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Executive Summary

Introduction

In May 2001, the Texas Water Development Board (TWDB) selected GDS Associates, Inc. (GDS) to perform a research study quantifying the effectiveness of various water conservation techniques (Study). The main purpose of the Study is to provide information regarding the effectiveness and costs of water conservation strategies on a regional level. The study also provides the sixteen water-planning regions (Regions) with comprehensive water conservation planning alternatives, as well as providing the TWDB with information to assist in the development of more accurate water demand scenarios.

The Study standardizes the language used to discuss and describe water conservation techniques in Texas. In general, the term **water conservation** is associated with a plan or program consisting of several strategies or techniques that when implemented reduces the overall demand for water and increases the efficiency of a water system. In this Study, a **water efficiency strategy** is an action or technique designed to result in the more efficient use of water. Water efficiency strategies consist of two types – **water efficiency measures** and **water efficiency incentives**. Water efficiency measures are specific tools, devices, and practices that result in the more efficient water use such as single-family (SF) toilet retrofits and clothes washer rebates. Water efficiency incentives promote water conservation and motivate customers to adopt specific water efficiency measures. Water efficiency incentives include education programs, water use regulations, and water rates. This Study focuses primarily on water efficiency measures. Since effective water conservation plans include both water efficiency measures and incentives, water efficiency incentives are briefly discussed within the context of providing the Regions with additional water conservation planning alternatives.

Water Efficiency Strategies

GDS identified sixteen residential and commercial water efficiency measures to include in the Study. Residential water efficiency measures are defined as measures for SF water use customers living in homes or duplexes and multi-family (MF) customers living in structures with housing units of three or more. Commercial water efficiency measures are measures for business water use customers excluding manufacturing, steam electric, mining, agricultural irrigation, and livestock. The sixteen water efficiency measures included in the Study are provided below:

<u>Residential</u>

- SF Toilet Retrofit
- SF Showerheads and Aerators
- SF Clothes Washer Rebate
- SF Irrigation Audit for High Users
- SF Rainwater Harvesting
- SF Rain Barrels
- MF Toilet Retrofit
- MF Showerheads and Aerators
- MF Clothes Washer Rebate
- MF Irrigation Audit
- MF Rainwater Harvesting

Commercial

- Commercial Toilet Retrofit
- Coin-Operated Clothes Washer Rebate
- Irrigation Audit
- Commercial General Rebate
- Commercial Rainwater Harvesting

For each measure, GDS calculated and determined estimated costs and potential water savings, identified expected customer participation rates, and projected a lifetime.

Estimated Costs

GDS calculated the costs for each water efficiency measure by estimating, as needed, both direct and indirect costs. Direct costs are the costs paid to implement the measure, such as a rebate or the labor cost to perform the service such as an audit. Indirect costs are in-house services including marketing, labor, and overhead. The indirect costs were based upon two items: 1) an hourly rate of $25 that includes the overhead costs associated with employee benefits and 2) an average amount of $10 per measure, person, or unit for marketing, processing, and administrative costs. Costs for measures will vary if the rebate amount changes or the labor costs are different from the estimates provided. For this Study, the costs for each water efficiency measure remain the same for each Region.

Potential Water Savings

The savings for each residential water efficiency measure were calculated for each measure in gallons per day (gpd) and per person in gallons per capita per day (gpcd). Where the size of the household is directly related to the water savings, the savings per person was used to calculate the savings per measure. Generally, these measures affect residential indoor water use. For example, changing out SF toilets will save approximately 10.5 gallons per person per day (gpcd) (*American Water Works Association Research Foundation, Residential End Use Study, 1999*). To calculate the savings per measure for the SF Toilet Retrofit, the 10.5 gpcd is multiplied by SF household size then divided by 2 measures (i.e. toilets for this example) per living unit. Therefore, the savings per person (gpcd) remains constant, while the savings per measure (gpd) varies between regions.

Where water efficiency measures are not affected by household size the savings per measure (gpd) is used to calculate the savings per person (gpcd). Generally, these measures affect residential outdoor water use. For example, a SF Irrigation Audit will save an estimated 50 gallons per measure (gpd). The gallons per person (gpcd) is calculated by multiplying 50 gpd by 1 measure per living unit then dividing by 2.47 SF household size. Therefore, the savings per measure (gpd) remains constant while the savings per person (gpcd) varies between regions.

As commercial water savings are not dependent on household size, the savings for commercial water efficiency measures in this Study are reported in savings per measure (gpd).

Maximum Participation Rates

GDS identified maximum participation rates for each water efficiency measure. The maximum participation rates are based upon the maximum percentage of eligible customers who could reasonably be expected to participate in an implemented water efficiency measure. Assumptions were made for each measure regarding the percentage of customers that have already implemented a measure due to regulation, natural replacement, or other factors. The maximum participation rates are also based on the assumption that an effective and aggressive marketing and outreach approach effort is implemented. For the purposes of this Study, maximum participation rates do not vary between Regions.

Projected Lifetime

GDS provided information regarding the projected lifetime for each water efficiency measure. For the Study, the projected lifetime is based upon the life of the device, amount of customer education, and type of materials. For example, replacing higher flush volume toilets with 1.6 gallons per flush toilets in a SF Toilet Retrofit should result in permanent savings as long as the new device is well maintained. Additionally, since a SF Toilet Retrofit is a hardware change and not dependent on customer education, the savings should be permanent. Further, if a new toilet breaks, only efficient toilets can now be purchased since the Texas Plumbing Efficiency Standards went into effect in 1992. On the other hand, irrigation audits are extremely dependent on customer education. Once an irrigation audit is complete, the savings depend on how well customers implement the recommendations to adhere to a watering schedule, repair broken sprinkler heads, etc. In order to maintain the savings of an irrigation audit over time, frequent follow-ups with the customer is necessary.

As water efficiency measures can impact water savings differently when implemented in various population concentrations, GDS analyzed the cost and savings of the sixteen water efficiency measures for three distinct population areas – urban, suburban, and rural. The United States Census Bureau defines urban areas as cities designated as Metropolitan Statistical Area (MSA) cities. Suburban areas are defined as non-MSA cities located in the counties making up each MSA. Rural areas are defined as cities and counties that lie outside of MSA Counties.

Cost-Savings Analysis

For each Region, GDS analyzed the costs and savings of the sixteen water efficiency measures for urban, suburban, and rural population areas. Each computational sheet includes: input data, estimated costs, the number of measures per living unit, water efficiency measure savings, and delivery options.

Input Data

The savings for each water efficiency measure are dependent upon several assumptions that remain the same for each Region. They include:

- 2.0 Bathrooms per SF House
- 1.2 Bathrooms per MF Unit
- 6 Irrigation Months
- 10 percent of SF Customers are “High Use” Customers (SF customers that use 20,000 gallons of water per month for irrigation during an irrigation season of six months)
- 18 MF Units per Clothes Washer
- 50 MF Units per Complex

The savings for each water efficiency measure varies for each Region based upon variables that differ between regions. These variables include:

- SF Population
- MF Population
- Number of SF Units
- Number of MF Units
- SF Household Size
- MF Household Size
- Average Yearly Rainfall

Estimated Costs

In the cost-savings analysis, GDS used the cost per measure to calculate a cost per acre-foot of water saved, which was then amortized at 5 percent interest over the life of the measure.

Number of Measures per Living Unit

For each water efficiency measure, the number of measures needed for each living unit was determined based upon input data described above.

Projected Water Savings

The water savings for each water efficiency measure were reported in three ways:

- water savings per residential capita in gallons per person per day.
- water savings per living unit in gallons per day
- water savings per measure in gallons per day

Delivery Options

For each water efficiency measure, delivery options are provided for which the costs are estimated. Delivery options are the methods of implementing a measure. Additionally, GDS included other possible delivery options, which if used, may increase or decrease the cost of a measure.

Per Capita Water Use

To assist the Regions in making water conservation planning decisions, GDS also calculated average annual per capita water use for each Region. The per capita numbers are also reported for urban, suburban, and rural areas and include figures for base use, seasonal use, and the dry year for the years analyzed. With such numbers, the Regions will be able to target water efficiency measures to specific areas and times.

GDS calculated the average annual per capita water use using the most current 10-year data available from the TWDB at the time of this Study – (1988 through 1997). Monthly water use data for each city was divided by the average monthly use for that year to determine what decimal fraction of annual water use occurred each month. This decimal fraction was then multiplied by the annual per capita water use for that year to obtain a monthly distribution of per capita uses. The base use per capita was determined by averaging the three winter months of December, January, and February. Average annual per capita water use (gpcd) was also separated into seasonal use. Seasonal use was calculated by taking the difference between base gpcd and annual gpcd.

The average annual per capita water use for dry year conditions was identified for each Region by selecting the highest per capita water use year in the 10-year period (1988-1997).

