of one inch of water per week, the model uses an algorithm to calculate a conservation target for each customer. Actual water usage is compared against the conservation target to flag water use above the target. By analyzing water use on individual lots, the model is used to gauge the efficiency of water used, not the volume.

San Marcos. The City of San Marcos is in the South Central Texas (Region L) water planning area, and it served roughly 56,000 people in 2009. San Marcos receives about a quarter of its annual water supply from the Edwards Aquifer Authority, and the remaining 75 percent from the Guadalupe-Blanco River Authority. The City estimated conservation savings of 3.5 million gallons during 2009.

Evaluation Method. San Marcos uses top-down GPCD approaches to gauge the big picture on water usage and uses bottom-up methods to evaluate programs. The City estimates savings attributable to some programs, such as toilet and clothes washer rebates, and uses guidance provided by the Edwards Aquifer Authority to set the amount of water savings attributable to each program. San Marcos finds quantifying savings from education and public outreach to be difficult.

The City has used tiered water rates for more than a decade. Rates can be useful conservation tools, but they affect various customers in San Marcos differently. For example, the largest of the San Marcos customers do not tend to decrease usage as water rates increase, while smaller customers — who can't afford higher rates — tend to cut back the most. San Marcos does not attempt to control for weather, economic, or demographic effects when estimating water savings.

Small Water Providers. In general, small water providers face the greatest challenge in attempting to evaluate and quantify conservation savings. Generally these providers do not have dedicated conservation staff and, often, the general manager takes on the responsibility of estimating conservation savings (and responding to reporting requirements) in addition to all of their other duties. These providers also frequently have fewer data available to them than larger providers.

Nonetheless, some smaller providers have devoted considerable effort to attempting to evaluate the effectiveness of their conservation programs and quantify their conservation savings.

Cash Special Utility District. Cash Special Utility District (the District) is located in the North East Texas (Region D) water planning area and served a population of approximately 16,000 in 2009. The District purchases treated water from North Texas Municipal Water District (NTMWD) and produces treated water from the District's treatment plant on Lake Tawakoni. The District also supplies wholesale water to nine area communities and school districts (CSUD 2010).

The District is a rural community with a housing density of approximately nine houses per mile. Their population growth has a strong positive correlation to the population growth in the Dallas metropolitan area, and they have very little industrial and commercial use.

Estimated water savings in 2009 was zero gallons based on a comparison of calculated use (in GPCD) between 2008 and 2009. Mr. Hodges, the District's General Manager, said that water use in their service area is completely dependent on weather, which is why their per capita use has increased (i.e., 2008 was a relatively wet year, 2009 was a relatively dry year).

Evaluation Method. The District has tracked water usage since 1994 and is required to submit an extensive report regarding water use trends to NTMWD as part of their water purchase contract. Because of this, Mr. Hodges believes their estimates of water conservation savings are "reasonably accurate" based on the data they have collected for 17 years. The NTMWD "matrix" provides monthly water use data by comparing water supply purchased versus water sales and other uses. According to Mr. Hodges, NTMWD uses the information provided by the District to calculate seasonal water use differences; their seasonal water use varies by 22 GPCD as calculated. There is also a portion of the series of spreadsheets that calculates a reduction in outdoor water usage via high efficiency plumbing and other fixtures.

Springs Hill Water Supply Corporation. Springs Hill Water Supply Corporation (Springs Hill) is located in the South Central Texas (Region L) water planning area. The Springs Hill served approximately 23,500 residents in 2009.

Estimated water savings in 2009 was 9.5 million gallons, corresponding to about a 1 GPCD reduction in annual usage across the service area. Conservation is important to the Springs Hill and they have increased their conservation efforts in recent years. One of Springs Hill's biggest issues in terms of conservation is system losses resulting from a combination of sandy soils and older distribution infrastructure.

Evaluation Method. Springs Hill's conservation savings estimate represents an estimate of the savings their conservation program achieved in 2009 relative to water usage in the prior year — while attempting to account for the influence of differences in weather. Springs Hill developed their estimates based on a year over year comparison of monthly metered sales data. They reviewed data

from the past 10 years, but their data quality was not very good prior to the last few years. However, Springs Hill's General Manager noted that it is important to look at long term water consumption averages to reduce the influence of annual variations in weather on customer water use. Both rainfall and temperature appear to significantly affect water use levels for Springs Hill.

Springs Hill is currently working with the appraisal districts in their service area to identify similar homes (based on size, age, presence of sprinklers, pools, etc.) in order to develop usage benchmarks for their customers to consider.

Springs Hill described their water savings estimate as reasonably accurate. They are supportive of the TWDB's efforts to develop additional tools to assist providers in evaluating conservation savings, but noted that it is "impossible to get a perfect answer" to this question. They suggested that a desktop tool that could take meter records and production data and translate it into bar graphs for easy evaluation and comparison might help smaller providers in analyzing their customers' water use patterns.

Standardized Tools and Methods Referenced by Providers

In the course of conducting interviews, the project team was made aware of several different tools used to estimate a reduction in water use resulting from a conservation program. Some of these tools are used by the entities interviewed, some are tools the entities would like to be using, and some are tools for which an entity might have had a recommendation. The following discussion is a summary of the information discussed regarding available tools that may or may not have been investigated as part of the review of conservation studies and guidance (Tasks 2 and 3).

Standard and Assisted Estimations. According to the water provider interviews, many municipal water providers would simply compare metered water use data in the current reporting year to the previous year and attribute that to conservation efforts. Some estimates were adjusted by providers based on a specific factor such as weather or were adjusted arbitrarily as the water providers saw fit. A more involved approach, also found to be common, was a comparison of metered water use data to an average annual water use amount in order to potentially dampen any weather affects. Some water providers compared annual water usage to a previous time period when conservation or drought management efforts were not in place. Others compared water use data to a comparable weather year to estimate conservation savings, and a few municipal providers estimated conservation savings based strictly on metered deliveries via the utilities' water reuse programs.

A couple of entities that purchased water from larger entities were provided tools as part of their water purchase agreements. For example, the Lower Colorado River Authority (LCRA) provides its customers with a conservation plan template. This template provides a framework with which to estimate five- and 10-year conservation goals. Entities that purchase water from the NTMWD were provided a series of spreadsheets that municipal providers populate annually.

According to a representative from Cash Special Utility District, the intent of the NTMWD tool is to illustrate the results of conservation efforts and water losses relative to wet and dry years. The City of Dallas also requires conservation tracking in a standardized report for those municipal providers who purchase water from Dallas. The City of San Marcos, because it uses Edwards Aquifer water as a supply source, estimates savings according to tools provided by the Edwards Aquifer Authority.

Tools Developed by the Entities Themselves. A few entities have developed their own tools. The City of El Paso, in addition to simply comparing current per capita water use to per capita water use before they began water conservation efforts in 1990, uses econometric models developed by staff or outside consultants to estimate the performance of each individual conservation measure. Using these models, El Paso is able to show the impact of pricing, turf rebates, and other programs on water usage. Because it is difficult to isolate the impact of an individual program when more than one program begins at the same time, El Paso also includes end-use studies to estimate the per-unit impact of specific conservation measures(e.g., low-flow showerheads versus traditional). It is then possible to calculate the expected savings of programs based on the number of conservation measures distributed (efficient showerheads, for example). El Paso may also verify estimated conservation savings by examining wastewater flows.

The City of Georgetown developed a model that accounts for lot size, permeable cover, impermeable cover, and other lot characteristics. The model uses algorithms to calculate a conservation target for each customer, assuming irrigation of one inch of water per week. Actual water usage of individual customers is compared against the customer's conservation target to identify water use greater than the conservation target. When a residential customer uses more water than the target, City staff will contact the resident and provide information and advice regarding water savings. This model is useful in that it distinguishes between high volumes and inefficiency, allowing the utility to focus on inefficient users; the model also accounts for weather.

The City of Dallas uses a time series econometric model spanning from 1978 to 2009. The model examines annual water use and controls for factors affecting water use including population growth, weather (temperature and rainfall), and economic conditions (using an index produced by the Dallas Federal Reserve Bank). Similarly, the City of Austin uses regression analyses to account for weather and national and city-specific end-use studies to account for individual program savings.

When estimating water use reductions affected by their own efforts, SAWS develops separate estimates for indoor programs and outdoor programs. Indoor program effects are estimated by the number and type of fixtures replaced or rebated. Outdoor program effects are estimated using observed changes of water use of individual customers participating in irrigation audits or similar irrigation-focused programs. SAWS then compares similar properties to develop estimates of the effects of outdoor conservation measures. For estimation purposes, SAWS staff assumes a 10-year savings life for indoor conservation efforts and a one-year savings life for outdoor water conservation efforts. Because SAWS accounts for outdoor conservation measures in a single year, SAWS effectively understates the impact from outdoor measures to arrive at a "conservative estimate" of water savings.

Existing Tools. A representative from the City of Frisco mentioned that she was impressed with a software program being used on the West Coast, ConserveTrack, developed by Joe Miller of RightThere, Inc.1 According to the interviewee, the software operates as a web-based database. It can stratify data numerous different ways and uses geographic information system (GIS) or computer-aided design (CAD) information such as a property appraisal districts, utility billing, and building ages. The software is cost prohibitive for the City of Frisco, however; the startup fee is

[1] http://www.ConserveTrack.com and http://www.RightThere.com – these websites appear to be under construction as of August 2011.

reportedly $20,000 with a monthly fee of $2000. There has been mention of a "ConserveTrack Lite" in development to offer a less expensive version.

