Statewide Water Conservation

Quantification Project

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Region F Individual Reports

Statewide Water Conservation Quantification Project
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1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Andrews's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Andrews's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Andrews's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Andrews with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. **Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.**

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	(28)	(28)	12	0	12	(39)
2016	0	(29)	(29)	15	0	15	(44)
2017	0	(30)	(30)	15	0	15	(45)
2018	0	(31)	(31)	18	0	18	(49)
2019	0	(33)	(33)	21	0	21	(54)
2020	0	(34)	(34)	27	0	27	(60)
2021	0	(34)	(34)	27	0	27	(62)
2022	0	(35)	(35)	28	0	28	(63)
2023	0	(36)	(36)	28	0	28	(64)
2024	0	(36)	(36)	29	0	29	(65)
2025	0	(37)	(37)	29	0	29	(67)
2026	0	(38)	(38)	30	0	30	(68)
2027	0	(39)	(39)	31	0	31	(69)
2028	0	(39)	(39)	31	0	31	(70)
2029	0	(40)	(40)	32	0	32	(72)
2030	0	(41)	(41)	32	0	32	(73)
2031	0	(41)	(41)	33	0	33	(75)
2032	0	(42)	(42)	35	0	35	(77)
2033	0	(43)	(43)	36	0	36	(79)
2034	0	(43)	(43)	37	0	37	(80)
2035	0	(44)	(44)	38	0	38	(82)
2036	0	(45)	(45)	39	0	39	(84)
2037	0	(45)	(45)	41	0	41	(86)
2038	0	(46)	(46)	42	0	42	(88)
2039	0	(47)	(47)	43	0	43	(90)
2040	0	(47)	(47)	44	0	44	(92)
2041	0	(48)	(48)	45	0	45	(93)
2042	0	(49)	(49)	46	0	46	(94)
2043	0	(50)	(50)	46	0	46	(96)
2044	0	(50)	(50)	47	0	47	(97)
2045	0	(51)	(51)	48	0	48	(99)
2046	0	(52)	(52)	48	0	48	(100)
2047	0	(53)	(53)	49	0	49	(102)
2048	0	(53)	(53)	50	0	50	(103)
2049	0	(54)	(54)	50	0	50	(105)
2050	0	(55)	(55)	51	0	51	(106)
2051	0	(56)	(56)	52	0	52	(108)
2052	0	(57)	(57)	53	0	53	(110)
2053	0	(58)	(58)	54	0	54	(111)
2054	0	(58)	(58)	55	0	55	(113)
2055	0	(59)	(59)	55	0	55	(115)
2056	0	(60)	(60)	56	0	56	(116)
2057	0	(61)	(61)	57	0	57	(118)
2058	0	(62)	(62)	58	0	58	(120)
2059	0	(63)	(63)	59	0	59	(122)
2060	0	(64)	(64)	60	0	60	(123)
2061	0	(65)	(65)	61	0	61	(125)
2062	0	(66)	(66)	62	0	62	(127)
2063	0	(67)	(67)	63	0	63	(129)
2064	0	(68)	(68)	64	0	64	(131)
2065	0	(69)	(69)	65	0	65	(133)
2066	0	(70)	(70)	66	0	66	(135)
2067	0	(71)	(71)	66	0	66	(137)
2068	0	(72)	(72)	67	0	67	(139)
2069	0	(73)	(73)	68	0	68	(141)
2070	0	(73)	(73)	69	0	69	(142)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Andrews's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	11,825	223	0	0	0
1	2015	12,000	222	3	(26)	(30)
2	2016	12,593	222	6	(29)	(34)
3	2017	13,187	221	9	(30)	(39)
4	2018	13,780	221	12	(31)	(44)
5-year Goal	2019	14,374	220	16	(33)	(49)
6	2020	14,967	220	19	(34)	(52)
7	2021	15,298	219	21	(34)	(55)
8	2022	15,630	219	24	(35)	(59)
9	2023	15,961	218	27	(36)	(62)
10-year Goal	2024	16,293	218	30	(36)	(66)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Andrews's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	11,625	25.00	0	0	0
1	2015	12,000	24.00	4	(28)	(32)
2	2016	12,593	23.00	9	(29)	(38)
3	2017	13,187	22.00	14	(30)	(45)
4	2018	13,780	21.00	20	(31)	(52)
5-year Goal	2019	14,374	20.00	26	(33)	(59)
6	2020	14,967	19.60	29	(34)	(63)
7	2021	15,298	19.20	32	(34)	(67)
8	2022	15,630	18.80	35	(35)	(70)
9	2023	15,961	18.40	38	(36)	(74)
10-year Goal	2024	16,293	18.00	42	(36)	(78)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 28 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
        i. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline		25.00	0
2015	12,000	31.00	(28)
2016	12,593	31.00	(29)
2017	13,187	31.00	(30)
2018	13,780	31.00	(31)
2019	14,374	31.00	(33)
2020	14,967	31.00	(34)
2021	15,298	31.00	(34)
2022	15,630	31.00	(35)
2023	15,961	31.00	(36)
2024	16,293	31.00	(36)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs

- The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications

b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)

c. Estimate assumes customers will save 10% of total annual use due to the portal
   i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)

d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
   i. This was the most common percentage of residential use among participating utilities in this project.
   ii. Actual customer class demand percentages will vary by utility.

e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand

f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(29)	(29)	17	15	0	15	(27)
2017	0	(30)	(30)	18	15	0	15	(28)
2018	0	(31)	(31)	18	18	0	18	(31)
2019	0	(33)	(33)	18	21	0	21	(33)
2020	0	(34)	(34)	19	27	0	27	(42)
2021	0	(34)	(34)	19	27	0	27	(42)
2022	0	(35)	(35)	19	28	0	28	(43)
2023	0	(36)	(36)	20	28	0	28	(44)
2024	0	(36)	(36)	20	29	0	29	(45)
2025	0	(37)	(37)	21	29	0	29	(46)
2026	0	(38)	(38)	21	30	0	30	(47)
2027	0	(39)	(39)	21	31	0	31	(48)
2028	0	(39)	(39)	22	31	0	31	(48)
2029	0	(40)	(40)	22	32	0	32	(50)
2030	0	(41)	(41)	22	32	0	32	(51)
2031	0	(41)	(41)	23	33	0	33	(52)
2032	0	(42)	(42)	23	35	0	35	(54)
2033	0	(43)	(43)	23	36	0	36	(55)
2034	0	(43)	(43)	24	37	0	37	(57)
2035	0	(44)	(44)	24	38	0	38	(58)
2036	0	(45)	(45)	24	39	0	39	(60)
2037	0	(45)	(45)	25	41	0	41	(61)
2038	0	(46)	(46)	25	42	0	42	(63)
2039	0	(47)	(47)	25	43	0	43	(64)
2040	0	(47)	(47)	26	44	0	44	(66)

2. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 26 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-2 for potential savings from this measure compared with the utility's conservation goals.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-2. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(29)	(29)	26	15	0	15	(18)
2017	0	(30)	(30)	26	15	0	15	(19)
2018	0	(31)	(31)	27	18	0	18	(23)
2019	0	(33)	(33)	27	21	0	21	(26)
2020	0	(34)	(34)	28	27	0	27	(32)
2021	0	(34)	(34)	28	27	0	27	(33)
2022	0	(35)	(35)	29	28	0	28	(34)
2023	0	(36)	(36)	30	28	0	28	(35)
2024	0	(36)	(36)	30	29	0	29	(35)
2025	0	(37)	(37)	31	29	0	29	(36)
2026	0	(38)	(38)	31	30	0	30	(37)
2027	0	(39)	(39)	32	31	0	31	(39)
2028	0	(39)	(39)	32	31	0	31	(38)
2029	0	(40)	(40)	33	32	0	32	(39)
2030	0	(41)	(41)	33	32	0	32	(40)
2031	0	(41)	(41)	34	33	0	33	(41)
2032	0	(42)	(42)	34	35	0	35	(42)
2033	0	(43)	(43)	35	36	0	36	(44)
2034	0	(43)	(43)	35	37	0	37	(43)
2035	0	(44)	(44)	36	38	0	38	(46)
2036	0	(45)	(45)	36	39	0	39	(48)
2037	0	(45)	(45)	37	41	0	41	(49)
2038	0	(46)	(46)	37	42	0	42	(50)
2039	0	(47)	(47)	38	43	0	43	(52)
2040	0	(47)	(47)	38	44	0	44	(53)

Statewide Water Conservation Quantification Project
City of Ballinger Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Ballinger's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Ballinger's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Ballinger's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Ballinger with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	0.2	0.2	8	0	8	(8)
2016	0	0.2	0.2	11	0	11	(10)
2017	0	0.2	0.2	11	0	11	(10)
2018	0	0.2	0.2	13	0	13	(12)
2019	0	0.2	0.2	15	0	15	(14)
2020	0	0.2	0.2	19	0	19	(19)
2021	0	0.2	0.2	19	0	19	(19)
2022	0	0.2	0.2	19	0	19	(19)
2023	0	0.2	0.2	19	0	19	(19)
2024	0	0.2	0.2	19	0	19	(19)
2025	0	0.2	0.2	19	0	19	(19)
2026	0	0.2	0.2	19	0	19	(19)
2027	0	0.2	0.2	19	0	19	(19)
2028	0	0.2	0.2	19	0	19	(19)
2029	0	0.2	0.2	19	0	19	(19)
2030	0	0.2	0.2	19	0	19	(19)
2031	0	0.2	0.2	19	0	19	(19)
2032	0	0.2	0.2	19	0	19	(19)
2033	0	0.2	0.2	19	0	19	(19)
2034	0	0.2	0.2	19	0	19	(19)
2035	0	0.2	0.2	19	0	19	(19)
2036	0	0.2	0.2	19	0	19	(19)
2037	0	0.2	0.2	19	0	19	(19)
2038	0	0.2	0.2	19	0	19	(19)
2039	0	0.2	0.2	19	0	19	(19)
2040	0	0.2	0.2	19	0	19	(19)
2041	0	0.2	0.2	19	0	19	(19)
2042	0	0.2	0.2	19	0	19	(19)
2043	0	0.2	0.2	19	0	19	(19)
2044	0	0.2	0.2	19	0	19	(19)
2045	0	0.2	0.2	19	0	19	(19)
2046	0	0.2	0.2	19	0	19	(19)
2047	0	0.2	0.2	19	0	19	(19)
2048	0	0.2	0.2	19	0	19	(19)
2049	0	0.2	0.2	19	0	19	(19)
2050	0	0.2	0.2	19	0	19	(19)
2051	0	0.2	0.2	19	0	19	(19)
2052	0	0.2	0.2	19	0	19	(19)
2053	0	0.2	0.2	19	0	19	(19)
2054	0	0.2	0.2	19	0	19	(19)
2055	0	0.2	0.2	19	0	19	(19)
2056	0	0.2	0.2	19	0	19	(19)
2057	0	0.2	0.2	19	0	19	(19)
2058	0	0.2	0.2	19	0	19	(19)
2059	0	0.2	0.2	19	0	19	(19)
2060	0	0.2	0.2	19	0	19	(19)
2061	0	0.2	0.2	19	0	19	(19)
2062	0	0.2	0.2	19	0	19	(19)
2063	0	0.2	0.2	19	0	19	(19)
2064	0	0.2	0.2	19	0	19	(19)
2065	0	0.2	0.2	19	0	19	(19)
2066	0	0.2	0.2	19	0	19	(19)
2067	0	0.2	0.2	19	0	19	(19)
2068	0	0.2	0.2	19	0	19	(19)
2069	0	0.2	0.2	19	0	19	(19)
2070	0	0.2	0.2	19	0	19	(19)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Ballinger's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	169	0	0	0
1	2015	3,767	168	2	0.2	(2)
2	2016	3,786	166	4	0.2	(4)
3	2017	3,806	165	6	0.2	(6)
4	2018	3,825	163	8	0.2	(8)
5-year Goal	2019	3,845	162	10	0.2	(10)
6	2020	3,864	161	11	0.2	(11)
7	2021	3,874	160	12	0.2	(12)
8	2022	3,884	160	13	0.2	(13)
9	2023	3,895	159	14	0.2	(14)
10-year Goal	2024	3,905	158	16	0.2	(15)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Ballinger's most recent water loss audit compares with five- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	14.00	0	0	0
1	2015	3,767	18.00	(3)	0.2	3
2	2016	3,786	18.00	(6)	0.2	6
3	2017	3,806	20.00	(8)	0.2	9
4	2018	3,825	22.00	(11)	0.2	11
5-year Goal	2019	3,845	24.00	(14)	0.2	14
6	2020	3,864	24.00	(14)	0.2	14
7	2021	3,874	24.00	(14)	0.2	14
8	2022	3,884	24.00	(14)	0.2	14
9	2023	3,895	24.00	(14)	0.2	14
10-year Goal	2024	3,905	24.00	(14)	0.2	14