Summary

This Study provides each Region with estimated costs and projected savings for sixteen water efficiency measures, discussions on water efficiency incentives, and average annual per capita water use. The assumptions used in this report reflect realistic scenarios and water utility experiences. The data are presented in such a way as to offer the Regions flexibility when considering different water efficiency measures. With the data provided, Regions have additional tools to develop more detailed analyses and make local water savings projections.

Acknowledgements

The following individuals and organizations provided valuable expertise and information during the development of this Study:

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Hari Krishna, Ph.D., P.E., Texas Water Development Board

Section 1 Introduction

GDS Associates, Inc. (GDS) performed this research study to quantify the effectiveness of various water conservation techniques (Study) as directed by the Texas Water Development Board (TWDB). The main purpose of this Study is to provide information regarding the effectiveness and costs of water conservation strategies on a regional level. The sixteen water-planning regions of Texas (Regions) are shown in *Attachment I*. The study also provides the Regions with comprehensive water conservation planning alternatives as well as providing the TWDB with information to assist in the development of more accurate water demand scenarios. With this Study, Regions have computational tools and research information to determine the most effective water conservation strategies to reduce water use.

This Study standardizes the language used to discuss and describe water conservation techniques in Texas. In general, the term **water conservation** is associated with a plan or program consisting of several strategies or techniques that when implemented reduce the overall demand for water and increase the efficiency of a water system. In this Study, a **water efficiency strategy** is an action or technique designed to result in the more efficient use of water. Water efficiency strategies consist of two types – **water efficiency measures** and **water efficiency incentives**. Water efficiency measures are specific tools, devices, and practices that result in more efficient water use such as single-family toilet retrofits and single-family clothes washer rebates. Water efficiency incentives promote water conservation and motivate customers to adopt specific water efficiency measures such as education programs and water use regulations. The Study primarily focuses on water efficiency measures. Since effective water conservation plans include both water efficiency measures and incentives, water efficiency incentives are briefly discussed within the context of providing the Regions with additional water conservation planning alternatives.

The Study is presented in Sections 2 - 5 as follows:

Section 2 offers detailed information and data on the costs and savings for sixteen water efficiency strategies, presents general information on water efficiency incentives, and addresses the need for public information programs.

Section 3 provides details on the cost-savings analysis performed for the sixteen water efficiency strategies. The cost-savings analysis for each of the Regions can be found in *Attachment VI*.

Section 4 offers average annual per capita water use numbers for each of the Regions by urban, suburban, and rural population areas.

Section 5 includes GDS' conclusions.

This Study provides each Region with estimated costs and projected savings for sixteen water efficiency measures and average annual per capita water use. The Study also discusses water efficiency incentives as well as other pertinent water efficiency strategies. The data is presented in such a way as to offer each Region flexibility when considering different water efficiency measures.

Section 2 Water Efficiency Strategies

2.1 Study Approach

GDS identified sixteen residential and commercial water efficiency measures to include in this Study. Residential water efficiency measures are defined as measures for single-family (SF) water use customers living in homes or duplexes and multi-family (MF) customers living in structures with housing units of three or more. Commercial water efficiency measures are measures for business water use customers excluding manufacturing, steam electric, mining, agricultural irrigation, and livestock. The sixteen water efficiency measures included in this Study are provided below:

Residential

- SF Toilet Retrofit
- SF Showerheads and Aerators
- SF Clothes Washer Rebate
- SF Irrigation Audit for High Users
- SF Rainwater Harvesting
- SF Rain Barrels
- MF Toilet Retrofit
- MF Showerheads and Aerators
- MF Clothes Washer Rebate
- MF Irrigation Audit
- MF Rainwater Harvesting

Commercial

- Commercial Toilet Retrofit
- Coin-Operated Clothes Washer Rebate
- Irrigation Audit
- Commercial General Rebate
- Commercial Rainwater Harvesting

2.2 Calculations and Assumptions

For each water efficiency measure, GDS provides expected maximum participation rates, estimated costs, potential savings, and projected lifetime.

2.2.1 Maximum Participation Rates

GDS identified maximum participation rates for each water efficiency measure. Maximum participation rates are assumptions based on professional experience, which indicate the maximum percentage of customers who could reasonably be expected to participate in an implemented measure. For each measure, the maximum participation rates are based on the estimated percentage of customers that have already implemented a measure due to regulation, natural replacement, or other outside factors. For the purposes of this Study, maximum participation rates do not vary between Regions.

2.2.2 *Estimated Costs*

GDS calculated the costs for each water efficiency measure by determining estimates for both direct and indirect costs. Direct costs are the costs paid to implement a measure, such as a rebate, or the labor cost to perform the service, such as an audit. Indirect costs are in-house services including marketing, overhead labor, and miscellaneous supplies. The indirect costs were based upon two items: 1) an hourly rate of $25 that includes the overhead costs associated with employee benefits and 2) an average amount of $10 per measure, person, or unit for marketing, processing, and administrative costs. For the purposes of this Study, the costs for each water efficiency measure remain the same for each Region. However, costs for water efficiency measures can vary between Regions if the rebate amount changes or the labor costs are different from the estimates provided.

2.2.3 *Projected Savings*

The savings for each residential water efficiency measure were calculated per measure in gallons per day (gpd) and per person in gallons per capita per day (gpcd). Where the size of the household is directly related to the water savings, the savings per person was used to calculate the savings per measure. Generally, these measures affect residential indoor water use. For example, exchanging SF higher flush volume toilets for 1.6 gallons per flush toilet will save approximately 10.5 gallons per person per day (gpcd) (*American Water Works Association Research Foundation, Residential End Use Study, 1999*). To calculate the savings per measure for the SF Toilet Retrofit, the 10.5 gpcd is multiplied by SF household size then divided by 2 measures (i.e. toilets for this example) per living unit. Therefore, the savings per person (gpcd) remains constant, while the savings per measure (gpd) varies between regions.

Where water efficiency measures are <u>not</u> affected by household size, the savings per measure (gpd) is used to calculate the savings per person (gpcd). Generally, these measures affect outdoor water use. For example, a SF Irrigation Audit will save an estimated 50 gallons per measure (gpd). The gallons per person (gpcd) is calculated by multiplying 50 gpd by 1 measure per living unit then dividing by 2.47 SF household size. Therefore, the savings per measure (gpd) remains constant while the savings per person (gpcd) varies between regions.

As commercial water savings are not dependent on household size, the commercial water efficiency measures' savings in this Study are only reported in savings per measure (gpd).

The savings for water efficiency measures are dependent upon several assumptions that remain the same for each Region including:

- 2.0 Bathrooms per SF House
- 1.2 Bathrooms per MF Unit
- 6 Irrigation Months
- 10 percent of SF Customers are "High Use" Customers (SF customers that use at least 20,000 gallons of water per month for irrigation during an irrigation season of six months)
- 18 MF Units per Clothes Washer
- 50 MF Units per Complex

For details on the assumptions presented above, see *Section 3.1.2* of this report.

The savings for water efficiency measures are dependent upon several variables that differ between Regions. These variables include:

- SF Population
- MF Population
- Number of SF Units
- Number of MF Units
- SF Household Size
- MF Household Size
- Average Yearly Rainfall

2.2.4 Projected Lifetime

GDS included information regarding the projected lifetime for each water efficiency measure, as it is an important factor when choosing a measure to implement. For the Study, the projected lifetime is based upon the life of the device, amount of customer education, and type of materials. For example, replacing higher flush volume toilets with 1.6 gallons per flush toilets in a SF Toilet Retrofit should result in permanent savings as long as the new device is well maintained. Additionally, since a SF Toilet Retrofit is a hardware change and not dependent on customer education, the savings should be permanent. Further, if the new toilet breaks, only efficient toilets can now be purchased due to the Texas Plumbing Efficiency Standards that went into effect in 1992. The standards require that toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet water efficient criteria. In contrast, irrigation audits are extremely dependent on customer education. Once an irrigation audit is complete, the savings depend on how well customers implement recommendations such as adhering to a watering schedule, repairing broken sprinkler heads, etc. In order to maintain the savings of an irrigation audit over time, frequent follow-ups with the customer is necessary.

2.3 Water Efficiency Measures

The sixteen water efficiency measures presented in this Study do not address all possible water efficiency measures. GDS has focused on measures that are most likely to be implemented by utilities and that have been included in recent studies, reports, and articles.

As mentioned earlier in this section, the sixteen water efficiency measures are separated into two categories – residential and commercial. Residential measures are directed towards SF and MF water use customers and Commercial measures are directed towards commercial water use customers excluding manufacturing, steam electric, mining, agricultural irrigation, and livestock customers.

Each water efficiency measure presented in this section includes a brief description, expected customer participation rates, estimated costs, potential savings, and projected lifetime. All potential costs and savings presented are taken from studies, reports, articles, or are computed from engineering estimates, all of which are referenced throughout this section.