More than one municipal water provider mentioned the Alliance for Water Efficiency (AWE) tracking tool in a favorable light and suggested it could be adapted for Texas. Austin staff believed the AWE tool to be useful, but suggested it incorporates data inputs that are not specific enough. These inputs include overall water use and climate drivers for outdoor water use, program implementation costs, and fixture costs, among others. SAWS mentioned the AWE tool as something that could be used throughout Texas, but believed it to be slightly intimidating as it currently stands with regard to data inputs. SAWS also suggested the New Mexico GPCD calculator, or something similar, could be a useful tool for the TWDB.

More than one water provider mentioned the use of the TWDB-developed Water Conservation Best Management Practices (BMP) Guide (2004). One provider, however, reported that a colleague at another city used the BMP Guide to estimate water conservation savings, with results that suggested the utility had saved more water than it had sold.

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SECTION 6.
Summary and Recommendations

Summary of Findings from Study Research and Analysis

The recommendations provided in this section stem from the information developed in the preceding portions of this study and are intended to be consistent with recently passed legislation in Texas (Senate Bill (S181 and SB660 – 2011 Regular Session). This section begins with a summary of the key findings from the earlier tasks in this study, and then provides recommendations for the TWDB regarding tools to help the State, and individual water providers, in analyzing and quantifying conservation effectiveness.

Prior Studies in Texas. Prior reports and planning documents in Texas demonstrate that Texas water user groups and regional planning groups are increasingly incorporating water conservation as part of a strategy to meet future water needs. This applies to water users in general, and municipal water use in particular. Along with the increasing reliance on municipal water conservation to meet future water needs, there has been an increasing focus on the need to monitor the actual savings achieved by municipal conservation efforts.

Based on our review of Texas conservation-related studies described in Section 2, there appears to be general agreement that the analysis of actual conservation savings must begin with some form of standardized GPCD, or water-use intensity, metric. However, some of the challenges associated with this type of evaluation are also well recognized. Variability in GPCD based on climate (particularly rainfall and temperature), region and customer base (e.g. urban, suburban, and rural; industrial and residential; or age of housing stock) complicate evaluations of differences or changes in GPCD.

While comparisons of GPCD across different municipal water systems may sometimes provide useful information, there are well-known difficulties in developing "apples to apples" comparisons of this metric across different municipalities. To estimate the actual water savings achieved by conservation strategies, the key metric is the change in GPCD over time for each individual provider (and, potentially, the changes in GPCD or use per account for each customer class), not GPCD comparisons between providers. Further, consistency in how each provider measures its own GPCD over time is important when comparing change in GPCD over time.

National Studies and Guidance Materials. The team's review of guidance documents and studies conducted outside of Texas confirms the challenges involved in evaluating water conservation programs and estimating the actual water savings they have achieved. Data requirements and survey needs required to develop valid results for evaluating specific conservation measures are extensive. Funding for such evaluations is typically a lower priority than funding for the conservation program itself. Both top-down and bottom-up evaluation approaches are used across the county; however, their results can be limited by data availability. Numerous other challenges exist to obtaining valid data to use in an evaluation, even when funding is available. Some organizations have developed tools to aid in the evaluation of conservation programs (as discussed later in the recommendations section), but the tools produce answers only as good as the data used to develop those answers. Incorporating the collection of data required for evaluation of individual efficiency measures or overall conservation programs into program

and reporting design during the planning stage should be encouraged. This will help providers demonstrate the cost-effectiveness of their programs, and also develop the empirical data to evaluate actual water savings from conservation practices as a whole.

Review of Provider Water Conservation Plans and Annual Implementation Reports. The study team identified a target sample of 100 retail municipal water providers based on system size and region and reviewed the providers' water conservation plans (WCPs) and annual implementation reports (ARs). The analysis helped identify the most commonly selected types of conservation measures and provided limited insight into how providers are tracking (or intend to track) the effectiveness of their conservation efforts. Based on the initial round of AR filings, at least 80 percent of municipal providers consider their conservation programs to be either "effective" or "somewhat effective." Smaller providers are more likely than larger ones to indicate they do not know how effective their programs are.

The initial round of AR filings included a wide range of estimated savings from conservation programs. The average estimate of water saved due to conservation programs during the reporting period (2009) was almost 5 percent of total water use; the median was about 2 percent. Many providers reported zero, or near zero, savings or left their response to this question blank. Based on subsequent interviews, municipal providers interpreted this question, and approached the problem of how to estimate their conservation savings, in a variety of different ways.

Interviews with Municipal Providers. The study team conducted interviews with 43 municipal water providers across Texas to gather further information regarding approaches to and challenges with estimating the savings achieved by their conservation efforts. Over 60 percent of the providers interviewed used a top-down approach to arrive at annual conservation savings. Top-down approaches generally compared annual GPCD or annual water loss totals to the providers' chosen baseline. While most water providers noted that weather, population growth, and economic activity were important factors in annual water usage, few providers attempted to account for these factors when estimating conservation savings using top-down approaches.

About half of the interviewees said that their annual conservation estimate was reasonably or very accurate. One quarter said that the estimate was the best guess possible given available data. The remaining 25 percent either did not have much confidence in the estimate or did not know how the estimate was calculated.

The interviews indicated that both top-down and bottom-up evaluation approaches are important. The combination of top-down approaches to evaluate overall usage with bottom-up approaches for program evaluation is likely the best method for comprehensive analysis of conservation savings, particularly for larger providers with multiple water efficiency measures or a more mature program in place. Top-down approaches may be well-suited for small to medium-sized providers if other factors such as weather and economic conditions can be normalized.

Providers expressed concerns about previous comparisons of GPCD between water systems and confirmed that the focus should be on trends and changes in GPCD from year to year for each individual provider. Providers also noted the influence of factors like weather, economic conditions, changes in the proportion of large industrial users to service population, or changes to socioeconomic makeup of the service area on their water use. Providers expressed the need to be able to adjust for these factors in estimating savings from conservation.

Providers would generally like to see tools and methods developed by the TWDB that could assist with both data collection and analysis. They would also like to streamline reporting requirements among various state and local/regional agencies.

Recommendations

The remainder of this section provides three sets of recommendations for consideration by the TWDB.

1. Approach for estimating statewide and regional conservation savings.

2. Potential "tools" to assist individual municipal water providers.

3. Other suggestions for consideration.

Recommendation #1: Estimating Actual Statewide and Regional Water Conservation Savings. One of the primary objectives of this study was to identify or develop potential tools and approaches to assist the TWDB in estimating the amount of water that is being saved by municipal conservation efforts on a statewide and regional basis. Conceptually, there are several alternative approaches that the TWDB could implement to accomplish this objective.

Potential Approaches. Approach A – One approach would be to simply aggregate the estimated water savings from conservation reported by the individual municipal water providers in their ARs. However, the study team's review of nearly 100 ARs and our interviews with over 40 municipal providers for this study demonstrate numerous problems with using this information to estimate statewide or regional conservation savings. As described in Section 4 of this report, many providers reported zero savings or simply left this question blank in their initial ARs. The subsequent provider interviews (Section 5) indicated that these types of responses were often due to uncertainty regarding how to estimate actual savings from conservation efforts. The interviews also revealed widely varying approaches to quantifying conservation savings among the providers and corresponding differences in the types of water savings that were included (or not included) in the estimates. At this time, the study team does not believe it is possible to develop reliable estimates of regional or statewide water conservation savings based on the data contained in the ARs.

Approach B – Another approach could be to identify one or more "best practices" used by Texas municipal water providers to quantify their conservation savings and encourage or require consistent adoption of the same approach by other providers. This approach also appears infeasible. As discussed in case studies in Section 5 of this report, a number of the larger municipal water providers in Texas — such as Austin, Dallas and San Antonio — have developed sophisticated approaches to estimating the savings that result from their conservation efforts. However, these approaches vary considerably and there is no evidence to suggest that one is better than another. Moreover, these larger providers are able to devote substantially greater resources to conservation analysis than most municipal water providers in Texas. Most of the state's municipal water systems are relatively small and are unlikely to be able to find the staff time and expertise to replicate these types of analyses for their own systems.

Approach C – We conclude that the best approach to estimating statewide and regional water conservation savings in Texas is for the TWDB to develop a "top-down" statistical analysis based on municipal water use data that it already collects, as well as some additional data from readily available

sources. The following paragraphs provide an outline of how this analytical model might be developed and the benefits and limitations of this approach.

Recommended Approach for Estimating Statewide and Regional Conservation Savings. The statistical technique necessary to estimate statewide and regional conservation savings based on TWDB water use data is called econometric analysis. More specifically, the study team recommends that the TWDB develop an econometric "panel model" that incorporates either random- or fixed-effects variables to estimate the impact of water conservation efforts on annual water use by region. Similar types of models have been used in AWWA's Residential End Uses of Water Study (to identify the effects of household characteristics on water use) and by Denver Water to estimate the water savings resulting from its conservation efforts.