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 0.2 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	14.00	0
2015	3,767	13.85	0.2
2016	3,786	13.85	0.2
2017	3,806	13.85	0.2
2018	3,825	13.85	0.2
2019	3,845	13.85	0.2
2020	3,864	13.85	0.2
2021	3,874	13.85	0.2
2022	3,884	13.85	0.2
2023	3,895	13.85	0.2
2024	3,905	13.85	0.2

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand

f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	3	11	0	11	(7)
2017	0	0	0	3	11	0	11	(7)
2018	0	0	0	3	13	0	13	(9)
2019	0	0	0	3	15	0	15	(11)
2020	0	0	0	3	19	0	19	(15)
2021	0	0	0	3	19	0	19	(15)
2022	0	0	0	3	19	0	19	(15)
2023	0	0	0	3	19	0	19	(15)
2024	0	0	0	3	19	0	19	(15)
2025	0	0	0	3	19	0	19	(15)
2026	0	0	0	3	19	0	19	(15)
2027	0	0	0	3	19	0	19	(15)
2028	0	0	0	3	19	0	19	(15)
2029	0	0	0	3	19	0	19	(15)
2030	0	0	0	3	19	0	19	(15)
2031	0	0	0	3	19	0	19	(15)
2032	0	0	0	3	19	0	19	(15)
2033	0	0	0	3	19	0	19	(15)
2034	0	0	0	3	19	0	19	(15)
2035	0	0	0	3	19	0	19	(15)
2036	0	0	0	3	19	0	19	(15)
2037	0	0	0	3	19	0	19	(15)
2038	0	0	0	3	19	0	19	(15)
2039	0	0	0	3	19	0	19	(15)
2040	0	0	0	3	19	0	19	(15)

2. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 5 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-2 for potential savings from this measure compared with the utility's conservation goals.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-2. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	5	11	0	11	(6)
2017	0	0	0	5	11	0	11	(6)
2018	0	0	0	5	13	0	13	(8)
2019	0	0	0	4	15	0	15	(10)
2020	0	0	0	4	19	0	19	(14)
2021	0	0	0	4	19	0	19	(14)
2022	0	0	0	4	19	0	19	(14)
2023	0	0	0	4	19	0	19	(14)
2024	0	0	0	4	19	0	19	(14)
2025	0	0	0	4	19	0	19	(14)
2026	0	0	0	4	19	0	19	(14)
2027	0	0	0	4	19	0	19	(14)
2028	0	0	0	4	19	0	19	(14)
2029	0	0	0	4	19	0	19	(14)
2030	0	0	0	4	19	0	19	(14)
2031	0	0	0	4	19	0	19	(14)
2032	0	0	0	4	19	0	19	(14)
2033	0	0	0	4	19	0	19	(14)
2034	0	0	0	4	19	0	19	(14)
2035	0	0	0	4	19	0	19	(14)
2036	0	0	0	4	19	0	19	(14)
2037	0	0	0	4	19	0	19	(14)
2038	0	0	0	4	19	0	19	(14)
2039	0	0	0	4	19	0	19	(14)
2040	0	0	0	4	19	0	19	(14)