2.3.1 Residential Water Efficiency Measures

<u>SF Toilet Retrofit</u>

With a SF Toilet Retrofit, 1.6 gallon per flush toilets are provided to replace high volume flush toilets (3.5 - 7 gallons per flush) in homes built before 1992 when the Texas Plumbing Efficiency Standards went into effect. The standards require that toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet more water efficient criteria than under previous regulations. Toilets could be offered free or the customer could purchase any qualifying toilet and receive a rebate.

- *Maximum Participation Rate*
  Since the plumbing standards went into effect in 1992, 1 percent of eligible customers per year are assumed to have replaced toilets due to breakage, remodeling, etc. Thus, approximately 10 percent of eligible customers have already replaced older toilet models with more efficient devices. Therefore, it is assumed that 50 percent of eligible customers will participate in a SF toilet retrofit program.

- *Estimated Costs*
  Direct Costs: $60 for rebate or free toilet
  Indirect Costs: $25 for processing, inspection, and marketing
  Total Costs: $85

- *Water Savings*
  10.5 gallons per person (gpcd).
  Source: American Water Works Association Research Foundation, Residential End Use Study, 1999.

  Example gallons per measure (gpd) calculation:
  13.0 gallons per measure (gpd) Region A - Urban
  The gallons per measure (gpd) are calculated by multiplying 10.5 gpcd by 2.47 SF household size then dividing by 2 measures per living unit. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  If toilets selected cannot be altered to use more water, the lifetime of the measure would be permanent since only 1.6 gallons per flush (gpf) toilets can be purchased. Toilets have an average life of 25 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation.

SF Showerhead and Aerator Kits

Provide low-flow showerhead and faucet aerators to replace less efficient devices installed before 1992 when the Texas Plumbing Efficiency Standards went into effect. The standards required that toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet more water efficient criteria than under previous regulations. Generally, these are free kits that can be picked up at the water utility, local events, or dispensed with other utility programs such as when free toilets are distributed.

- *Maximum Participation Rate*
  Since the plumbing standards went into effect in 1992, 1 percent of eligible customers per year are assumed to have replaced showerheads and aerators due to breakage, remodeling, etc. Thus, approximately 10 percent of eligible customers have already replaced older showerheads and aerator model with more efficient devices. Therefore, it is assumed that 50 percent of eligible customers will replace less efficient showerheads and aerators with low-flow showerheads and aerators if kits are included in a public information/education program or other type of distribution program.

- *Estimated Costs*
  Direct Costs: $6 for 2 showerheads and aerators (bulk purchased)
  Indirect Costs: $1 for labor and marketing
  Total Costs: $7

- *Water Savings*
  5.5 gallons per person (gpcd).
  Source: BMP Costs & Savings Study, California Urban Water Conservation Council, July 2000.

  Example gallons per measure (gpd) calculation:
  6.8 gallons per measure (gpd) Region A - Urban
  The gallons per measure (gpd) are calculated by multiplying 5.5 gpcd by 2.47 SF household size then dividing by 2 measures per living unit. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  The lifetime of the measure would be permanent since only water efficient showerheads and aerators can be purchased. Showerheads and faucet aerators have an average life of 15 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation

SF Clothes Washer Rebate

Provide a rebate for high-efficiency clothes washers that have a water factor of not more than 9.5 gallons per cubic foot of washer capacity (27 gallons per load - depending on tank capacity of the particular model). Rebates can be offered in conjunction with local gas and electric utilities. Federal energy standards for clothes washers take effect in 2004 with only a slight improvement in water efficiency expected. A more stringent energy standard will take place in 2007 that should improve the water efficiency of all clothes washers. Conventional washers currently on the market have an average water factor of over 13 gallons per cubic foot and average 40.9 gallons per normal load which includes both wash and rinse cycles.
Source: American Water Works Association Research Foundation, Residential End Use Study, 1999.

- *Maximum Participation Rate*
  As long as less expensive washers remain on the market or until regulations change requiring more efficient machines to be manufactured, bought, or sold; market acceptance and demand will remain low. The assumption is that 5 percent of eligible customers have already purchased efficient clothes washers and if local energy utilities contribute an additional $100 (thereby reducing the incremental costs to a utility), 45 percent of eligible customers could be expected to participate.

- *Estimated Costs*
  Direct Costs: $100 for water utility portion of the incentive
  Indirect Costs: $20 for processing, inspection, and marketing
  Total Costs: $120

- *Water Savings*
  5.6 gallons per person (gpcd).
  Source: Deoreo, William, Report Realities. American Water Works Association Journal, Mar. 2001.

  Example gallons per measure (gpd) calculation:
  13.8 gallons per measure (gpd) Region A - Urban
  The gallons per measure (gpd) are calculated by multiplying 5.6 gpcd by 2.47 SF household size then dividing by 1 measure per living unit. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  If federal standards were maintained, the lifetime of the measure would be permanent. Since the life of a clothes washer is between 10 and 13 years, there should only be efficient clothes washers on the market after 2007. However, it is not known at the time of this report if all clothes washers offered after 2007 will have water factors of 9.5 gallons per cubic foot of washer capacity or less. It may be possible for appliance manufactures to meet the 2007 energy standards without maximizing water efficiency. Clothes washers have an average life of approximately 13 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation

<u>SF Irrigation Audits – High Users</u>

Irrigation audits are provided to customers that have underground irrigation systems and use 20,000 gallons of water or more per month during the summer months (mid-April through mid-October). With these audits water utility personnel identify ways to increase the efficiency of SF customer irrigation systems and reduce SF customer water use. Some ways may include, but are not limited to, proper scheduling, repairing breaks or leaks, and replacing broken sprinkler heads. Additionally, the customer could be offered rebates for items that would allow their system to operate more efficiently such as rain sensor devices.

- *Maximum Participation Rate*
  The assumption is that 10 percent of residential customers are high users (consume more than 20,000 gallons per month for outdoor usage during the summer months) who would qualify for this measure and that half of these customers would participate in the program. Therefore, 5 percent of eligible customers could be expected to participate.

- *Estimated Costs*
  Direct Costs: $50 for labor (to perform SF Irrigation Audit)
  Indirect Costs: <u>$20</u> for administration and marketing
  Total Costs: $70

- *Water Savings*
  50 gallons per measure (gpd). The savings calculation assumes an average outdoor water use of 500 gpd and an average audit savings of 10 percent. Therefore, a SF irrigation audit would result in a reduction of 50 gpd. The calculation assumes the following:

  - 20,000 gallons per month during the summer months (180 days) is considered high usage;
  - the audit results in 10 percent reduction of water use during the summer months; and
  - the estimated savings computes to 100 gallons per day during the summer months and are then annualized.

Example gallons per person (gpcd) calculation:
20.3 gallons per person (gpcd) Region A - Urban
The gallons per person (gpcd) is calculated by multiplying 50 gpd by 1 measure per living unit then dividing by 2.47 SF household size. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 3 years if follow-ups are provided, such as a reminder letter or additional audits. As this measure requires substantial customer education and action, the lifetime of the savings is short.

<u>SF Rainwater Harvesting Rebate</u>

Provide a $200 rebate for the installation of a rainwater harvesting system. For the purposes of this Study, the average system is projected to include a 1,000-gallon collection tank and cost approximately $670 including tank, pump, and roof washer.

- *Maximum Participation Rate*
  The assumption is that 5 percent of residential customers will participate. This rate is based upon current market acceptance and demand, which, at the time of this Study, are generally low. As technology becomes more affordable and demand increases, participation rates will increase accordingly.

- *Estimated Costs*
  Direct Costs: $200 for rebate
  Indirect Costs: <u>$50</u> for labor and marketing
  Total Costs: $250

- *Water Savings*
  21.6 gallons per measure (gpd). (*The savings per measure varies with each region due to average annual rainfall. The 21.6 gpd reported is for Region A - Urban.)*

  The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions:

  - 2,000 square-foot roof;
  - irrigation demand of 500 gallons every five days;
  - a 1,000-gallon tank; and
  - after each rainfall of 0.2 inches or greater, it is assumed that there will be no water demand for five days.

  The Austin Model savings of 35.2 gpd were adjusted for each region based upon the ratio of Regional average annual rainfall to the City of Austin's rainfall. The ratio is [35.2 gpd X Region average annual rainfall ÷ 31.9 inches City of Austin rainfall]. For details on the 35.2 gpd calculation, see *Attachment II*.

  A 1,000-gallon tank size was chosen for two reasons. First, a 1,000-gallon tank produces the most savings per customer dollar spent. Second, a 1,000-gallon tank is a size more likely to be acceptable to customers. A 1,000-gallon system including tank, roof washer, and pump costs approximately $670. For a 2,000-gallon tank, the savings per capita increase to 46.7 gallons per day, which is about a 33 percent increase in savings for a tank twice as large. If rainwater systems are buried or designed as part of new home construction, it is likely that customers would be willing to select larger tanks.