Econometric panel models incorporate a combination of time series data (information that varies by month and/or year) and cross-sectional data (information that varies by provider or location). The TWDB's annual water use dataset for municipal providers, which contains annual water use for each Texas municipal provider from 1980 to the present (net of sales to other water systems) would be the starting point for this analysis. Figure 6-1, below, provides an illustration of how the TWDB's municipal water use data could be organized for this purpose.

Figure 6-1.
Conceptual Illustration of TWDB Municipal Water Use Data Panel

		Annual System-wide Water Use per Capita (GPCD)										
		1980	1981	1982	1983	1984	1985	…	2007	2008	2009	2010
Region A	Provider 1	193	196	209	215	190	195	…	177	153	149	162
	Provider 2	194	197	196	185	194	192	…	173	155	172	161
	Provider 3	185	239	232	241	206	174	…	206	185	169	211
	Provider 4	231	244	190	198	215	192	…	218	228	212	189
	Provider 5	221	197	216	192	202	210	…	176	176	149	165
	Provider …	…	…	…	…	…	…	…	…	…	…	…
Region B	Provider 1	208	181	178	204	190	190	…	157	151	150	151
	Provider 2	216	210	187	191	176	212	…	167	164	203	198
	Provider 3	193	184	181	176	176	173	…	156	154	153	155
	Provider 4	220	223	239	226	176	257	…	191	196	186	201
	Provider 5	195	197	188	195	184	175	…	172	171	166	165
	Provider 6	220	209	211	181	211	196	…	170	166	175	158
	Provider 7	198	199	213	216	181	179	…	220	201	222	171
	Provider …	…	…	…	…	…	…	…	…	…	…	…
Region …	Provider 1	189	186	215	224	210	180	…	200	149	201	150
	Provider 2	221	238	195	239	238	265	…	199	238	175	196
	Provider 3	205	185	198	192	175	178	…	158	162	155	146
	Provider 4	194	179	200	177	179	178	…	151	167	153	155
	Provider 5	228	189	176	209	185	218	…	180	167	155	154
	Provider 6	231	194	220	215	229	182	…	172	211	155	199
	Provider …	…	…	…	…	…	…	…	…	…	…	…

The general specification for this statistical model would be similar to the following equation:

$$\mathbf{GPCD_{PT} = K + B_1*ProviderX_D + B_2*Precip_{RY} + B_3*Temp_{RY} + B_4*Econ_{RY} + B_5*YearRegion_D + B_6*Drought_{XD}}$$

Where:

- $GPCD_{PT}$ would be the average daily water use per capita for Provider (P) in Year (T);
- $ProviderX_D$ would be a series of indicator (dummy) variables representing each provider to be modeled – for example, the dummy variable for Austin would be coded as a 1 if the data were for Austin and as a zero if the data were for some other provider;
- $Precip_{RY}$ would be a variable designed to capture the effects of variations in rainfall by year and region;
- $Temp_{RY}$ would be a variable designed to capture the effects of variations in temperature by year and region;

- $Econ_{RY}$ would be a variable designed to capture the effects of variations in economic conditions by year and region; and
- $YearRegion_{D}$ would be a series of dummy variables representing each combination of year and region. For example, there would be a variable $YearRegion_{L2010}$, and for 2010 water use for Region L water providers, that variable would be coded as a 1; for data all other years, and for data for other regions in 2010, that variable would be coded as a zero).
- $Drought_{XD}$ would be a dummy variable that would be coded as a 1 if water provider X had implemented their drought management plan during the year, otherwise coded as a zero.

The coefficients K, B_1, B_2, B_3, B_4, B_5 and B_6 would be estimated using a statistical software package such as STATA or SAS.

For the TWDB's purposes, the most important information that would be derived from this type of model would be the coefficient B_5 on the YearRegion variables. That coefficient would indicate the average change in GPCD for each region and year combination, after accounting for the influences of weather and varying economic conditions. For example, if the TWDB chose to use 2002 as the base year for comparison, and if the estimated value for B_5 for Region Z in year 2010 was -8, that result would indicate that municipal water use among Region Z providers had declined by an average of 8 GPCD from 2002 to 2010, excluding the effects of weather and changing economic conditions. By multiplying the B_5 coefficients for each region by the region's population and by 365 days per year, these estimated changes in GPCD can be converted into aggregate water savings estimates.

The B_5 coefficient estimates would reflect changes in water use per capita (GPCD) net of the other factors (weather and economic conditions) specified in the model. Such changes would not only include the effects of proactive conservation efforts, but also the effects of changes in water rates and/or rate structures and the effects from the natural replacement of older plumbing fixtures with newer, more efficient models. The TWDB has previously developed projections of natural replacement savings for each municipal water provider in Texas, and, if desired, these projections could be compared to the results of the econometric analysis to distinguish the reductions in water use due to natural replacement from reductions due to proactive conservation efforts and rate changes.

Extraordinary events (e.g. major line breaks or flushing flows) and other, unknown factors contributing to annual variability in water use would also be reflected in the coefficient estimates. Changes in the proportion of large industrial use, or changes in the socioeconomic makeup of the providers' service areas, could also affect the coefficient estimates, though these factors are likely to have less effect at the regional level than at the individual provider level. To develop the most reliable estimates of conservation savings, it may be useful to evaluate the B_5 coefficients over several years (e.g. perhaps the average over a three year period).

The type of econometric analysis described above would also provide other useful information. The coefficients on the weather variables for each year and region would provide information that could be given to the Regional Water Planning Groups, or to individual providers, to help them normalize or interpret their own water use data to reflect the influence of weather variation on water use. The coefficients on the economic variables would provide similarly useful information.

The statewide and regional conservation estimates developed from the econometric model would be based on a consistent methodology, and consistent water use data, as required under the recent revisions to Texas Statutes (SB181 and SB660). The econometric model would also provide the information necessary for the TWDB to estimate conservation savings for individual providers. However, there are some important limitations concerning the application of the econometric model in this regard. In developing its water use data, and population estimates, the TWDB standardizes this information to reflect geopolitical boundaries (e.g. cities and counties) and reports the information by water user group (WUG). Consequently, the water use and population for a specific city, may include more than one water provider, or may include only a portion of the water use for a large water provider that also serves customers outside the city limits. Further, as described in Section 5 of this report, many of the larger municipal water providers in Texas have developed their own customized evaluation and estimation approaches that reflect the specific characteristics of their conservation programs and their service areas. The study team does not recommend that results from this model – which is primarily intended to develop regional and statewide conservation savings estimates – should supplant customized, provider-developed approaches already in place for estimating water conservation effects. Municipal WUG-specific conservation estimates from the regional and statewide statistical model could, however, provide useful information for municipal water providers that have not yet developed comprehensive evaluation approaches and could also provide a consistent metric for comparing provider conservation results when evaluating applications for state funding assistance. In using the model to estimate individual WUG conservation savings, TWDB would need to examine both the overall regional conservation estimates (based on the B_5 coefficients as described earlier) and patterns in the "residuals" for the individual provider.[1]

While the outline for development of an econometric model to estimate statewide and regional conservation savings is relatively straightforward, like many things, the devil is in the details. One important issue is the selection of data to use to specify the weather variables and the economic conditions variable. As noted in Section 2 of this report, the 2002 TWDB study *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas* by GDS Associates, Inc. identified the geographically-central city in each region and the possibility of obtaining weather data for those cities from the Texas Climatologist. Alternatively, weather data could be incorporated on a county-specific basis (rather than region-specific basis) using weather information for each county seat or other central location with a sufficiently long data record. In the study team's experience, however, some trial and error may be required to determine the specific weather variables to be used. For example, the frequency of rain events may be almost as important as the cumulative total precipitation over the irrigation season. Furthermore, the economic variable chosen for this analysis should be readily available for all geographic regions on an annual basis and updated on a timely basis. Regional averages based on county unemployment rates, for example, might be a reasonable proxy for variability in economic conditions over time and by region.

The most appropriate functional specification of the model would also need to be explored. The simple example shown above assumes an additive equation. In some cases, however, logarithmic transformations of the equation or other specification alternatives may provide better results. The best functional form would likely need to be determined through a trial and error process. This process will also need to evaluate, and make adjustments if necessary, to avoid potential statistical problems that can

[1] The residuals would be the differences between the estimated GPCD for each provider based on the equation and the providers actual GPCD in the same time period.

arise in econometric panel models. The model may produce the most reliable results, at the regional level, if the observations are weighted by the populations of the providers. This can be readily accomplished using statistical software packages such as STATA.

Finally, there will need to be some consideration given to the potential benefits of using the TWDB's annual "intake data" to approximate monthly data. Although this would require additional work in developing the dataset for the model, monthly water use models tend to more accurately capture the effects of weather on water demand than annual models.

Some uncertainty about the volume of water saved as a result of conservation programs will remain even after using the type of econometric model just described. That is, the model would not produce a *perfect* answer regarding actual conservation savings to be compared to projections in the regional or state water plans. As noted previously, for example, based on the structure of the model it is likely to be difficult or impossible to isolate the effects of proactive conservation efforts from the effects of changes in water rates and/or rate structures and the effects from the natural replacement of older plumbing fixtures with newer, more efficient models. The modeled estimates of conservation savings would also be subject to a degree of statistical uncertainty, although the standard errors of the coefficient estimates from the regression analysis would provide TWDB with data to evaluate this issue. For example, a similar model developed by the study team estimated that water conservation efforts by Denver Water had reduced water use by approximately 11 percent between 1998 and 2006. Based upon the standard errors of the model's coefficient estimates, the 95 percent confidence interval around the conservation savings estimate ranged from about 8.5 percent to about 13.5 percent.