Statewide Water Conservation Quantification Project
City of Brady Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Brady's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Brady's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Brady's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Brady with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	5.4	(26)	(21)	5	0	5	(25)
2016	5.4	(26)	(21)	6	0	6	(26)
2017	5.4	(26)	(21)	6	0	6	(26)
2018	5.4	(26)	(21)	7	0	7	(28)
2019	5.4	(26)	(21)	8	0	8	(29)
2020	5.4	(26)	(21)	10	0	10	(31)
2021	5.4	(26)	(21)	10	0	10	(31)
2022	5.5	(26)	(21)	10	0	10	(31)
2023	5.5	(26)	(21)	11	0	11	(31)
2024	5.5	(26)	(21)	11	0	11	(31)
2025	5.5	(26)	(21)	11	0	11	(31)
2026	5.5	(26)	(21)	11	0	11	(31)
2027	5.5	(26)	(21)	11	0	11	(31)
2028	5.5	(26)	(21)	11	0	11	(31)
2029	5.5	(26)	(21)	11	0	11	(31)
2030	5.5	(26)	(21)	11	0	11	(32)
2031	5.5	(26)	(21)	11	0	11	(32)
2032	5.5	(26)	(21)	11	0	11	(32)
2033	5.5	(26)	(21)	11	0	11	(32)
2034	5.5	(26)	(21)	11	0	11	(32)
2035	5.5	(26)	(21)	11	0	11	(32)
2036	5.5	(26)	(21)	11	0	11	(32)
2037	5.5	(26)	(21)	11	0	11	(32)
2038	5.5	(26)	(21)	11	0	11	(32)
2039	5.5	(26)	(21)	11	0	11	(32)
2040	5.5	(26)	(21)	11	0	11	(32)
2041	5.5	(26)	(21)	11	0	11	(32)
2042	5.5	(26)	(21)	11	0	11	(32)
2043	5.5	(26)	(21)	11	0	11	(32)
2044	5.5	(27)	(21)	11	0	11	(32)
2045	5.5	(27)	(21)	11	0	11	(32)
2046	5.5	(27)	(21)	11	0	11	(32)
2047	5.5	(27)	(21)	11	0	11	(32)
2048	5.5	(27)	(21)	11	0	11	(32)
2049	5.5	(27)	(21)	11	0	11	(32)
2050	5.5	(27)	(21)	11	0	11	(32)
2051	5.5	(27)	(21)	11	0	11	(32)
2052	5.5	(27)	(21)	11	0	11	(32)
2053	5.5	(27)	(21)	11	0	11	(32)
2054	5.5	(27)	(21)	11	0	11	(32)
2055	5.5	(27)	(21)	11	0	11	(32)
2056	5.5	(27)	(21)	11	0	11	(32)
2057	5.5	(27)	(21)	11	0	11	(32)
2058	5.5	(27)	(21)	11	0	11	(32)
2059	5.5	(27)	(21)	11	0	11	(32)
2060	5.5	(27)	(21)	11	0	11	(32)
2061	5.5	(27)	(21)	11	0	11	(32)
2062	5.5	(27)	(21)	11	0	11	(32)
2063	5.5	(27)	(21)	11	0	11	(32)
2064	5.5	(27)	(21)	11	0	11	(32)
2065	5.5	(27)	(21)	11	0	11	(32)
2066	5.5	(27)	(21)	11	0	11	(32)
2067	5.5	(27)	(21)	11	0	11	(32)
2068	5.5	(27)	(21)	11	0	11	(32)
2069	5.5	(27)	(21)	11	0	11	(32)
2070	5.5	(27)	(21)	11	0	11	(32)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Brady's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline		231	0	0	0
1	2015	5,946	228	6	(21)	(26)
2	2016	5,953	226	11	(21)	(32)
3	2017	5,960	223	17	(21)	(38)
4	2018	5,966	221	23	(21)	(43)
5-year Goal	2019	5,973	218	28	(21)	(49)
6	2020	5,980	217	31	(21)	(51)
7	2021	5,983	216	33	(21)	(54)
8	2022	5,985	215	35	(21)	(56)
9	2023	5,988	214	37	(21)	(58)
10-year Goal	2024	5,991	213	39	(21)	(60)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Brady's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	10.00	0	0	0
1	2015	5,946	9.70	1	(26)	(27)
2	2016	5,953	9.40	1	(26)	(27)
3	2017	5,960	9.10	2	(26)	(28)
4	2018	5,966	8.80	3	(26)	(29)
5-year Goal	2019	5,973	8.50	3	(26)	(29)
6	2020	5,980	8.56	3	(26)	(29)
7	2021	5,983	8.62	3	(26)	(29)
8	2022	5,985	8.68	3	(26)	(29)
9	2023	5,988	8.74	3	(26)	(29)
10-year Goal	2024	5,991	8.80	3	(26)	(29)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 26 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 3% increase in 2015
        ii. 3% increase in 2016
    b. Estimated customer demand reduction of 1.2%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014		0
2015	5.38	5.4
2016	5.39	5.4
2017	5.40	5.4
2018	5.41	5.4
2019	5.42	5.4
2020	5.43	5.4
2021	5.44	5.4
2022	5.45	5.5
2023	5.47	5.5
2024	5.48	5.5
2025	5.49	5.5
2026	5.50	5.5
2027	5.51	5.5
2028	5.52	5.5
2029	5.53	5.5
2030	5.55	5.5
2031	5.54	5.5
2032	5.53	5.5
2033	5.52	5.5
2034	5.52	5.5
2035	5.51	5.5
2036	5.50	5.5
2037	5.49	5.5
2038	5.49	5.5
2039	5.48	5.5
2040	5.47	5.5
2041	5.47	5.5
2042	5.48	5.5
2043	5.48	5.5
2044	5.49	5.5
2045	5.49	5.5
2046	5.49	5.5
2047	5.50	5.5
2048	5.50	5.5
2049	5.50	5.5
2050	5.51	5.5
2051	5.51	5.5
2052	5.51	5.5
2053	5.51	5.5
2054	5.51	5.5
2055	5.51	5.5
2056	5.51	5.5
2057	5.51	5.5
2058	5.51	5.5
2059	5.51	5.5
2060	5.51	5.5
2061	5.52	5.5
2062	5.52	5.5
2063	5.52	5.5
2064	5.52	5.5
2065	5.52	5.5
2066	5.52	5.5
2067	5.52	5.5
2068	5.52	5.5
2069	5.52	5.5
2070	5.52	5.5

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	10.00	0
2015	5,946	22.00	(26)
2016	5,953	22.00	(26)
2017	5,960	22.00	(26)
2018	5,966	22.00	(26)
2019	5,973	22.00	(26)
2020	5,980	22.00	(26)
2021	5,983	22.00	(26)
2022	5,985	22.00	(26)
2023	5,988	22.00	(26)
2024	5,991	22.00	(26)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region F savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 36 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	5	(26)	(21)	36	6	0	6	9
2017	5	(26)	(21)	36	6	0	6	9
2018	5	(26)	(21)	36	7	0	7	8
2019	5	(26)	(21)	36	8	0	8	7
2020	5	(26)	(21)	36	10	0	10	5
2021	5	(26)	(21)	36	10	0	10	5
2022	5	(26)	(21)	36	10	0	10	5
2023	5	(26)	(21)	36	11	0	11	5
2024	5	(26)	(21)	37	11	0	11	5
2025	5	(26)	(21)	37	11	0	11	5
2026	6	(26)	(21)	37	11	0	11	5
2027	6	(26)	(21)	37	11	0	11	5
2028	6	(26)	(21)	37	11	0	11	5
2029	6	(26)	(21)	37	11	0	11	5
2030	6	(26)	(21)	37	11	0	11	5
2031	6	(26)	(21)	37	11	0	11	5
2032	6	(26)	(21)	37	11	0	11	5
2033	6	(26)	(21)	37	11	0	11	5
2034	6	(26)	(21)	37	11	0	11	5
2035	6	(26)	(21)	37	11	0	11	5
2036	6	(26)	(21)	37	11	0	11	5
2037	5	(26)	(21)	37	11	0	11	5
2038	5	(26)	(21)	37	11	0	11	5
2039	5	(26)	(21)	37	11	0	11	5
2040	5	(26)	(21)	36	11	0	11	5