Example gallons per person (gpcd) calculation:
8.7 gallons per person (gpcd) Region A - Urban
The gallons per person (gpcd) is calculated by multiplying 21.6 gallons per day by 1 measure per living unit then dividing by 2.47 SF household size. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 15 years based upon the life of the polypropylene (or similar material) collection tank, which is the most significant portion of measure's cost.
  Source: Heinichen, Richard. Tank Town. Personal Interview. 1 Oct. 2001.

Note: The savings for a SF rainwater harvesting measure presented in this report are based upon a tank size of 1,000 gallons and a 500-gallon demand every five days. However, more water savings can be achieved with a larger tank size. As water savings are higher with larger tanks, the cost of the measure will also be higher. Therefore, it may be necessary to evaluate the impact of the cost to implement the measure with larger tank sizes on expected participation rates. In *Attachment II*, GDS provides an example of water savings that can be achieved with larger tank sizes, water demand, and roof sizes.

SF Rain Barrels

Provide 75-gallon rain barrels at a reduced cost or offer a rebate on the purchase of a barrel.

- *Maximum Participation Rate*
  The assumption is that 30 percent of residential customers will participate. This rate is based upon current market acceptance and demand, which, at the time of this report, are generally low. However, as demand increases participation rates will also increase.

- *Estimated Costs*
  Direct Costs: $35 for rebate
  Indirect Costs: $10 for labor and marketing
  Total Costs: $45

- *Water Savings*
  2.3 gallons per measure (gpd) (*The savings per measure varies with each region due to average annual rainfall. The 2.3 gpd reported is for Region A - Urban.)*

  The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions:

  - 500 square-foot roof;
  - irrigation demand of 75 gallons per day;

- a 75-gallon barrel; and
- after each rainfall of 0.2 inches or greater, it is assumed that there will be no water demand for five days.

The Austin Model savings of 35.2 gpd were adjusted for each region based upon the ratio of Regional average annual rainfall to the City of Austin's rainfall. The ratio is [35.2 gpd X Region average annual rainfall ÷ 31.9 inches City of Austin rainfall]. For details on the 35.2 gpd calculation, see *Attachment II*.

Example gallons per person (gpcd) calculation:
0.9 gallons per person (gpcd) Region A - Urban
The gallons per person (gpcd) is calculated by multiplying 2.3 gallons per day by 1 measure per living unit then dividing by 2.47 SF household size. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to SF household size.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 15 years based upon the rain barrel life, which is the most significant portion of the measure's cost.
  Source: Heinichen, Richard. Tank Town. Personal Interview. 1 Oct. 2001.

<u>MF Toilet Retrofit</u>

With a MF toilet retrofit, 1.6 gallons per flush toilets are provided to replace high flush toilets in housing units built before 1992 when the Texas Plumbing Efficiency Standards went into effect. Toilets could be offered free or the customer could purchase any qualifying toilet and receive a rebate.

- *Maximum Participation Rate*
  Since the plumbing standards went into effect in 1992, 1 percent of eligible customers per year are assumed to have replaced showerheads and aerators due to breakage, remodeling, etc. Thus, approximately 10 percent of eligible customers have already replaced older showerhead and aerator models with more efficient devices. With multi-family customers, participation rates are higher than with SF customers due to lower labor costs per unit, the dual benefit of new plumbing fixtures and cost savings to property managers and owners, and large-volume toilet replacements made by one decision maker. Therefore, it is assumed that 60 percent of eligible customers will participate in a MF toilet retrofit program.

- *Estimated Costs*

Direct Costs:	$60 for rebate or free toilet
Indirect Costs:	<u>$15</u> for processing, inspection, and marketing
Total Costs:	$75

- *Water Savings*
  10.5 gallons per person (gpcd).
  Source: American Water Works Association Research Foundation, Residential End Use Study, 1999. A 2001 study performed by the City of Austin, Texas, found that retrofitting apartments built before 1980 resulted in an average savings of 21.2 gpcd and savings of 18 gpcd for those complexes built after 1980. The City of Austin study found an average of 1.2 toilets per unit and an average of 2.0 persons living in each unit. Therefore, the 10.5 gpcd being used appears to be very conservative.

Example gallons per measure (gpd) calculation:
12.0 gallons per measure (gpd) Region A - Urban
The gallons per measure (gpd) are calculated by multiplying 10.5 gpcd by 1.37 MF household size then dividing by 1.2 measures per living unit. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to MF household size.

- *Project Lifetime*
  If toilets selected cannot be altered to use more water and are maintained, the lifetime of the measure would be permanent since only 1.6 gallons per flush (gpf) toilets can be purchased. Toilets have an average life of 25 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation.

<u>MF Showerhead and Aerator Kits</u>

Provide low-flow showerhead and faucet aerators to replace less efficient devices installed before 1992 when the Texas Plumbing Efficiency Standards went into effect. The standards required that toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet more water efficient criteria than under previous regulations. Generally, these are free kits that can be picked up at the water utility, local events, or dispensed with other utility programs such as when free toilets are distributed.

- *Maximum Participation Rate*
  Since the plumbing standards went into effect in 1992, 1 percent of eligible customers per year are assumed to have replaced toilets due to breakage, remodeling, etc. Thus, approximately 10 percent of eligible customers have already replaced older toilet models with more efficient devices. With multi-family customers, participation rates are higher than with SF customers due to lower labor costs per unit, the dual benefit of new plumbing fixtures and cost savings to property managers and owners, and large-volume toilet replacements made by one decision maker. Therefore, it is assumed that 60 percent of eligible customers will participate in a MF toilet retrofit program.

- *Estimated Costs*

Direct Costs:	$3 for one showerhead and one aerator (1.1 bathroom per unit) (bulk purchased)
Indirect Costs:	<u>$1</u> for labor and marketing
Total Costs:	$4

- *Water Savings*
  5.5 gallons per person (gpcd).
  Source: BMP Costs & Savings Study, California Urban Water Conservation Council, July 2000.

  Example gallons per measure (gpd) calculation:
  6.3 gallons per measure (gpd) Region A - Urban
  The gallons per measure (gpd) are calculated by multiplying 5.5 gpcd by 1.37 MF household size then dividing by 1.2 measures per living unit. The savings per measure will vary for each region and population area (urban, suburban, or rural) due to MF household size.

- *Projected Lifetime*
  The lifetime of the measure would be permanent since only water efficient showerheads and aerators can be purchased. Showerheads and aerators have an average life of 15 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation

MF Clothes Washer Rebate

A rebate is provided for high-efficiency clothes washers that have a water factor of not more than 9.5 gallons per cubic foot of washer capacity. If possible, offer a rebate in conjunction with local gas and electric utilities. The Federal energy standards for residential clothes washers that take effect in 2004 do not apply to coin-operated washing machines. Conventional washers currently on the market have an average water factor of over 13 gallons per cubic foot and average 35 gallons per normal load which includes both wash and rinse cycles.
Source: Consortium for Energy Efficiency, Fact sheet for Commercial Clothes Washer Incentive.

- *Maximum Participation Rate*
  The assumption is that 2 percent of eligible customers have already purchased efficient washers. As long as less expensive washers remain on the market or until regulations change requiring more efficient machines to be manufactured, bought, and sold; market acceptance and demand will remain low. However, if local energy utilities (natural gas or electric) contribute an additional $100 to the rebate, 45 percent of eligible customers could be expected to participate.

- *Estimated Costs*
  Direct Costs: $100 for water utility portion of the incentive
  Indirect Costs: $20 for processing, inspection, and marketing
  Total Costs: $120

- *Water Savings*
  30 gallons per measure (gpd)
  The savings is based upon 2 uses per machine per day and a savings of 15 gallons per washer.

  Example gallons per person (gpcd) calculation:
  1.2 gallons per person (gpcd) Region A - Urban
  The gallons per person (gpcd) are calculated by dividing 30 gpd by the estimated number of persons using the washer (1.37 MF household size multiplied by 18 MF units per washer). The savings per measure will vary for each region and population area (urban, suburban, or rural) due to MF household size.

- *Projected Lifetime*
  If Federal energy standards were maintained, the lifetime of the measure would be permanent. The projected lifetime for clothes washers used in MF complexes is estimated to be 8 years.
  Source: Webster, Mike. Coinmach. Personal Interview 1 Oct. 2001.

MF Irrigation Audit

Irrigation audits are provided to commercial customers with underground irrigation systems. With these audits, utility personnel identify ways to increase the efficiency of MF customer irrigation systems and reduce MF customer water use. Some ways may include, but are not limited to, proper scheduling, repairing breaks or leaks, and replacing broken sprinkler heads. The customer could be offered rebates for items that would allow their system to operate more efficiently as an additional measure.

- *Maximum Participation Rate*
  With multi-family customers, participation rates are higher than with SF customers due to the cost savings of more efficient large-scale irrigation systems to property managers and owners and the larger number of irrigation audits made by one decision maker. Therefore, it is assumed that 50 percent of eligible customers will participate in a MF irrigation audit.