Developing and maintaining this type of model would also require additional TWDB resources. The study team estimates that 200 to 400 hours of professional time might be required to initially develop the model. If the model is specified on an annual water use basis, the effort required would likely be closer to the lower end of the range. If the model is specified on a monthly basis, the additional work required to develop the necessary datasets and to interpret the model's results would likely push the level of effort towards the upper end of the range or perhaps higher. Once the initial model is developed, annual updates would be relatively straightforward. To update the model, it would be necessary to add the new water use data, new weather data, and new economic data to the dataset and then rerun the existing model specification. Updates might require 40 to 80 hours of professional time each year.

Recommendation #2: Potential "Tools" to Assist Individual Municipal Water Providers. Our research on statewide and national practices, as well as the water provider interviews, indicates that most conservation quantification practices and tools are designed to facilitate planning of conservation measures and programs rather than evaluating or quantifying effectiveness of individual conservation measures or overall conservation programs. A variety of tools, however, are being used throughout the nation to evaluate the effectiveness of conservation programs, both through individual conservation measures and observed overall water use reductions. The following section summarizes existing approaches and tools and conceptually develops an ideal tool that would meet the needs of water providers, incorporating the best elements of the existing tools.

Objectives for Tools for Water Providers. Water providers indicated a strong desire for tools that provide a consistent and defensible measurement of actual water savings for a variety of reasons. The potential uses for such tools most commonly mentioned during the interviews include:

- Planning for future water supply and infrastructure (water and wastewater) needs;
- Evaluating cost-efficiency and water-savings effectiveness among various conservation measures and programs;
- Tracking effectiveness and water savings over time;
- Consistency of reporting among water providers and evaluation of conservation savings as a criterion for state funding;
- Minimum practicable staff labor required for reporting compliance; and
- Meeting ancillary regulatory requirements related to illustrating the maximum practicable conservation savings (e.g., for interbasin transfers).

In addition to being adaptable to meet the variety of uses described by water providers, tools and approaches would ideally also achieve the following objectives:

- Suitable to address the water use reporting requirements specified in recently enacted state legislation (SB 181 and SB 660);
- Appropriate for smaller to medium systems with limited resources (e.g., staff and budget) and a small number of individual conservation measures;
- Scalable for larger systems that wish to evaluate numerous conservation devices, measures and programmatic elements;
- Easily accessible, inexpensive and "user-friendly";
- Diverse in applicability, accounting for regional variations in customer profiles, weather, implementation costs and conservation awareness, as well as the water provider's previous investment in conservation;
- Populated with default assumptions regarding the end users of water and the savings and costs associated with common conservation measures. These assumptions would provide regionally appropriate factors for water providers' use if system-specific data is not available; and
- Useful for multiple purposes, such as internal planning and budgeting, reporting to state agencies and local providers, and regional planning water demand forecasting.

Existing Tools Related to These Objectives. Most of the water providers interviewed during this study incorporated a top-down approach in some form to validate or report conservation savings to state agencies, their governing bodies or other parties. Generally, this included tracking overall GPCD, GPCD by various sectors and/or overall water use. For larger utilities with established conservation programs, this approach was consistent with the provider's overall conservation goal, but was often combined with bottom-up evaluations to assess the effectiveness of individual measures and to validate assessment of overall water savings attributable to conservation measures. The level of detail in the analyses was generally commensurate with the complexity of the conservation program. Therefore, tools and reporting methods provided by the TWDB may need to be flexible enough to address the needs of small, medium-sized and larger utilities.

Most of the state's municipal water systems are relatively small, and small water providers are unlikely to have the staff resources and expertise to perform complex conservation analyses or implement extensive programs. For example, a large percentage of water service providers do not implement individual conservation measures such as rebate programs; they are more likely to simply have a public education program. Tools and reporting methods should provide a method to estimate non-quantifiable measures for these smaller water service providers (i.e., a top-down approach), as well as a more complex method that includes water savings associated with specific individual conservation measures (i.e., a bottom-up approach) for those entities that have implemented such measures.

For comparison purposes, Figure 6-2 summarizes the tools previously discussed in this report and includes both factual information and opinions/thoughts offered during the provider surveys. None of the tools reviewed are perfectly suited to meet all of the uses and objectives identified by the surveyed water providers, but many provide unique advantage(s) and attributes.

Building the best features of the various tools into a single tool would advance providers' ability to consistently evaluate the effectiveness of water efficiency measures and estimate actual water savings. After operating a number of the existing tools, the project team observed first-hand a number of items that, along with the literature research summarized in the table, inform the recommendations regarding a water provider tool. These observations include:

- Instructions and links to relevant data sets within the tool itself are very helpful; not all the calculators operated included clear instructions and explanations of the data.
- A pre-populated version of the tool as a case study was useful to illustrate how the tool worked and how the data should be entered.

FIGURE 6-2
Comparison of Existing Tools

Tool	Description	Cost	Hosted By	Strengths	Limitations	Approach Type[1]
System-Wide Conservation Savings Tools						
Time Series Model	Annual production data spanning from 1978 to 2009 is used to predict savings resulting from conservation efforts	Developed by staff in-house.	City of Dallas	Accounts for population growth, weather (temperature and rainfall), and economic conditions (based on an index produced by the Dallas Federal Reserve Bank).	Provides gross, utility-level information, rather than measure-specific data.	TD
Conserve Track	Web-based customer management tool specifically designed for conservation calculations, linked to a customer's billing system. It is intended for day to day management through individual conservation measure evaluations, including cost-benefit analyses.	Dependent on utility. Approx. $20,000 start-up, $2,000/month maintenance fee.	Right There, Inc.	It is intended to address all kinds of water conservation measures, from rebates to ordinances, has several different types of reporting options and there are various ways to compare actual use versus predicted use. Enables targeted marketing and implementation.	Does not currently account for weather (but reportedly could do so without substantial modification). Cost prohibitive for many utilities.	BU and TD
Target Method 4 Calculator	Establishes a consistent method for determining if a water agency (and the state as a whole) is meeting target savings. Also provides flexibility in determining those water use targets (other methods available).	Free	California Dept. of Water Resources	Estimates water savings implemented in 3 water sectors: residential indoor; commercial, industrial, and institutional; and landscape water use, water loss, and unaccounted-for water. Default values are provided.	Data and calculation intensive.	BU
IWR-MAIN	Originally developed by the US Army Corps of Engineers as a water use forecasting system, it is also used to estimate water use with and without conservation.	$1995 as of February 2011[2]	CDM	Analyses incorporate price and socio-economic factors, weather conditions. Non-residential uses are disaggregated into 280 categories and price elasticities are applied.	Requires verification of the empirical equations and coefficients used, thus historical data and extensive analysis required.	TD
Measure-Specific Conservation Savings Tools						
Water Conservation Tracking Tool	An Excel-based model that evaluates the water savings, costs, and benefits of conservation programs. Includes a library of pre-defined conservation activities.	Free to AWE Members ($200-$25,000 per membership)	Alliance for Water Efficiency	Includes a TX-specific tool, as well as multiple perspectives. Updated as end-use studies become available.	Very much user input intensive. The data in the tool itself is not regionally specific.	BU
EZ Urban Water Conservation Guide	Conservation planning tool for calculating potential water savings and evaluating potential BMPs.	Free to utilities in Florida	Conserve Florida Clearinghouse	Includes non-quantifiable measures and quantified best management practices in its options. Savings potential is driven by the utility profile and annual investment.	Only produces estimates of gross and residential per capita use.	BU
ECoBA Interactive Calculator	Excel workbook designed to assist utilities in evaluating the actual water savings, costs and cost-effectiveness of individual conservation measures.	Free to members; membership is location specific.	Water CASA	Includes standardized data including estimated lifespans for conservation savings from a number of different measures; Office of Management and Budget discount rates to assist in present value calculations; and a table of consumer price index values to help adjust for inflation.	Requires extensive data collection prior to use.	BU
Econometric Models	Complex models to determine how an individual conservation measure is performing.	Developed both by staff in-house and by consultants.	City of El Paso	City-specific and able to show the impact of pricing, rebates, and other programs. Multiple methods to validate estimated values (e.g., end use studies, wastewater flows, and actual data).	Unable to isolate savings from actual programs that begin concurrently.	BU
Water Conservation Best Management Practices Guide	BMPs and cost effectiveness tools provided for planning and designing effective conservation programs for municipal, industrial and agricultural water user groups.	Free	TWDB	Gathered TX-specific data. In-depth information about each BMP offered as potential for use.	The values cannot be updated until the state deems an update appropriate. Allows for bottom-up planning, only. User claimed to get an impossible result, so requires groundtruthing.	BU
Water Use Analysis Support Tools						