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	5	(26)	(21)	6	6	0	6	(20)
2017	5	(26)	(21)	6	6	0	6	(20)
2018	5	(26)	(21)	6	7	0	7	(22)
2019	5	(26)	(21)	6	8	0	8	(23)
2020	5	(26)	(21)	6	10	0	10	(25)
2021	5	(26)	(21)	6	10	0	10	(25)
2022	5	(26)	(21)	6	10	0	10	(25)
2023	5	(26)	(21)	6	11	0	11	(25)
2024	5	(26)	(21)	6	11	0	11	(25)
2025	5	(26)	(21)	6	11	0	11	(25)
2026	6	(26)	(21)	6	11	0	11	(25)
2027	6	(26)	(21)	6	11	0	11	(25)
2028	6	(26)	(21)	6	11	0	11	(25)
2029	6	(26)	(21)	6	11	0	11	(25)
2030	6	(26)	(21)	6	11	0	11	(25)
2031	6	(26)	(21)	6	11	0	11	(25)
2032	6	(26)	(21)	6	11	0	11	(25)
2033	6	(26)	(21)	6	11	0	11	(25)
2034	6	(26)	(21)	6	11	0	11	(25)
2035	6	(26)	(21)	6	11	0	11	(25)
2036	6	(26)	(21)	6	11	0	11	(25)
2037	5	(26)	(21)	6	11	0	11	(25)
2038	5	(26)	(21)	6	11	0	11	(25)
2039	5	(26)	(21)	6	11	0	11	(25)
2040	5	(26)	(21)	6	11	0	11	(26)

3. Rain Barrels
   - **a.** In Region F, utilities could save approximately 11.2 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Coleman Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Coleman's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Coleman's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Coleman's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Coleman with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	7.5	22.3	30	4	0	4	26
2016	7.5	22.4	30	5	0	5	25
2017	7.5	22.6	30	5	0	5	25
2018	7.5	22.7	30	6	0	6	25
2019	7.5	22.8	30	7	0	7	24
2020	7.5	22.9	30	8	0	8	22
2021	7.5	22.9	30	9	0	9	22
2022	7.5	23.0	30	9	0	9	22
2023	7.5	23.0	31	9	0	9	22
2024	7.5	23.1	31	9	0	9	22
2025	7.5	23.1	31	9	0	9	22
2026	7.5	23.1	31	9	0	9	22
2027	7.5	23.2	31	9	0	9	22
2028	7.4	23.2	31	9	0	9	22
2029	7.4	23.3	31	9	0	9	22
2030	7.4	23.3	31	9	0	9	22
2031	7.4	23.4	31	9	0	9	22
2032	7.4	23.4	31	9	0	9	22
2033	7.4	23.4	31	9	0	9	22
2034	7.4	23.4	31	9	0	9	22
2035	7.4	23.4	31	9	0	9	22
2036	7.3	23.4	31	9	0	9	22
2037	7.3	23.4	31	9	0	9	22
2038	7.3	23.4	31	9	0	9	22
2039	7.3	23.4	31	9	0	9	22
2040	7.3	23.4	31	9	0	9	22
2041	7.3	23.4	31	9	0	9	22
2042	7.3	23.4	31	9	0	9	22
2043	7.3	23.4	31	9	0	9	22
2044	7.3	23.4	31	9	0	9	22
2045	7.3	23.4	31	9	0	9	22
2046	7.3	23.4	31	9	0	9	22
2047	7.3	23.4	31	9	0	9	22
2048	7.2	23.4	31	9	0	9	22
2049	7.2	23.4	31	9	0	9	22
2050	7.2	23.4	31	9	0	9	22
2051	7.2	23.4	31	9	0	9	22
2052	7.2	23.4	31	9	0	9	22
2053	7.2	23.4	31	9	0	9	22
2054	7.2	23.4	31	9	0	9	22
2055	7.2	23.4	31	9	0	9	22
2056	7.2	23.4	31	9	0	9	22
2057	7.2	23.4	31	9	0	9	22
2058	7.2	23.4	31	9	0	9	22
2059	7.2	23.4	31	9	0	9	22
2060	7.2	23.4	31	9	0	9	22
2061	7.2	23.4	31	9	0	9	22
2062	7.2	23.4	31	9	0	9	22
2063	7.2	23.4	31	9	0	9	22
2064	7.2	23.4	31	9	0	9	22
2065	7.2	23.4	31	9	0	9	22
2066	7.2	23.4	31	9	0	9	22
2067	7.2	23.4	31	9	0	9	22
2068	7.2	23.4	31	9	0	9	22
2069	7.2	23.4	31	9	0	9	22
2070	7.2	23.4	31	9	0	9	22

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Coleman's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	211	0	0	0
1	2015	4,709	205	11	30	19
2	2016	4,731	199	21	30	9
3	2017	4,753	192	32	30	(2)
4	2018	4,776	186	43	30	(13)
5-year Goal	2019	4,798	180	54	30	(24)
6	2020	4,820	176	62	30	(31)
7	2021	4,831	172	69	30	(38)
8	2022	4,842	168	76	30	(46)
9	2023	4,852	164	83	31	(53)
10-year Goal	2024	4,863	160	91	31	(60)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Coleman's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	58.00	0	0	0
1	2015	4,709	50.40	13	22.3	9
2	2016	4,731	42.80	26	22.4	(4)
3	2017	4,753	35.20	40	22.6	(17)
4	2018	4,776	27.60	53	22.7	(30)
5-year Goal	2019	4,798	20.00	67	22.8	(44)
6	2020	4,820	19.00	69	22.9	(46)
7	2021	4,831	18.00	71	22.9	(48)
8	2022	4,842	17.00	72	23.0	(49)
9	2023	4,852	16.00	74	23.0	(51)
10-year Goal	2024	4,863	15.00	76	23.1	(53)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 22.3 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 14% increase in 2014
    b. Estimated customer demand reduction of 2.8%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2012		0
2013		0
2014	7.54	7.5
2015	7.53	7.5
2016	7.53	7.5
2017	7.52	7.5
2018	7.51	7.5
2019	7.51	7.5
2020	7.50	7.5
2021	7.49	7.5
2022	7.49	7.5
2023	7.48	7.5
2024	7.48	7.5
2025	7.47	7.5
2026	7.46	7.5
2027	7.46	7.5
2028	7.45	7.4
2029	7.44	7.4
2030	7.44	7.4
2031	7.42	7.4
2032	7.40	7.4
2033	7.39	7.4
2034	7.37	7.4
2035	7.35	7.4
2036	7.33	7.3
2037	7.32	7.3
2038	7.30	7.3
2039	7.28	7.3
2040	7.26	7.3
2041	7.26	7.3
2042	7.26	7.3
2043	7.26	7.3
2044	7.26	7.3
2045	7.25	7.3
2046	7.25	7.3
2047	7.25	7.3
2048	7.25	7.2
2049	7.25	7.2
2050	7.25	7.2
2051	7.24	7.2
2052	7.24	7.2
2053	7.24	7.2
2054	7.24	7.2
2055	7.24	7.2
2056	7.23	7.2
2057	7.23	7.2
2058	7.23	7.2
2059	7.23	7.2
2060	7.23	7.2
2061	7.23	7.2
2062	7.23	7.2
2063	7.23	7.2
2064	7.23	7.2
2065	7.23	7.2
2066	7.23	7.2
2067	7.23	7.2
2068	7.23	7.2
2069	7.23	7.2
2070	7.23	7.2