- *Estimated Costs*
  Direct Costs: $130 for labor (to perform MF Irrigation Audit)
  Indirect Costs: $ 20 for administration and marketing
  Total Costs: $150

- *Water Savings*
  125 gallons per day. The savings were calculated based upon the following assumptions:

  - 50,000 gallons per month average outdoor water use;
  - the audit results in 15 percent reduction of outdoor water use; and
  - the estimated savings computes to 250 gallons per day during the summer months and are then annualized.

  Example gallons per person (gpcd) calculation:
  1.8 gallons per person (gpcd) Region A - Urban
  The gallons per person (gpcd) are calculated by dividing 125 gpd by the average population per MF complex (1.37 MF household size multiplied by 50 MF units per complex). The savings per measure will vary for each region and population area (urban, suburban, or rural) due to MF household size.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 3 years if follow-ups are provided, such as a reminder letter or additional audits. As this measure requires substantial customer education and action, the lifetime of the savings is short.

<u>MF Rainwater Harvesting</u>

Provide a $2,000 rebate for the installation of a rainwater harvesting system. For the purposes of this Study, the average system is projected to include a 10,000-gallon collection tank and cost approximately $7,500 including tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line.

- *Maximum Participation Rate*
  The assumption is that 5 percent of commercial customers will participate. This rate is based upon current market acceptance and demand, which, at the time of this report, are generally low. As technology becomes more affordable and demand increases, participation rates will increase accordingly.

- *Estimated Costs*
  Direct Costs: $2,000 for rebate
  Indirect Costs: $50 for labor and marketing
  Total Costs: $2,050

- *Water Savings*
  205.7 gallons per measure (gpd). (*The savings per measure varies with each region due to average annual rainfall. The 205.7 gpd reported is for Region A - Urban).*

  The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions:

  - 50,000 square-foot roof;
  - irrigation demand of 5,000 gallons every five days;
  - a 10,000-gallon tank; and
  - after each rainfall of 0.2 inches or greater, it is assumed that there will be no water demand for five days.

  The Austin Model savings of 35.2 gpd were adjusted for each region based upon the ratio of Regional average annual rainfall to the City of Austin's rainfall. The ratio is [35.2 gpd X Region average annual rainfall ÷ 31.9 inches City of Austin rainfall]. For details on the 35.2 gpd calculation, see *Attachment II*.

  Example gallons per person (gpcd) calculation:
  3.7 gallons per person (gpcd) Region A - Urban
  The gallons per person (gpcd) are calculated by dividing 205.7 gpd by the average population per MF complex (1.37 MF household size multiplied by 18 MF units per complex). The savings per measure will vary for each region and population area (urban, suburban, or rural) due to MF household size.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 15 years based upon the life of the polypropylene (or similar material) collection tank, which is the most significant portion of the measure's cost.
  Source: Heinichen, Richard. Tank Town. Personal Interview. 1 Oct. 2001.

2.3.2. Commercial Water Efficiency Measures

As commercial water savings are not dependent on household size, the savings for commercial water efficiency measures in this section are only reported in savings per measure (gpd).

<u>Commercial Toilet Retrofit</u>

With a commercial toilet retrofit, 1.6 gallon per flush toilets are provided to replace high flush toilets installed in businesses built before 1992 when the Texas Plumbing Efficiency Standards went into effect. The standards require toilets, urinals, showerheads, and faucet aerators sold or manufactured in the state meet more water efficient criteria than under previous regulations. Toilets could be offered free or the customer could purchase any qualifying toilet and receive a rebate.

- *Maximum Participation Rate*
  Since the plumbing standards went into effect in 1992, 1 percent of eligible customers per year are assumed to have replaced toilets due to breakage, remodeling, etc. Thus, approximately 10 percent of eligible customers have already replaced older toilet models with more efficient

devices. Based upon the participation in the City of Austin's commercial toilet retrofits, it is assumed that 30 percent of eligible customers will participate in a commercial toilet retrofit program.

- *Estimated Costs*
  Direct Costs: $125 for rebate
  Indirect Costs: $25 for processing, inspection, and marketing
  Total Costs: $150

- *Water Savings*
  26 gallons per day per toilet.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation.

- *Projected Lifetime*
  If toilets selected cannot be altered to use more water and are maintained, the lifetime of the measure would be permanent since only 1.6 gallons per flush (gpf) toilets can be purchased. Toilets have an average life of approximately 25 years.
  Source: Vickers, Amy. May 2001. Handbook of Water Use and Conservation.

Coin-Operated Clothes Washer Rebate

Provide a $150 rebate for high-efficiency commercial washing machines that have a water factor of not more than 9.5 gallons per cubic foot of washer capacity. There is approximately one coin-operated machine for every 170 people. This number will vary locally. If possible, a higher rebate can be offered if partnered with local gas and/or electric utilities. *Note: The Federal energy standard does not apply to coin-operated machines.*
Source: Consortium for Energy Efficiency, "Commercial Washer Update"

- *Maximum Participation Rate*
  As long as less expensive washers remain on the market or until regulations change requiring more efficient machines to be manufactured, bought, and sold,; market acceptance and demand will remain low. However, if local energy utilities (natural gas or electric) contribute an additional $100 to the rebate, 50 percent of eligible customers could be expected to participate.

- *Estimated Costs*
  Direct Costs: $150 for rebate from water utility
  Indirect Costs: $20 for processing, inspection, and marketing
  Total Costs: $170

- *Water Savings*
  24 gallons per measure (per washer). The savings calculation is based upon 3 washer uses per day with a savings of 8 gallons per load.

- *Projected Lifetime*
  The lifetime of the measure would be 8 years based upon the approximate life of coin-operated washing machines.
  Source: Webster, Mike. Coinmach. Personal Interview 1 Oct. 2001.

Commercial Irrigation Audit

Irrigation audits are provided to commercial customers with underground irrigation systems. With these audits utility personnel identify ways to increase the efficiency of commercial irrigation systems and reduce commercial water use. Some ways may include, but are not limited to, proper scheduling, repairing breaks or leaks, and replacing broken sprinkler heads. The customer could be offered rebates for items that would allow their system to operate more efficiently.

- *Maximum Participation Rate*
  With multi-family customers, participation rates are higher than with SF customers due to the cost savings of more efficient large-scale irrigation systems to property managers and owners and the larger number of irrigation audits made by one decision maker. Therefore, it is assumed that overall commercial water use can be reduced by one percent.

- *Estimated Costs*
  Direct Costs: $130 for labor (to perform Commercial Irrigation Audit)
  Indirect Costs: $ 20 for administration and marketing
  Total Costs: $150

- *Water Savings*
  125 gallons per day. The savings were calculated based upon the following assumptions:

  - 50,000 gallons per month average outdoor water use;
  - the audit results in 15 percent reduction of outdoor water use; and
  - the estimated savings computes to 250 gallons per day during the summer months and are then annualized.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 3 years if follow-ups are provided, such as a reminder letter or additional audit. As this measure requires substantial customer education and action, the lifetime of the savings is short.

Commercial General Rebate

Provide a cash rebate for the installation of water efficient equipment. This incentive would depend on the amount of daily water savings. For example, the incentive could be $1 per gallon per day that water use is reduced.

- *Maximum Participation Rate*
  The percent reduction by customer can vary greatly depending upon the type of commercial property. Therefore, for the purposes of this Study, it is assumed that overall commercial water use can be reduced by three percent.

- *Estimated Costs*
  Direct Costs: $1.00 per gallon per day of savings
  Indirect Costs: $0.20 per gallon per day of savings
  Total Costs: $1.20

- *Water Savings*
  One gallon for each dollar of the rebate.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 15 years based upon the assumption that the savings are related to hardware changes.

Commercial Rainwater Harvesting

Provide a $2,000 rebate for the installation of a rainwater harvesting system. For the purposes of this Study, the average system is projected to include a 10,000-gallon collection tank and cost approximately $7,500 including tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line.

- *Maximum Participation Rate*
  The assumption is that overall commercial water use can be reduced by 1 percent. This rate is based upon current market acceptance and demand, which, at the time of this report, are generally low. As technology becomes more affordable and demand increases, participation rates will increase accordingly.

- *Estimated Costs*

Direct Costs:	$2,000 for rebate
Indirect Costs:	$50 for labor and marketing
Total Costs:	$2,050

- *Water Savings*
  205.7 gallons per measure (gpd). (*The savings per measure varies with each region due to average annual rainfall. The 205.7 gpd reported is for Region A - Urban).*

  The savings were calculated based upon a City of Austin, Texas, model (Austin Model) using 50 years of actual rainfall data. The Austin Model is based on the mass balance principle, which performs daily balances of supply and demand. The model is set up on the assumption that all water collected will be used for landscape irrigation that will occur on a five-day cycle unless a set rainfall has occurred. The Austin Model makes the following assumptions:

  - 50,000 square-foot roof;
  - irrigation demand of 5,000 gallons every five days;
  - a 10,000-gallon tank; and
  - after each rainfall of 0.2 inches or greater, it is assumed that there will be no water demand for five days.