FIGURE 6-2

Comparison of Existing Tools

Tool	Description	Cost	Hosted By	Strengths	Limitations	Approach Type[1]
New Mexico GPCD Calculator	Tracks municipal water use over time and provides the utility with a categorized baseline of historical and current water use per person per day.	Free	New Mexico Office of the State Engineer	Incorporates census data and utility-specific data. Default values provided for incomplete data.	Data intensive. Water use/sales must be divided into specific sectors.	TD
Lot-specific Model	Accounts for lot size, permeable cover, impermeable cover, and other lot characteristics, and then uses algorithms to calculate an appropriate water conservation target, "flagging" values above.	Developed by staff in-house.	City of Georgetown	Enables City staff to target inefficient users, rather than just high volume users. Accounts for weather.	Not a program-wide planning tool.	N/A
Water Conservation Report	Series of spreadsheets with input parameters consistent across wholesale customers, populated annually.	Developed by a consultant.	North Texas Municipal Water District	Intent is to illustrate the results of a utility's water conservation efforts and where they are losing water. Relatively easy to populate. Accounts for weather (according to wholesale customer).	Only provides gross, utility-level information, rather than measure-specific data.	TD

1. *BU = bottom-up. TD = top-down.*
2. *http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=74/pagename=alpha_list*

- A methodology to identify and estimate the benefits and avoided costs associated with the conservation program, such as sewer, natural gas, electricity, or other relevant benefits such as green house gas emissions reduction, will provide additional value to the water provider.
- Some sort of "red flag" indicator that identifies when a value is not realistic or is inconsistent with another value is helpful.
- The ability to analyze costs from the customers' perspective, as well as the provider's perspective, expands the utility of the tool and provides a means to understand broader implications of a particular water efficiency measure.
- The ability to upload or pre-populate information into the tool from monthly operating reports required by state agencies enhances efficiency in using the tool.
- Default values for some data fields will facilitate use of the tool by smaller utilities without designated conservation staff.
- A standard approach to account for savings attributable to "non-hardware" measures (e.g., from public outreach efforts) is needed; none of the tools reviewed do this well.

Framework of a Texas-specific Municipal Water Provider Conservation Planning and Analysis Tool. Tools available at the national level include numerous elements that could advance the ability of Texas water providers to assess the overall effectiveness of conservation measures (top-down evaluation), as well as the effectiveness of individual measures (bottom-up evaluation). Both are important to meet the objectives for local water provider evaluations. This section describes key aspects of the "ideal" tool that could be developed by the TWDB and made available to water providers throughout the state.

Key Elements of an Ideal Evaluation Tool. An ideal tool to evaluate the effectiveness of conservation programs and conservation measures would incorporate both a means to gauge overall water savings from entire water conservation programs, as well as those attributable to individual measures. It is important to establish clear and consistent methodologies for use in reporting to state agencies in order to improve confidence in accounting for conservation savings as a water management strategy, particularly to meet forecasted water needs in regional and state water plans. Further, the tools should be designed to facilitate decision-making at the water provider level, not just for reporting purposes. Recommended attributes of the tool include that it:

- Be web-based so that the information requested and entered by the utility would feed into TWDB and TCEQ databases. This would provide data consistency among statewide reporting and reduce reporting requirements of water providers as it streamlines data entry requirements for these and other entities. If consistent with Water User Group (WUG) designations used by Regional Water Planning Groups, it would also provide a method to evaluate conservation program effectiveness against predicted region-wide conservation estimates and as a criterion for state funding applications. Further, different fiscal years could be easily accounted for (if necessary) across the different entities requesting data. Recently, Florida's EZ Urban Water Conservation Guide was transferred to a web-based format. (http://ezguide.conservefloridawater.org/Account/LogOn?ReturnUrl=%2f)

- Includes "fields" for building a database over time. In other words, while the previous bullet described the possibility of numerous entities having access to a single year's data for a given WUG, historical data (e.g., total water use, number of customers) would also be accumulated, thus enabling the development of trends and rolling averages, which tend to temper the effects of climate and other non-conservation related factors affecting GPCD. The New Mexico GPCD Calculator provides this sort of database storage. Further, the data could be organized to be consistent with funding (and other) requests that require demonstration of an active and effective conservation program.

- Incorporates historical data and relevant factors that account for weather patterns, economic conditions, overlapping program savings reductions, etc. so that some calculations can be incorporated into the model and do not require input from the WUG. Such information and "pre-set" methodology would provide consistency across water providers. The Dallas Federal Reserve Bank indices used by Dallas Water Utilities in their reporting calculations provide an example of a standard factor that could be used for other providers in the region.

- Designed with modules appropriate for small users or those with minimal conservation programs (i.e., top-down calculations) with supplemental or optional bottom-up calculation modules, similar to the AWE Water Conservation Tracking Tool. This could also lend itself to distinct measuring modules and planning modules. For planning purposes, the tool could incorporate available values from appropriate end-use studies. Actual numbers resulting from a top-down calculation could be compared against the estimates developed during the planning phase.

- Includes drop-down menus for default data sets if no provider-specific data is available. Examples include regional factors to address weather, shared media markets, etc. Almost all of the tools we reviewed included default data sets for use, with the ability to update with user-specific data.

- Contains a standardized "baseline" calculator for what water use would have been without conservation, which is useful for both establishing conservation targets and benchmarking achievement. The City of Georgetown has incorporated this sort of calculation into their conservation program, "flagging" those customers that are above a set "conservation water use target" for outdoor irrigation. Such a methodology could provide indications of the degree to which a conservation program is effective.

- Includes the capability for various queries and report generation that are water-provider designed. Several of the tools researched included charts that were updated once data had been input but none were found that included provider-designed output. Such a feature would allow the tool to have utility to both the TWDB and the water provider.

- Includes a standard method to quantify qualitative measures. The best example of this is Florida's EZ Urban Water Conservation Guide. The Guide includes measures labeled as operational, educational, and policy, but there are currently no savings values associated with these.

- Provides a methodology for setting five-year and 10-year conservation goals, including goals for utility water loss. The Target Method 4 Calculator provides goal-setting suggestions by water use sector.

- Includes standardized method for calculating cost savings. The tool could include a method to estimate utility investment in conservation programs and use this as a criterion for assessing cost effectiveness of conservation rebates and incentives. This would require an estimation of the cost of additional water supply, plus cost avoidance for future capital and operations costs for water and wastewater treatment in addition to monetized environmental benefits (such as savings for greenhouse gas emissions). For an example, the AWE Water Conservation Tracking Tool provides a methodology to calculate and identify all benefits and avoided costs associated with a specified conservation program.

Resources Required to Develop and Maintain an Evaluation Tool. The labor, expertise and time required to produce and maintain the type of tool envisioned for Texas municipal water providers would be substantial. Developing the tool would require several meetings with TWDB staff to ensure the tool is compatible with existing systems, resources, and objectives. Further, to ensure consistency with regulatory and regional reporting needs, the initial needs assessment, development and design phase would be critical. Web developers and database experts would also be needed. Based on some broad assumptions, the study team estimates the development of this tool could require at least 700 labor hours. If TWDB hosted the tool on external infrastructure, the hosting fee is estimated to be approximately $2,000 per month, or $24,000 per year; if TWDB hosted the tool internally, an annual maintenance fee of $10,000 might be required for on-call technical support.

Associated Guidance and Tool Components. To meet the needs of various agency reporting requirements, including the recent SB181 and SB660 revisions to Texas Statutes, and to have utility for local water providers, items suggested for the tool would include:

- List of clearly defined data needs provided up front;

- Step-by-step instructions to populate the tool or form. Each calculation should be separated out as its own individual step. The TWDB could provide webinars and/or regional training sessions to provide training on both estimating conservation savings and using the tool;

- List of the types of staff who should be involved in providing inputs to populate the tool and that would be expected to use the information, and identify the managers or officials who should sign off on and be accountable for the validity of the information; and

- Little to no difference in reporting requirements between utility sizes, although the TWDB could potentially offer more help to smaller WUGs, similar to TCEQ's Small Business and Local Government Assistance program.

Synergies between Recommendations 1 and 2. There would be a number of potential synergies in developing the tools described in Recommendation #1 and Recommendation #2. For example, some

of the variables used in the statewide and regional model (e.g., precipitation, temperature, and economic conditions) are factors that should be included in the calculations performed by the individual municipal water providers via the tool described in Recommendation 2. The water use data collected by TWDB and/or TCEQ could be used as input for both tools. Theoretically, the total water conservation savings developed as a result of the statewide model should be comparable to the sum of the water conservation savings calculated by each municipal water provider (with some caveats discussed later).

Ideally, the statewide model and the tool for use by the municipal water providers would be developed in parallel. Following initial development, it would likely be prudent to allow for a testing period (e.g., one year) to give TWDB the ability to run "beta tests," and modify any factors, assumptions, or calculations that are inconsistent between the two tools and to carefully evaluate the performance of both tools. The likelihood of inconsistencies would be reduced if the coefficients/factors were developed simultaneously. Note that the sum of all bottom-up calculations should be less than the total of the top-down calculations due to education and other non-quantifiable conservation-related efforts.

Recommendation #3: Related Suggestions for Consideration. During the course of the study team's research, two related themes appeared to be important for municipal water providers: assistance and training in data collection and analysis and a streamlined reporting system.