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

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The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

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In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Junction's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Junction's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Junction's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Junction with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	3.7	(0.6)	(3)	7	0	7	(3)
2016	3.7	(0.6)	(3)	8	0	8	(11)
2017	3.7	(0.6)	(3)	8	0	8	(11)
2018	3.7	(0.7)	(3)	10	0	10	(13)
2019	3.7	(0.7)	(3)	11	0	11	(14)
2020	3.7	(0.7)	(3)	15	0	15	(18)
2021	3.7	(0.7)	(3)	15	0	15	(19)
2022	3.7	(0.7)	(3)	15	0	15	(18)
2023	3.7	(0.7)	(3)	15	0	15	(18)
2024	3.7	(0.8)	(3)	15	0	15	(18)
2025	3.7	(0.8)	(3)	15	0	15	(18)
2026	3.7	(0.8)	(3)	15	0	15	(18)
2027	3.6	(0.8)	(3)	15	0	15	(18)
2028	3.6	(0.8)	(3)	15	0	15	(18)
2029	3.6	(0.8)	(3)	15	0	15	(18)
2030	3.6	(0.8)	(3)	15	0	15	(18)
2031	3.6	(0.8)	(3)	15	0	15	(18)
2032	3.6	(0.8)	(3)	15	0	15	(18)
2033	3.6	(0.8)	(3)	15	0	15	(18)
2034	3.6	(0.8)	(3)	15	0	15	(18)
2035	3.6	(0.8)	(3)	15	0	15	(18)
2036	3.6	(0.8)	(3)	15	0	15	(18)
2037	3.6	(0.8)	(3)	15	0	15	(18)
2038	3.6	(0.8)	(3)	15	0	15	(18)
2039	3.6	(0.8)	(3)	15	0	15	(18)
2040	3.6	(0.8)	(3)	15	0	15	(18)
2041	3.6	(0.8)	(3)	15	0	15	(18)
2042	3.6	(0.8)	(3)	15	0	15	(18)
2043	3.6	(0.8)	(3)	15	0	15	(18)
2044	3.6	(0.8)	(3)	15	0	15	(18)
2045	3.6	(0.8)	(3)	15	0	15	(18)
2046	3.6	(0.8)	(3)	15	0	15	(18)
2047	3.6	(0.8)	(3)	15	0	15	(18)
2048	3.6	(0.8)	(3)	15	0	15	(18)
2049	3.6	(0.8)	(3)	15	0	15	(18)
2050	3.5	(0.8)	(3)	15	0	15	(18)
2051	3.5	(0.8)	(3)	15	0	15	(18)
2052	3.5	(0.8)	(3)	15	0	15	(18)
2053	3.5	(0.8)	(3)	15	0	15	(18)
2054	3.5	(0.8)	(3)	15	0	15	(18)
2055	3.5	(0.8)	(3)	15	0	15	(18)
2056	3.5	(0.8)	(3)	15	0	15	(18)
2057	3.5	(0.8)	(3)	15	0	15	(18)
2058	3.5	(0.8)	(3)	15	0	15	(18)
2059	3.5	(0.8)	(3)	15	0	15	(18)
2060	3.5	(0.8)	(3)	15	0	15	(18)
2061	3.5	(0.8)	(3)	15	0	15	(18)
2062	3.5	(0.8)	(3)	15	0	15	(18)
2063	3.5	(0.8)	(3)	15	0	15	(18)
2064	3.5	(0.8)	(3)	15	0	15	(18)
2065	3.5	(0.8)	(3)	15	0	15	(18)
2066	3.5	(0.8)	(3)	15	0	15	(18)
2067	3.5	(0.8)	(3)	15	0	15	(18)
2068	3.5	(0.8)	(3)	15	0	15	(18)
2069	3.5	(0.8)	(3)	15	0	15	(18)
2070	3.5	(0.8)	(3)	15	0	15	(18)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Junction's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	190	0	0	0
1	2015	2,574	188	2	(3)	(5)
2	2016	2,586	186	3	(3)	(6)
3	2017	2,597	185	5	(3)	(8)
4	2018	2,609	183	7	(3)	(10)
5-year Goal	2019	2,620	181	9	(3)	(12)
6	2020	2,632	179	11	(3)	(14)
7	2021	2,635	177	13	(3)	(16)
8	2022	2,637	175	14	(3)	(18)
9	2023	2,640	173	16	(3)	(19)
10-year Goal	2024	2,642	171	18	(3)	(21)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Junction's most recent water loss audit compares with five- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	30.00	0	0	0
1	2015	2,574	29.80	0	(6.6)	(7)
2	2016	2,586	29.60	0	(6.6)	(7)
3	2017	2,597	29.40	1	(6.6)	(7)
4	2018	2,609	29.20	1	(6.7)	(7)
5-year Goal	2019	2,620	29.00	1	(6.7)	(8)
6	2020	2,632	28.60	1	(6.7)	(6)
7	2021	2,635	28.20	2	(6.7)	(8)
8	2022	2,637	27.80	2	(6.7)	(9)
9	2023	2,640	27.40	3	(6.7)	(9)
10-year Goal	2024	2,642	27.00	3	(6.8)	(10)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 7 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 8% increase in 2015
    b. Estimated customer demand reduction of 1.6%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014		0
2015	3.70	3.7
2016	3.69	3.7
2017	3.69	3.7
2018	3.69	3.7
2019	3.68	3.7
2020	3.68	3.7
2021	3.67	3.7
2022	3.67	3.7
2023	3.67	3.7
2024	3.66	3.7
2025	3.66	3.7
2026	3.65	3.7
2027	3.65	3.6
2028	3.65	3.6
2029	3.64	3.6
2030	3.64	3.6
2031	3.63	3.6
2032	3.63	3.6
2033	3.62	3.6
2034	3.61	3.6
2035	3.61	3.6
2036	3.60	3.6
2037	3.60	3.6
2038	3.59	3.6
2039	3.58	3.6
2040	3.58	3.6
2041	3.58	3.6
2042	3.57	3.6
2043	3.57	3.6
2044	3.57	3.6
2045	3.56	3.6
2046	3.56	3.6
2047	3.56	3.6
2048	3.55	3.6
2049	3.55	3.6
2050	3.55	3.5
2051	3.55	3.5
2052	3.55	3.5
2053	3.55	3.5
2054	3.55	3.5
2055	3.55	3.5
2056	3.55	3.5
2057	3.54	3.5
2058	3.54	3.5
2059	3.54	3.5
2060	3.54	3.5
2061	3.54	3.5
2062	3.54	3.5
2063	3.54	3.5
2064	3.54	3.5
2065	3.54	3.5
2066	3.54	3.5
2067	3.54	3.5
2068	3.54	3.5
2069	3.54	3.5
2070	3.54	3.5