  The Austin Model savings of 35.2 gpd were adjusted for each region based upon the ratio of Regional average annual rainfall to the City of Austin's rainfall. The ratio is [35.2 gpd X Region average annual rainfall ÷ 31.9 inches City of Austin rainfall]. For details on the 35.2 gpd calculation, see *Attachment II*.

- *Projected Lifetime*
  The lifetime of the measure would be approximately 15 years based upon the life of the collection tank, which is the most significant portion of measure's cost.
  Source: Heinichen, Richard. Tank Town. Personal Interview. 1 Oct. 2001.

2.4 Water Efficiency Incentives

Water efficiency incentives are important components of water conservation planning. Incentives are tools to promote efficient water use habits and encourage the adoption of water efficiency measures.

2.4.1 Regulations

Regulations that establish water conservation requirements or encourage the more efficient use of water can be used in local communities to maximize water use and reduce peak demand periods.

Examples:

- Retrofit of Plumbing Fixtures on Resale - When buildings or houses are sold, all plumbing fixtures would be retrofitted in order to meet current plumbing standards.

- Irrigation Permitting – Require all new underground irrigation systems to obtain a permit, ensuring that the system be constructed in the most water efficient manner including the installation of a rain shut off switch, wind sensor, check valves, or other water saving equipment.

- Separate Irrigation Meter Requirement – Require all commercial properties including duplexes, triplexes, and four-plexes to install separate irrigation meters so that the property owner could effectively monitor outdoor water use.

- Waste of Water Regulations - Regulation or ordinances could be passed prohibiting the waste of water such as running an irrigation system with broken heads, heads directed over paved areas, allowing water to run down the street or pond in a parking lot, or other similar events.

- Landscape Ordinance - A landscape ordinance could be adopted requiring the use of water efficient plants, irrigation systems that have rain shut off switches, etc. Additionally, the ordinance could require that parking lot medians and buffer areas be at least 8 feet wide to prevent water waste.

Before considering new or revised regulation, it is important to enlist the support of customers, community interest groups, and other stakeholders. Such an approach will facilitate easier implementation and enforcement. After regulations have been established, enforcement becomes a key issue. When regulations are properly enforced, they can be effective tools to reduce water waste and manage peak demand periods.

2.4.2 Water Rates

Many water utilities implement water conservation rates to promote more efficient use of water. If conservation rates are properly designed and implemented, they can motivate customers to reduce water use, while allowing water utilities to meet revenue requirements.

The 1999 Water Price Elasticities Study for Single-Family Homes in Texas (Price Elasticities Study) provides several useful conclusions with regard to water rates and water conservation.

- Customers who were concerned about their water bill focused on the total dollar amount of the bill since they were less knowledgeable about the details of the water rate structure.

- Price sensitivity is greatest with respect to outdoor irrigation.

- The quantity of water demand clearly decreased with increasing water prices.

- Price elasticity is not correlated with the age of the house or wealth of the occupant when household income is less than $100,000 per year.

In the Price Elasticities Study, The weighted average price elasticities of the water systems for the three cities of Austin, Texas; Corpus Christi, Texas; and San Antonio, Texas averaged –0.19. An example of this price elasticity is that a 1 percent increase in water price leads to a 0.19 percent reduction in water use. The results of the 1999 study indicate that rates, under certain conditions, can be an effective method of reducing water use.

According to the *American Water Works Association M-1 Rate Manual*, there are four generally accepted conservation rate structures: uniform rates, inverted block rates, seasonal rates, and marginal cost rates.

- *Uniform Rates*
  With uniform rates, the same rate applies to all water users.

- *Inverted Block Rates*
  Under the inverted block rate, a schedule of rates applicable to blocks of increasing usage in which the usage in each succeeding block is charged at a higher unit rate than in the previous blocks.

- *Seasonal Rates*
  Seasonal rates are based upon the cost of service variations with respect to system season requirements. For example, a higher unit rate for water may be charged in the summer than for the rest of the year.

- *Marginal Cost Rates*
  With marginal cost rates, the cost of water is based upon the cost of providing the next unit of production such as an increment of plant capacity and supply. Example: If a water utility needed to develop a new source of supply at considerable expense, the charge for all water sold should reflect that cost even though the average could be less.

Deciding which type of rate structure is most appropriate depends upon a number of factors. Thus, before implementing water conservation rates, careful analysis and study is required.

2.5 Public Information/Education

In order to achieve water savings from any water efficiency measure or incentive, public information/education programs for children and adults are necessary. Public information/education programs are critical tools that create community awareness about water conservation and market water efficiency strategies to customers. Below is a list of different education and public information programs that are currently being used by water utilities to promote water efficiency incentives.

- Direct-mail brochures
- Bill stuffers
- Television and radio advertisements or public service announcements
- School education programs (for grades K-2, 3-5, 6-8, and 9-12)
- Local workshops and training seminars
- Billboards
- Community displays (at home & garden shows, etc.)

In addition to the TWDB, many utilities, agencies, and companies have already produced a variety of public education materials ranging from educational videos to brochures. Regions can contact the TWDB for information regarding their products and services.

If little or no funding is available for public education/information, many education programs can be combined with programs from other municipal departments, neighboring water suppliers, local environmental groups, or community organizations.

Section 3 Cost-Savings Analysis

As water efficiency measures can impact water savings differently when implemented in various population concentrations, GDS analyzed the sixteen water efficiency measures' costs and savings for three distinct population areas – urban, suburban, and rural. The United States Census Bureau defines urban areas as cities designated as Metropolitan Statistical Area (MSA) cities. Suburban areas are defined as non-MSA cities located in the counties making up each MSA. Rural areas are defined as cities and counties that lie outside of MSA counties. GDS provided computational sheets for each population area (urban, suburban, and rural) for each Region. It is noted that Regions J and P consist of all rural population areas and thus do not include computational sheets for urban and suburban populations.

Each computational sheet includes regional input data, estimated measure costs, projected measure savings, and delivery options. The cost-savings analysis for each region is provided in *Attachment VI.*

3.1 Regional Data

3.1.1 Data Variables

Region-specific data included in the cost-savings analysis consist of the following:

- SF Population
- MF Population
- Number of SF Units
- Number of MF Units
- SF Household Size
- MF Household Size
- Average Yearly Rainfall

The data in each category differ for each Region as well as by population concentration (urban, suburban, or rural).

<u>Population and Number of Units</u>

GDS used the TWDB's 1997 population figures in this Study. Since breakdowns into MF and SF populations were not available from the TWDB data, the 1990 Census portions for MF and SF populations were applied to the 1997 population figures. The populations were then divided into respective regions based upon TWDB definitions. The number of SF and MF units were determined in the same manner.

<u>Household Size</u>

Household size is the number of people per living unit. Household size was calculated by dividing the population by the number of units. SF and MF household sizes were calculated in the same way, but using respective populations and unit numbers.

Average Yearly Rainfall

The precipitation for each region was taken from the average rainfall records compiled by the State Climatologist of Texas. These are updated every 10 years. The last update available was dated January 1, 1993. Since each region has more than one county, rainfall for the region was estimated using the most centrally located county using an east to west orientation. The east to west orientation was used since rainfall in Texas is primarily a function of the longitude. In some regions, only one city met the urban criteria. In such cases, the average annual rainfall for the individual city was used. The average annual rainfall for each Region used in this Study is provided in *Attachment III*.

3.1.2 Data Inputs

The following data inputs remain the same for each Region:

- 2.0 Bathrooms per SF House
- 1.2 Bathrooms per MF Unit
- 6 Irrigation Months
- 10 percent of SF Customers are "High Use" Customers (SF customers that use 20,000 gallons of water per month for irrigation during an irrigation season of six months)
- 18 MF Units per Washer
- 50 MF Units per Complex

Number of Bathrooms per SF House and MF Unit

The *American Water Works Research Foundation Residential End Use Study* found 2.27 toilets per home based on a mail survey of 1,100 single-family homes. The number was rounded off to 2.0 toilets per home for use in this Study.

Number of Irrigation Months

There is a wide range of irrigation practices within each region and within water service areas and no data are available to indicate such variability for each region. Therefore, an irrigation season of six months was assumed for all regions.

Percentage of High Use SF Customers

In order to determine the savings for irrigation audits, an assumption on the percentage of high use SF customers was made. The assumption is that 10 percent of SF customers use 20,000 gallons of water per month for irrigation during an irrigation season of six months. It is noted that the percentage of SF customers can vary greatly within regions and can be adjusted if such information is available.