Water providers of all sizes can have difficulty accurately and consistently collecting and analyzing water use data and estimating water savings attributable to conservation programs. The smaller providers, with limited resources to devote to water conservation programs or to program evaluation, would benefit from training by the TWDB regarding what data need to be collected and how the data should be analyzed. It might be possible for TWDB to coordinate with other organizations, such as the Texas Rural Water Association, to provide training on a regional basis. If attendees could receive continuing education units, it might encourage further participation in training efforts. A scenario where the TWDB provides tools to municipal providers without training the providers in the "hows" and "whys" of the tools would likely limit their efficacy and the value of the results of those tools. Additionally, leveraging technology, such as using webinar, could make such training more accessible to WUG's and reduce travel and logistics costs for the TWDB.

Municipal water providers also face increasing reporting requirements from state, regional, and local entities, as well as their wholesale water sources. In addition to the TWDB water conservation plans and water conservation annual implementation reports, a single municipal provider may also be required to report related data to the Texas Commission on Environmental Quality (TCEQ), the appropriate Regional Water Planning Group, the local governing body of the utility, and the utility's wholesale water provider (in some cases). This level of reporting becomes redundant and repetitious at best; burdensome and inaccurate at worst. Developing a common reporting system that the state, regional, and local agencies would design and to which they would all have access (likely online) would streamline reporting and, over time, create a robust database of water usage data.

Based on our discussions with people supporting conservation efforts and programs throughout the state and country, the following are additional recommendations we encourage the TWDB to investigate to better support statewide conservation efforts:

- Creation of an online message board for information sharing between water user groups and the TWDB;

- Encouragement of the regionalization of conservation efforts since utilities benefit from nearby conservation campaigns, and sharing resources tends to provide more return on investment (statewide education campaigns, such as the Texas Water IQ public awareness campaign, provide a good example of this);

- Access to web links associated with:

  - Conservation programs throughout the state as a resource or to provide examples;
  - Statewide data resulting from TWDB reporting;
  - Statistics resulting from annual reports;
  - State-specific listing of conservation funding opportunities;
  - Information and resources specific to water reuse systems;

- Development of an easy method for requesting TWDB support, feedback, and/or contact information; and

- Creation and distribution of conservation awards by city size (most improved, etc.) on site (for example at city council meetings) for as much exposure as possible.

APPENDICES

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MEMORANDUM

To:	TWDB Project Files
From:	Doug Jeavons and Josh Sidon
Re:	Outline for Provider Interviews (Task 5)
Date:	April 28, 2011

Background

Explain who we are and what we are doing.

Estimating Conservation Savings Achieved to Date

In your 2009 Water Conservation Annual Report (Annual Report), your utility indicated that you estimated that conservation efforts had reduced water use by _____ gallons during that year. This translates into approximately _____ GPCD based on the population of your service area during 2009.

1. When you estimated these savings, what was your "baseline" for comparison? In other words, is this savings estimate an estimate of the water saved as a cumulative effect of your conservation efforts to date, or an estimate of the water saved by conservation efforts occurring during that year? (If the estimate is based on "savings to date", what is the start year)?

2. How did you estimate these savings?

3. Do you feel that your estimate is very accurate, reasonably accurate, or just a best estimate given limited information?

4. What other information would have been useful to you in attempting to estimate actual savings from your conservation efforts?

5. Which of the following programs or savings components were included in your estimated savings? (For each one, try to ascertain the volume of estimated savings -- gallons, gallons per day or GPCD -- and how the savings were estimated)

   - Reclaimed or reuse water that your utility may distribute and sell?
   - Utility leak detection and repair efforts that you may have undertaken?
   - Changes you may have made in your rate structure that promote conservation?
   - Residential or commercial customer water use audits?
   - Rebate programs?
   - Landscaping or other codes affecting new development?
   - Public education and awareness programs?
   - Other components or programs? (If so, briefly explain)

6. Did these savings include any savings resulting from natural replacement of older fixtures (sometimes referred to as "passive conservation")? If so, how did you calculate such savings and what is the savings estimated through natural replacement (in gallons per day, GPCD or percent of the estimate)?

7. Did you try to account for the influence of weather (or other indirect factors like economic conditions) on the demands of your customers in 2009? If so, how did you do so?

5 Year and 10 Year Conservation Goals

Based on your 2009 Annual Report and the most recent conservation plan your utility filed with TWDB, we understand that your 5-year conservation goal is ____ GPCD and your 10-year goal is ____ GPCD.

8. How did your utility set these goals?

9. What did you use for a baseline in setting the goals?

10. Which elements of your conservation program do you feel will play the most important role in meeting these goals?

11. Have you attempted to project savings associated with individual measures from your conservation plan --e.g. rebate programs, leak detection, etc.? (If so, ask for projections and methodology).

12. Are savings from water conservation an important component for your utility in meeting future water demands?

13. Do you believe you are on track to achieve the goals?

14. How are you monitoring progress toward the goals?

15. Do you think it is important to have a standardized and consistent method to estimate conservation savings and track progress?

Ideas for Potential TWDB Tools and Methods

TWDB is interested in developing desktop methods to help the Board and individual water providers evaluate progress in achieving conservation savings. The alternatives could include either a "top down" approach, based on changes in water use in terms of GPCD, or a bottom up approach of attempting to add up the savings attributable to individual conservation measures (such as rebate programs, audit programs, public information, conservation rates, etc.).

16. Do you feel a "top down" approach or a "bottom up" approach is most appropriate for tracking actual conservation savings? Would your answer differ depending on whether it is the municipal provider themselves tracking the water savings or a state level tracking effort by the TWDB?

17. If conservation savings are estimated based on a top down approach (based on changes in GPCD), it seems important to attempt to account for the influences of weather and natural replacement (passive conservation) on annual GPCD. Do you agree that these factors need to be accounted for?

18. Do you have any suggestions on how they should be accounted for in this type of analysis?

19. Are there other factors that should be taken into account in estimating conservation savings based on changes in GPCD?

20. Overall, do you support TWDB's goal of developing better defined and more consistent approaches to measure actual conservation savings?

Stakeholder Review

Within the next few months, we will be preparing a draft report regarding current practices to quantify conservation savings and potential methods to develop more standardized approaches for quantification. We would like to ask you to review the draft report as part of a stakeholder review process. Would you be willing to review the report and provide comments and suggestions to us?

APPENDIX B.
Stakeholder Feedback Regarding Conservation Quantification Draft Report

On October 13-14, the BBC team distributed the preliminary draft report Water Conservation Savings Quantification Study (dated October 6, 2011) to the 43 municipal water providers previously interviewed by the study team. The stakeholders were given 30 days to review the preliminary draft report. The BBC team also sent a follow-up e-mail on November 7 to encourage review and feedback.

We received comments from 9 of the 43 stakeholders. The following table summarizes the comments and feedback regarding the preliminary draft report.

Figure 1.
Summary of Comments from Stakeholders

Municipal Water Provider	Summary of Comments
Cash Special Utility District (Clay Hodges)	Minor correction to description of the District's operations in Section 5. Support for Approach C in Issue/Recommendation #1, but suggestion that more site specific weather data should be used. Suggests using weather data for each county seat. Stated that "tools" for providers should be made available at no cost. Costs of software increase costs of conservation and reduce savings for small providers. Agreed with need for training (Issue/Recommendation #3) and suggested a regional training program where attendees could receive CEUs for their participation. Also suggested training could be supplied as an on-line course. Also suggested that the Texas Rural Water Association could be an asset in facilitating training for small systems.
City of Dallas Water Utilities (Carole Davis)	Minor changes to description of Dallas' methods for evaluating conservation savings in Section 5.

City of Brownwood ***(David Harris)***	"Overall the document looks OK." "More repetition than I would like, but it may be useful background if someone just reads one section and not the entire report." "I don't think many utilities will learn anything from the report that they don't already know." "…glad to see that statewide or even regional averages should not be used to critique a system but use of system specific trends was more appropriate."
City of Arlington ***(Darryl Westbrook)***	Concerned that on page 22 of Pdf, "effort" is suggested as a means of assessing progress. Strongly agree that slight variations in reporting requirements for different entities is time consuming (page 61 of Pdf). Agree that GPCD analysis should focus on changes over time. Agree that GPCD should be standardized as a starting point. In general, agrees with recommendations in the report. Consistency of application for the recommendations may be an issue. Resources for implementation are a concern. Suggests that bottled water should be taxed, with proceeds going to conservation programs and landfill recycling programs.
City of Kerrville ***(Grant Terry)***	Likes report and will forward up the management chain when finalized to help in updating their drought and conservation plans.

Springs Hill Water Supply Corporation (Jeanne Schnuriger)	Report was very well done.
City of Plano (Gentry Strickland)	"Looking forward to a user friendly version to be used for filing the TWDB annual report."
City of Abilene (Scott Hibbs, Enprotec/Hibbs & Todd, Inc.)	Report is extremely well prepared and will be a tremendous resource to the TWDB and water providers. Strongly agrees with statement on page 18 of Section 2 that comparison of GPCD between providers is irrelevant. The potential TWDB tools and methods are on target. Conclusion on page 7 of Section 6 that frequency of rainfall, as well as cumulative total, is important. Economic variability (as also discussed) is an important concept to continue to develop. Important to convert data to monthly using intake data for analysis purposes.
City of Murphy (Kim Lenoir)	Report looks great.