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline		30.00	0
2015	2,574	37.00	(7)
2016	2,586	37.00	(7)
2017	2,597	37.00	(7)
2018	2,609	37.00	(7)
2019	2,620	37.00	(7)
2020	2,632	37.00	(7)
2021	2,635	37.00	(7)
2022	2,637	37.00	(7)
2023	2,640	37.00	(7)
2024	2,642	37.00	(7)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	4	(7)	(3)	3	8	0	8	(8)
2017	4	(7)	(3)	3	8	0	8	(8)
2018	4	(7)	(3)	3	10	0	10	(10)
2019	4	(7)	(3)	3	11	0	11	(12)
2020	4	(7)	(3)	3	15	0	15	(13)
2021	4	(7)	(3)	3	15	0	15	(15)
2022	4	(7)	(3)	3	15	0	15	(15)
2023	4	(7)	(3)	3	15	0	15	(15)
2024	4	(7)	(3)	3	15	0	15	(15)
2025	4	(7)	(3)	3	15	0	15	(15)
2026	4	(7)	(3)	3	15	0	15	(15)
2027	4	(7)	(3)	3	15	0	15	(15)
2028	4	(7)	(3)	3	15	0	15	(15)
2029	4	(7)	(3)	3	15	0	15	(15)
2030	4	(7)	(3)	3	15	0	15	(15)
2031	4	(7)	(3)	3	15	0	15	(15)
2032	4	(7)	(3)	3	15	0	15	(15)
2033	4	(7)	(3)	3	15	0	15	(15)
2034	4	(7)	(3)	3	15	0	15	(15)
2035	4	(7)	(3)	3	15	0	15	(15)
2036	4	(7)	(3)	3	15	0	15	(15)
2037	4	(7)	(3)	3	15	0	15	(16)
2038	4	(7)	(3)	3	15	0	15	(16)
2039	4	(7)	(3)	3	15	0	15	(16)
2040	4	(7)	(3)	3	15	0	15	(16)

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1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Midland's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Midland's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Midland's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Midland with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	311	49	360	118	0	118	242
2016	313	48	361	147	0	147	214
2017	315	48	363	147	0	147	216
2018	317	48	364	177	0	177	188
2019	318	48	366	206	0	206	160
2020	320	48	367	265	0	265	103
2021	322	48	369	267	0	267	102
2022	323	48	372	269	0	269	102
2023	325	49	374	271	0	271	102
2024	327	49	376	274	0	274	102
2025	328	49	378	276	0	276	102
2026	330	50	380	278	0	278	102
2027	332	50	382	280	0	280	102
2028	334	50	384	282	0	282	102
2029	335	51	386	284	0	284	101
2030	337	51	388	286	0	286	101
2031	340	51	391	290	0	290	102
2032	343	52	395	293	0	293	102
2033	346	52	398	296	0	296	103
2034	349	53	402	299	0	299	103
2035	352	53	405	302	0	302	103
2036	355	54	409	305	0	305	104
2037	358	55	412	308	0	308	104
2038	361	55	416	311	0	311	105
2039	364	56	419	314	0	314	105
2040	367	56	423	317	0	317	106
2041	370	57	426	320	0	320	106
2042	373	57	430	323	0	323	107
2043	376	58	434	326	0	326	108
2044	379	58	438	329	0	329	109
2045	383	59	441	332	0	332	110
2046	386	59	445	335	0	335	110
2047	389	60	449	337	0	337	111
2048	392	60	452	340	0	340	112
2049	395	61	456	343	0	343	113
2050	398	61	460	346	0	346	114
2051	402	62	463	349	0	349	114
2052	405	62	467	352	0	352	115
2053	408	63	471	355	0	355	116
2054	412	63	475	358	0	358	117
2055	415	64	479	360	0	360	118
2056	418	64	482	363	0	363	119
2057	421	65	486	366	0	366	120
2058	425	65	490	369	0	369	121
2059	428	66	494	372	0	372	122
2060	431	66	498	375	0	375	123
2061	435	67	501	378	0	378	124
2062	438	67	505	380	0	380	125
2063	441	68	509	383	0	383	126
2064	444	68	513	386	0	386	127
2065	448	69	516	389	0	389	128
2066	451	69	520	392	0	392	129
2067	454	70	524	394	0	394	130
2068	457	70	528	397	0	397	131
2069	461	71	532	400	0	400	131
2070	464	71	535	403	0	403	132