Number of MF units per Washer/Number of MF Units per Complex

The number of MF units per washer and complex were based upon a number of assumptions. If a MF complex was built before 1990, in-unit washing machine hookups were not usually installed and will have approximately one washing machine for every 15 units. If the MF complex was built after 1990, washing machine hookups are generally installed in the unit and the MF complex will have approximately one washing machine per 30 units located in a common area. Assuming that 80 percent of all MF complexes do not have in-unit washing machine hookups and 20 percent do have in-unit hookups, a weighted average of 18 units per washer or 0.056 machines per unit can be estimated (15 + 0.20(15) = 18 units per washing machine).

3.2 Estimated Costs

The costs determined for each measure include rebates, staff time, and marketing. The costs per measure remain the same for each region and population area. In addition to the costs per measure, GDS calculated a cost per acre-foot of water saved each year amortized at five percent interest over the life of the measure using the following equation:

> [(costs per measure x 325,851 gal/ac-ft) ÷ (savings per measure x 365 days)] amortized at 5 percent over the life of the measure

The MF and SF irrigation audit savings and cost per acre-foot of water saved stays the same for each region and population area based on the assumption that the same reduction of water use is achieved regardless of rainfall.

The costs per measure for each of the sixteen water efficiency measures analyzed in this section are provided in *Table 1* below. For details on cost per measure assumptions and calculations see *Section 2*.

Table 1
Water Efficiency Measures' Costs

Water Efficiency Measure	Costs Per Measure
Residential	
SF Toilet Retrofit	$ 85
SF Showerheads and Aerators	$ 7
SF Clothes Washer Rebate	$ 120
SF Irrigation Audit-high user	$ 70
SF Rainwater Harvesting	$ 250
SF Rain Barrels	$ 45
MF Toilet Retrofit	$ 75
MF Showerheads and Aerators	$ 4
MF Clothes Washer Rebate	$ 120
MF Irrigation Audit	$ 150
MF Rainwater Harvesting	$ 2,050
Commercial	
Commercial Toilet Retrofit	$ 150
Coin-Operated Clothes Washer Rebate	$ 170
Irrigation Audit	$ 150
Commercial General Rebate	$ 1.2
Commercial Rainwater Harvesting	$ 2,050

3.3 Number of Measures per Living Unit

For each water efficiency measure, except MF Irrigation Audit and MF Rainwater Harvesting, the number of measures needed for each living unit were determined based upon input data described earlier in this section.

3.4 Projected Savings

The water savings for each water efficiency measure were reported in three ways:

- water savings per residential capita in gallons per person per day
- water savings per living unit in gallons per day
- water savings per measure in gallons per day

For details on projected savings' calculations and assumptions see *Section 2*.

3.5 Delivery Options

Delivery options are the methods of implementing a measure. Delivery options are presented in two categories – standard and other. Standard delivery options are those options for which the costs are estimated. Other delivery options are presented in the cost-savings analysis for each water efficiency measure. If the other delivery options are used, the costs of the measures may be affected. For example, if SF Toilet Retrofits were installed directly, the cost would be higher than if a rebate were offered. With rebates, individual customers install the devices, not the utility.

Section 4 Per Capita Water Use

To assist the Regions in making water conservation planning decisions, GDS also calculated average annual per capita water use for each Region. The per capita numbers are also reported for urban, suburban, and rural population areas and include figures for base use, seasonal use, and the dry year for the years analyzed. With such numbers, the Regions will be able to target water efficiency measures to specific areas and for seasonal variations.

4.1 Methodology

GDS calculated the average annual per capita water use using the most current 10-year data available from the TWDB at the time of this Study (1988 through 1997). Monthly water use data for each city was divided by the average monthly use for that year to determine what decimal fraction of annual use occurred each month. This decimal fraction was then multiplied by the annual per capita use for that year to obtain a monthly distribution of per capita uses. The base use per capita was determined by averaging the three winter months of December, January, and February. Average gpcd use was also separated into seasonal use. Seasonal use was calculated by taking the difference between base gpcd and annual gpcd. Once calculated, the average annual per capita water use for each city was separated into respective Regions and population concentrations (urban, suburban, and rural).

The average annual per capita water use for dry year conditions was identified for each Region by selecting the highest per capita water use year in the 10-year period (1988-1997) for urban, suburban, and rural population concentrations. *Attachment IV* identifies the dry year for each Region and population concentration.

The average annual per capita water use for each Region in Figure 1 was determined by a population weighted average based upon the suburban, urban, and rural areas.

In an effort to keep consistency of data, GDS performed the following data management operations:

- Estimated monthly distributions for cities with some missing monthly water use data.
- Deleted cities from the analysis that did not have substantial monthly water use data.
- Excluded military bases, resorts, and other data sets that did not reflect municipal use characteristics.

GDS assumed the data received from the TWDB were corrected for major reporting inconsistencies.

In Figures 2 - 4, GDS presents average annual per capita water use for the Regions by population concentration (urban, suburban, and rural). Please note that Regions J and P consist of all rural population areas and are, therefore, not included on the graphs for urban and suburban areas.