APPENDIX C.
Power Point Summary of the Study

Study Tasks

1. Project Communications and Reporting
2. Review Published Information on Conservation in Texas
3. Review Published Information on Conservation Elsewhere
4. Analyze Municipal Provider Conservation Plans & Annual Reports
5. Gather Additional Information from Providers
6. Evaluate/Develop Preliminary Recommendations/Draft Report
7. Stakeholder Review
8. Refinements and Final Report

Task 2: Conservation in 2006/07 Regional and State Water Plans

- By 2060, municipal conservation expected to provide about 617,000 acre-feet of water per year (7 percent of all new supplies).
- The figure below summarizes information from the regional plans.

Region	Municipal Conservation Savings	Estimated Projected Savings	Review of Existing Municipal Conservation
Panhandle (Region A)	✓	Section 4.3.2	
Region B	✓	Attachment 4-5	
Region C	✓	Appendix M	✓
North East Texas (Region D)			✓
Far West Texas (Region E)	✓	Section 4.4	✓
Region F	✓	Appendix 4I	
Brazos G (Region G)	✓	Section 4B.2	
Region H	✓	Appendix 4B	✓
East Texas (Region I)	✓	Chapter 4B	
Plateau (Region J)	✓	Chapter 4.5.4	
Lower Colorado (Region K)	✓	Appendix 4D	
South Central Texas (Region L)	✓	Section 4C.1	
Rio Grande (Region M)	✓	Chapter 4	
Coastal Bend (Region N)	✓	Section 4C.1	
Llano Estacado (Region O)	✓	Chapter 4.4.1	
Lavaca (Region P)			

Task 2: Special Regional Studies for Current Planning Process

- *Region C Water Conservation and Reuse Study*
- *Water Conservation Conference for Far West Texas Water Plan Region E*
- *Municipal Conservation Survey (Region F Water Planning Group)*
- *East Texas RWPG Study #3: Study of Municipal Uses to Improve Water Conservation Strategies and Projections*
- *Region L Study 3: Enhanced Water Conservation, Drought Management, and Land Stewardship*
- *Coastal Bend RWPG Study #5: Region Specific Water Conservation BMPs (Region N)*

Task 2: Published Information on Conservation in Texas

Relevant Studies Outside of the Regional and State Water Plans

- *Quantifying The Effectiveness Of Various Water Conservation Techniques In Texas (2002)*
- *Water Conservation Implementation Task Force: Report to the 79th Legislature and BMP Guide (2004)*
- *Final report – An Analysis of Water Loss as Reported by Public Water Suppliers in Texas (2007)*
- *A Report on the Progress of Water Conservation in Texas (2010)*
- *Recent reports from the Texas chapters of the National Wildlife Federation and Sierra Club (2010)*
- *TWDB Sunset Report (2010)*
- *Water Price Elasticities For Single-family Homes In Texas (1999)*

Task 2: Data Sources and Analytical Methods Currently Available to the TWDB

- Annual water use survey data
- Gallons per capita per day estimates
- Natural replacement projections
- Ranking of financial assistance applications
- Water conservation plans
- Annual water conservation implementation reports

Task 2: Summary Findings

- WUGs (and RWPGs) increasingly relying on conservation to meet future needs.
- Growing concern about lack of information on actual progress towards meeting goals.
- Most assessments to date have focused on “effort” rather than “achievement.”
- No Texas studies so far provide estimates of actual conservation savings achieved to date.
- Most studies and planning documents are focusing on changes in GPCD as the way to measure conservation savings.
- Proper measurement – and accounting for non-conservation factors – appear to be the key challenges in using changes in GPCD for this purpose.

Task 3: Published Information on Conservation in Other Places

Overall outline of Task 3 research and documentation

- Estimating Potential Conservation Savings (that *will* happen)
  - Data requirements
  - Estimating Savings by Best Management Practice or “Bottom Up” Approach
  - Estimating Savings Using an Aggregated or “Top Down” Approach
  - Monitoring Usage Trends

Task 3: Published Information on Conservation in Other Places

Overall outline of Task 3 research and documentation, continued

- Estimating Actual Conservation Savings (that *have* happened)
  - Conservation Targets and Evaluation Using a "Bottom Up" Approach
  - Conservation Targets and Evaluation Using a "Top Down" Approach
  - Challenges to Estimating Water Conservation Savings
  - Metrics for Evaluating Conservation Program Effectiveness
  - Further Research Recommended
- Available Conservation Calculation Tools

Task 3: Published Information on Conservation in Other Places

- Alliance for Water Efficiency
- AWWA
- State of California
- California Dept of Water Resources
- California Urban Water Agencies
- California Urban Water Conservation Council
- State of Washington
- Denver Water
- Georgia Department of Natural Resources
- New Mexico Office of the State Engineer
- Pacific Institute
- Phoenix Water Services Department
- Saving Water Partnership (Seattle Area)
- South Florida Water Management District
- U.S. Environmental Protection Agency
- Conserve Florida Water Clearinghouse
- Water Conservation Alliance of Southern Arizona

Task 3: Key Findings

- Data requirements and survey/monitoring needs required to develop valid results for evaluating specific conservation measures are extensive.
- Water suppliers should incorporate data collection and evaluation efforts into their conservation program at the planning stage, when funding is secured.
- Majority of national studies and guides address estimating potential water savings *likely to result* from practices and programs rather than the effectiveness of implemented programs.
- There is a lack of reliable knowledge of actual water savings, market penetration, and interaction effects.

Task 3: Key Findings, Continued

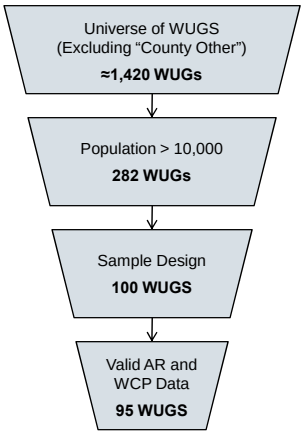
- Most studies determine total anticipated water conservation savings by aggregating the estimated savings from each best management practice to be implemented ("bottom up" approach), relying on end use studies.
- Program savings differ widely from utility to utility. Some of this can be attributed to different utility definitions of user categories (e.g., multifamily).
- Several external factors affect water use (e.g., weather, price changes, housing makeup, income, etc.), and require normalization or other considerations when comparing.
- Several "calculators" exist, for which extensive data are required. The results are only as strong as the data input.

Task 4: Review of Conservation Plans and Annual Reports

Objectives:

- Identify water conservation measures
- Analyze water savings estimates
- Identify savings estimation methods and data sources
- Identify providers for interviews in Task 5

Task 4: Sample Selection



Task 4: General Observations from WCPs

- WCPs contain many similar elements (consistent with Texas Administrative Code requirements).
- The WCPs vary widely in their descriptions of existing and proposed specific water conservation measures and programs.
- Often unclear how 5 and 10 year goals relate to the specific conservation measures described in the plan.
- Most of WCPs discuss measuring the effectiveness of their water conservation program using a "top-down" approach
- WCPs generally do not address other important factors that may affect GPCD (e.g. weather and natural replacement of fixtures).

Task 4: Conservation Measures from WCPs

- Plans vary in clarity regarding implementation status of conservation measures.
- 90 of the 97 plans with info on conservation measures discuss existing rate structures. Most WUGs (62) have adopted an increasing rate structure.

Conservation Measures	Number of Plans	Percent of Total (97)
Metered use	97	100%
Leak detection	97	100%
Education and Outreach		
School programs	63	65%
Public Service Annoucements	68	70%
Bill inserts	75	77%
Conservation web page	61	63%
Other	82	85%
Any ed/outreach	97	100%
Rebates		
Washing machine	8	8%
Toilet	13	13%
Other plumbing fixtures	10	10%
ET controllers	4	4%
Rain gauge	2	2%
Other	9	9%
Any rebate	17	18%
Irrigation Audits		
Identify customers	18	19%
On request	6	6%
Any irrig audit	22	23%
Conservation ordinances	78	80%
Reuse		
Industrial	23	24%
Landscape	28	29%
Rainwater	1	1%
Any reuse program	34	35%

City of Humble was excluded from the analysis since documentation received from TWDB only included a utility profile (with no information related to Humble's water conservation program).

Task 4: Tracking Conservation Savings

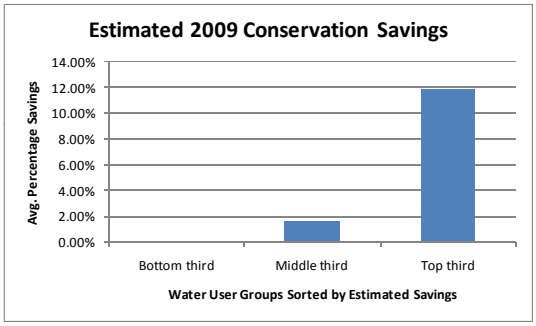
- Almost 80 percent of the plans directly address tracking the effectiveness of their conservation programs.
- About two-thirds of the WUGs plan to measure effectiveness through quantitative methods. Most commonly, WUGs discuss this issue as part of their “record management system.”
- Typically, WUGs intend to track GPCD, unaccounted-for water and other system-wide statistics. Plans often reference annual reporting requirements, and their intention to complete annual implementation forms.
- A handful of the plans qualify this approach to measuring the effectiveness of their program only during periods of “normal” weather.
- Plans do not discuss how to account for weather, natural replacement and other factors that might lead to differences in GPCD.