FIGURE 1

Average Annual Per Capita Water Use In Texas by Region

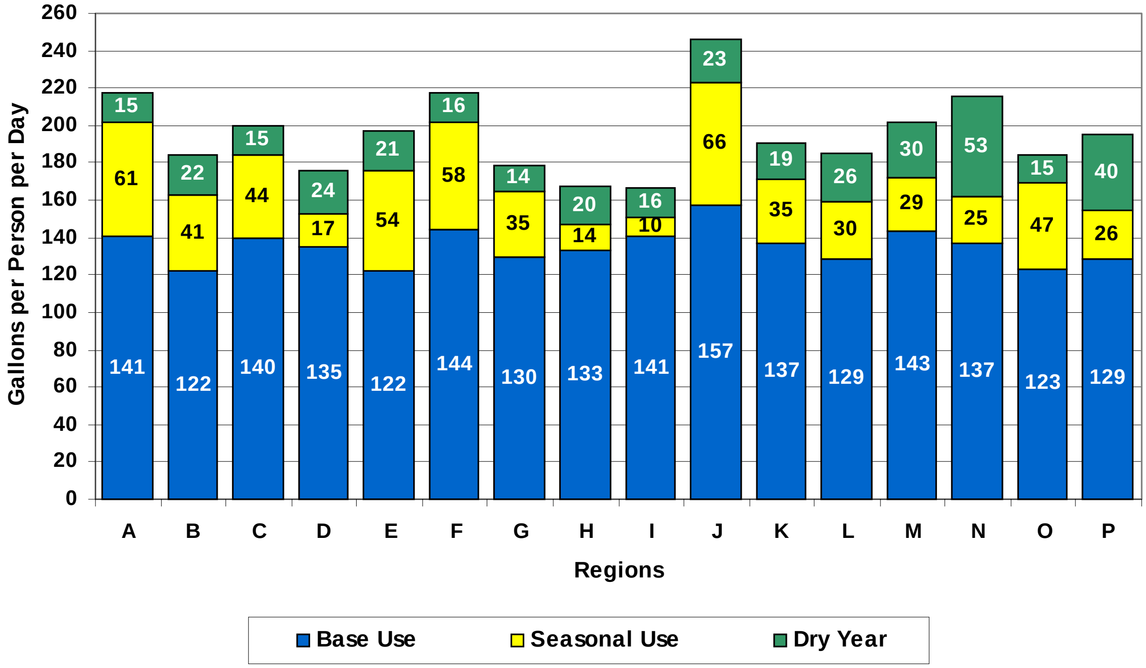


FIGURE 2

Average Annual Per Capita Water Use In Urban Areas

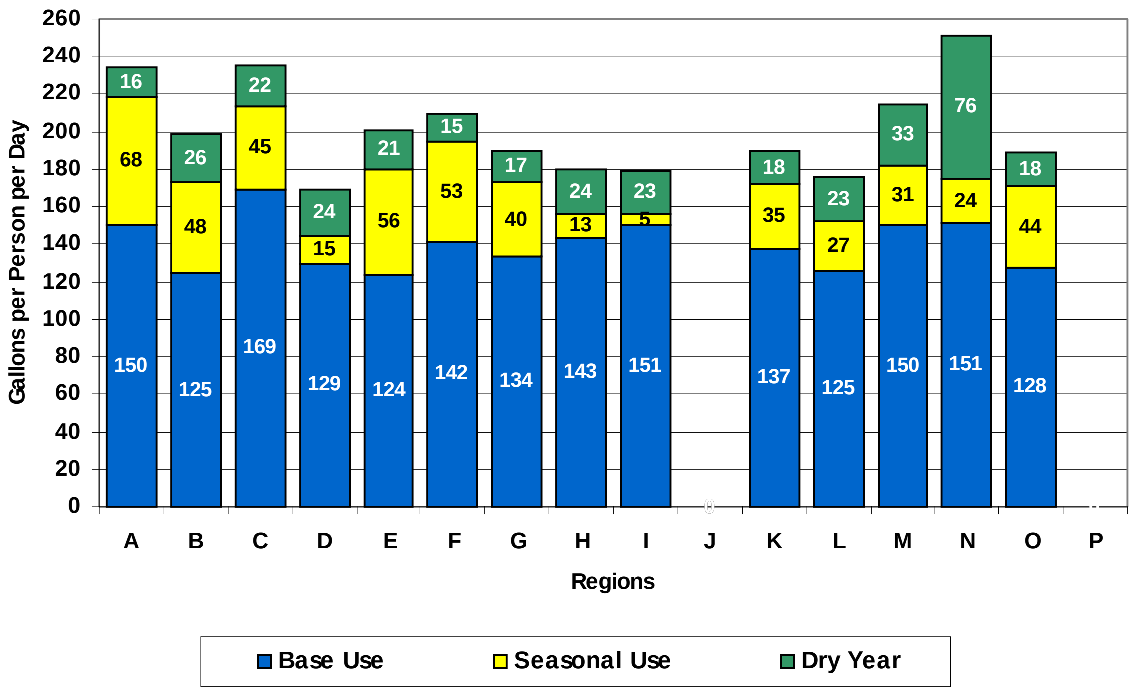


FIGURE 3

Average Annual Per Capita Water Use In Suburban Areas

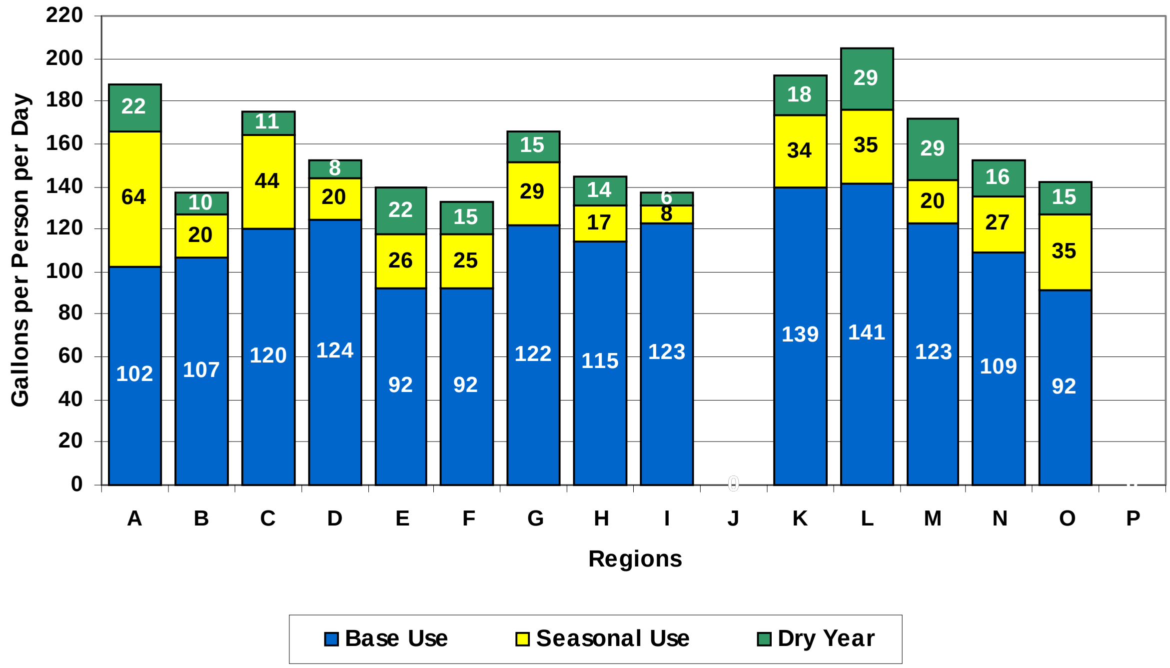
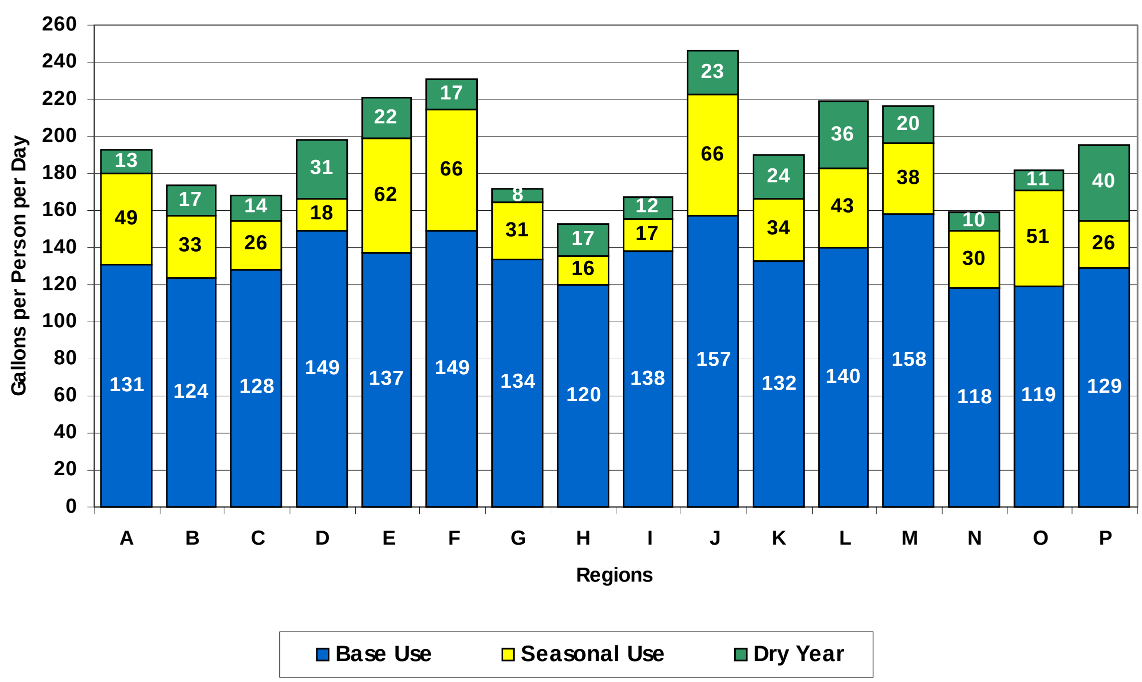


FIGURE 4

Average Annual Per Capita Water Use In Rural Areas



Section 5 Conclusion

This Study provides each Region with estimated costs and projected savings for sixteen water efficiency measures and average annual per capita water use. The data are presented in ways that offer Regions flexibility when considering different water efficiency measures. Additionally, the data provided can be used to develop more detailed analyses and make local water savings projections. *Attachment V* provides an example of how the information provided in this Study can be applied to local scenarios.

Climate is an important factor when considering water efficiency measures. In particular, attention should be paid to variations in rainfall. Water efficiency measures that target outdoor water use will be generally more effective in areas that receive considerable rainfall than in areas with little rainfall. For example, Region E receives on average 9 inches of rainfall annually. If one SF Rainwater Harvesting measure were implemented in Region E, the measure would save 9.7 gpd and cost $2,221 per acre-foot of water saved. However, Region H receives on average 46 inches of rainfall annually. If one SF Rainwater Harvesting measure were implemented in Region H, the measure would save 50.7 gpd and cost $424 per acre-foot of water saved. Therefore, Rainwater Harvesting in Region H would be more cost effective than in Region E.

The average annual per capita water use numbers provided in *Section 4* indicate when and where water efficiency measures would be most effective. In 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. In Regions with little seasonal per capita water use, indoor water efficiency measures can be implemented to help reduce base per capita water use. Regions with high dry year per capita water should consider water efficiency measures and strategies to reduce water use during times of drought.

This Study is intended to focus on those water efficiency strategies that target customer end uses. In order for regions to achieve overall water system efficiency, GDS strongly suggests that Regions implement water management programs in addition to water conservation programs. Water management programs, when properly developed and implemented, can significantly reduce system water waste. Some of these programs include:

- Unaccounted for water
- Universal metering and repair
- Pressure management
- Leak detection and repair

TWDB and other industry organizations have developed several materials that address these issues.

This Study is intended to represent a regional approach to making water conservation decisions in Texas by providing useful and meaningful regional information. This Study also serves as a starting point for additional studies on water use efficiency in Texas.

Glossary

Commercial	Business customers excluding manufacturing, steam electric, mining, agricultural irrigation, and livestock
gpcd	Gallons per capita per day
gpd	Gallons per day
gpf	Gallons per flush
Multi-Family (MF)	structure with 3 or more housing/living units
Region (s)	Texas water planning region(s)
Rural	All cities and counties outside MSA counties
Single-Family (SF)	homes or duplexes
Suburban	Non-MSA cities located in MSA counties
Urban	MSA cities defined by the Census Bureau
Water Efficiency Incentive	Programs that promote water conservation and motivate customers to adopt specific water efficiency measures.
Water Efficiency Measure	Specific tool, practice, or device that results in more efficient water use
Water Efficiency Strategy	Action or technique resulting in the more efficient use of water
Water Factor	Gallons per cycle

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