Task 4: General Observations from ARs

- The ARs, along with the WCPs, provide important data for evaluating municipal conservation efforts.
- Over 80 percent of WUGs rated their conservation programs as “Effective” or “Somewhat Effective.” Most others indicated they “Do Not Know.” These results vary by provider size.
- The ARs also provide estimates of 2009 water savings due to conservation and reported expenditures for conservation programs.
- 2009 was the first reporting period for the ARs. Not surprisingly, there appeared to be some confusion in responding to the form.
- Minor modifications to the AR form might improve the data from future reports.

Task 4: Estimated Water Saved in 2009

- 67 out of 95 WUGs provided conservation savings estimates for 2009 (including reported zeros).
- Annual mean savings estimate was 4.9% of total treated or diverted water (median was 2.1%).
- Savings estimates not correlated with WUG size.



Task 4: Conservation Spending in 2009

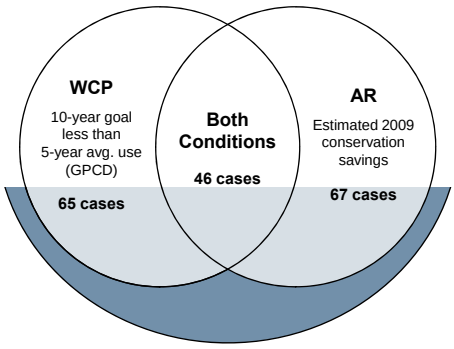
- 59 of the 95 WUGs provided an estimate of their conservation spending in 2009 – the study team converted these estimates into spending per capita for analysis.
- The average (mean) spending on conservation was $6.23. Weighted by system size, the average was $4.39 per capita.
- Estimated mean spending per capita is heavily influenced by a few utilities reporting large conservation expenditures. Median spending was much lower ($0.23 per capita).

		Spending per Capita	
Program Self Evaluation	**Number**	**Mean**	**Median**
Effective	22	$14.09	$0.48
Somewhat Effective	31	$1.64	$0.10
Less than Effective	1	$0.16	$0.16
Not Effective	0		
Do Not Know	5	$1.26	$0.13
Overall	59	$6.23	$0.23

Task 4: Conservation Goals Compared to Historic Use

- For 65 of 95 providers, the 10 year goal in GPCD is lower than their historic, 5 year average use.
- Among these 65 providers, the 10 year goal requires an average reduction in GPCD of about 11 percent.

System Size (Population)	All 95 Providers			10-yr Goal < Historic Use		
	Number	Change in GPCD* 5-yr Goal	10-yr Goal	Number	Change in GPCD* 5-yr Goal	10-yr Goal
100,000+	20	1%	-2%	13	-5%	-8%
25,000-99,999	40	-1%	-4%	26	-10%	-13%
Less than 25,000	35	4%	0%	26	-6%	-10%
Overall	95	1%	-2%	65	-7%	-11%



Task 5: Provider Interviews and Data Collection

Interview Guide – three major areas of inquiry:

- **Estimating water conservation savings achieved to date** – how did they respond to this question in their Annual Report?
- **Five- and 10-year conservation goals** – how were they established? Are they on track?
- **Ideas for potential TWDB tools and methods** – which approaches do they feel are most appropriate for quantifying savings? How can TWDB help them?

Task 5: Sample of Completed Interviews

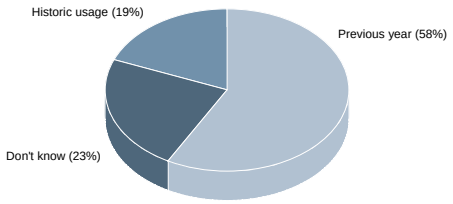
	Number of Providers		
		Interviews	
Region	Overall	Target	Completed
A	3	2	3
B	1		
C	35	16	13
D	5	3	1
E	2	1	2
F	4	2	3
G	10	2	5
H	15	7	5
I	3		
J	1	1	1
K	3	2	2
L	8	6	5
M	2	2	1
N	2	1	2
O	3	1	
P	1		
Total	**98**	**46**	**43**

	Number of Providers		
		Interviews	
Service Area Population	Overall	Target	Completed
100,000+	23	13	17
25,000-99,999	37	20	16
Under 25,000	38	13	10
Total	**98**	**46**	**43**

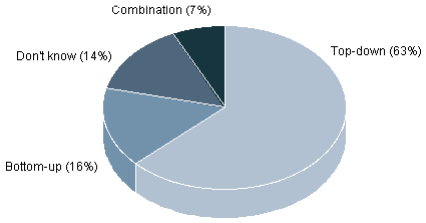
	Number of Providers		
Conservation Self		Interviews	
Evaluation	Overall	Target	Completed
Effective	28	17	14
Somewhat Effective	50	25	24
Less than Effective	4	1	0
Do Not Know	13	3	2
No Data			3
Total	**95**	**46**	**43**

Task 5: Analysis of Interview Responses

Interpretation/approach to the AR savings question varied.
Providers baseline for comparison:



Approaches to developing savings estimates



Task 5: Key Themes from Interviews

- Tools and methods must be useful to and usable by different providers.
- Water providers want to streamline their reporting.
- Both top-down and bottom-up approaches are important.
- Analyses of GPCD should focus on changes over time rather than comparisons across providers.

Task 5: Case Studies of Selected Providers

Large	Medium	Small
Dallas	Denton	Cash SUD
SAWS	Georgetown	Springs Hill WSC
El Paso	San Marcos	
Austin		

Task 6: Overall Findings

- Estimating actual water conservation savings is not a simple task, and Texas is not alone in struggling with this challenge
- Change in GPCD over time is a useful metric, but requires consistent data collection and adjustments for other factors affecting water use
- Comparison of GPCD between providers is not helpful in assessing conservation savings
- Providers currently use a variety of methods to estimate savings, with top down (GPCD-based) approaches being the most common
- Providers are interested in assistance from TWDB in developing more consistent data and in analyzing the data

Task 6: Recommendation 1

Consider developing a statistical (econometric) model to estimate statewide and regional conservation savings

- A "panel model" based on data TWDB already collects, plus other public data, could produce estimates of conservation savings net of variability in weather, economic conditions and other factors
- This type of analysis would produce estimates, which would be subject to uncertainty due to both model specification/data limitations and statistical uncertainty
- Model development and maintenance would require additional TWDB resources (time and money)

Task 6: Recommendation 2

Consider developing a new "desktop" tool to assist providers in standardizing data collection and analyzing data

- There are a range of existing tools available, but none are ideally suited to meet the needs of Texas providers
- A tool could be developed to leverage the strengths of various existing tools, customized to provider needs in Texas
- Development of the tool would require time (including pilot testing and refinement) and resources. Extensive training would also be required to make the tool useful for providers.

Task 6: Recommendation 3

Seek to develop a common, web-based, data collection and reporting system

- Providers report that varied reporting requirements for local, state and federal agencies are an increasing burden
- Developing a common platform that would provide the data needed by the various agencies could both reduce provider effort and increase data quality and consistency

APPENDIX D.
Comments from TWDB Staff Regarding Draft Final Report

TWDB staff provided comments on the draft report. Those comments, and the study team's responses, are provided below.

- As part of Task 1, the Contractor was required to meet with TWDB staff on 3 occasions. If there was any pertinent direction given or changes to the study direction/scope clarifications as a result of these meetings, it would be useful to include a brief summary of meeting results, for example, in an appendix.

  Response: A brief summary of the three meetings has been added to Section 1 (Introduction).

- As part of Task 2, the Contractor reviewed published information on municipal water conservation in Texas. Although the Contractor included Region Specific studies from the 2011 Regional Water Plans and older RWPs, it is not clear whether they reviewed any of the actual 2011 RWPs. It would be beneficial if the Contractor reviewed said plans, as they were available as early as the spring of 2010 in draft form, and if not, provide the reason why.

  Response: TWDB staff provided information from the draft regional plans to us from their database and t his information was reviewed and considered during the study.

- Throughout Chapter 2, the report mentions the difficulty in trying to compare GPCDs between water systems. The report refers several times to the fact that it would not be comparing "apples to apples". It would be beneficial if the report further explained why that is, i.e. large cities are likely to have a higher GPCD due to a larger amount of facilities such as office buildings, malls, tourist destinations with visitors, sprawling rural systems etc.

  Response: Further explanation has been added in Section 2.

- Task 4 deliverable states: "Contractor will prepare and present an interim report in the form of a presentation at the mid-point meeting…" Please include a reference/documentation within the report related to this scope item, for example, as an appendix.

  Response: The presentation provided as the interim report was expanded at the end of the study to encompass the full scope of the work, the findings and the recommendations. The expanded presentation is included in the report as Appendix C.

- Task 5 states: "The Contractor will also gather information regarding: the interview responses obtained from regional water planning group chairs by the Texas Water Conservation Advisory Council regarding implementation of conservation water management strategies in regional water plans." This item does not appear to be included in the draft report.

  Response: The information that the WCAC obtained from the regional water planning group interviews was summarized on Section 2, page 5.