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Midland's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	186	0	0	0
1	2016	132,413	185	58	361	303
2	2017	131,877	184	116	363	247
3	2018	131,340	182	173	364	191
4	2019	130,804	181	230	366	136
5-year Goal	2020	130,267	180	286	367	81
6	2021	131,182	179	333	369	37
7	2022	132,097	178	383	372	(12)
8	2023	133,012	177	434	374	(60)
9	2024	133,927	176	485	376	(110)
10-year Goal	2025	134,842	175	538	378	(160)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Midland's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	16.00	0		0
1	2016	132,413	16.40	(19)	48	68
2	2017	131,877	16.80	(39)	48	87
3	2018	131,340	17.20	(58)	48	106
4	2019	130,804	17.60	(76)	48	124
5-year Goal	2020	130,267	18.00	(95)	48	143
6	2021	131,182	18.00	(96)	48	143
7	2022	132,097	18.00	(96)	48	144
8	2023	133,012	18.00	(97)	48	145
9	2024	133,927	18.00	(98)	49	146
10-year Goal	2025	134,842	18.00	(98)	49	147

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 49 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 5% increase in 2014
        ii. 5% increase in 2015
        iii. 4.5% increase in 2016
    b. Estimated customer demand reduction of 2.9%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014	310	310
2015	311	311
2016	313	313
2017	315	315
2018	317	317
2019	318	318
2020	320	320
2021	322	322
2022	323	323
2023	325	325
2024	327	327
2025	328	328
2026	330	330
2027	332	332
2028	334	334
2029	335	335
2030	337	337
2031	340	340
2032	343	343
2033	346	346
2034	349	349
2035	352	352
2036	355	355
2037	358	358
2038	361	361
2039	364	364
2040	367	367
2041	370	370
2042	373	373
2043	376	376
2044	379	379
2045	383	383
2046	386	386
2047	389	389
2048	392	392
2049	395	395
2050	398	398
2051	402	402
2052	405	405
2053	408	408
2054	412	412
2055	415	415
2056	418	418
2057	421	421
2058	425	425
2059	428	428
2060	431	431
2061	435	435
2062	438	438
2063	441	441
2064	444	444
2065	448	448
2066	451	451
2067	454	454
2068	457	457
2069	461	461
2070	464	464

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	16.00	0
2015	132,950	15.00	49
2016	132,413	15.00	48
2017	131,877	15.00	48
2018	131,340	15.00	48
2019	130,804	15.00	48
2020	130,267	15.00	48
2021	131,182	15.00	48
2022	132,097	15.00	48
2023	133,012	15.00	49
2024	133,927	15.00	49

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region F savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 791 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	313	48	361	791	147	0	147	1,005
2017	315	48	363	795	147	0	147	1,011
2018	317	48	364	800	177	0	177	988
2019	318	48	366	804	206	0	206	964
2020	320	48	367	808	265	0	265	911
2021	322	48	369	813	267	0	267	915
2022	323	48	372	817	269	0	269	919
2023	325	49	374	821	271	0	271	923
2024	327	49	376	825	274	0	274	928
2025	328	49	378	830	276	0	276	932
2026	330	50	380	834	278	0	278	936
2027	332	50	382	838	280	0	280	940
2028	334	50	384	843	282	0	282	944
2029	335	51	386	847	284	0	284	948
2030	337	51	388	851	286	0	286	953
2031	340	51	391	859	290	0	290	961
2032	343	52	395	866	293	0	293	969
2033	346	52	398	874	296	0	296	976
2034	349	53	402	881	299	0	299	984
2035	352	53	405	889	302	0	302	992
2036	355	54	409	896	305	0	305	1,000
2037	358	55	412	904	308	0	308	1,008
2038	361	55	416	911	311	0	311	1,016
2039	364	56	419	919	314	0	314	1,024
2040	367	56	423	927	317	0	317	1,032

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	313	48	361	140	147	0	147	354
2017	315	48	363	141	147	0	147	356
2018	317	48	364	141	177	0	177	329
2019	318	48	366	142	206	0	206	302
2020	320	48	367	143	265	0	265	245
2021	322	48	369	144	267	0	267	246
2022	323	48	372	144	269	0	269	247
2023	325	49	374	145	271	0	271	247
2024	327	49	376	146	274	0	274	248
2025	328	49	378	147	276	0	276	249
2026	330	50	380	147	278	0	278	249
2027	332	50	382	148	280	0	280	250
2028	334	50	384	149	282	0	282	251
2029	335	51	386	150	284	0	284	251
2030	337	51	388	150	286	0	286	252
2031	340	51	391	152	290	0	290	254
2032	343	52	395	153	293	0	293	255
2033	346	52	398	154	296	0	296	257
2034	349	53	402	156	299	0	299	259
2035	352	53	405	157	302	0	302	261
2036	355	54	409	158	305	0	305	262
2037	358	55	412	160	308	0	308	264
2038	361	55	416	161	311	0	311	266
2039	364	56	419	162	314	0	314	268
2040	367	56	423	164	317	0	317	269

Statewide Water Conservation Quantification Project
City of Odessa Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Odessa's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Odessa's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Odessa's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Odessa with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	434	434	104	0	104	331
2016	674	431	1,105	130	0	130	976
2017	681	428	1,109	130	0	130	980
2018	689	425	1,114	156	0	156	958
2019	696	422	1,118	181	0	181	936
2020	703	419	1,122	233	0	233	889
2021	711	424	1,135	237	0	237	898
2022	718	430	1,148	240	0	240	907
2023	725	435	1,160	244	0	244	916
2024	733	441	1,173	248	0	248	926
2025	740	446	1,186	251	0	251	935
2026	747	446	1,193	255	0	255	939
2027	755	452	1,206	258	0	258	948
2028	762	457	1,219	262	0	262	957
2029	769	463	1,232	265	0	265	967
2030	777	468	1,245	269	0	269	976
2031	785	473	1,258	272	0	272	986
2032	793	479	1,272	275	0	275	997
2033	801	485	1,286	279	0	279	1,007
2034	809	491	1,300	282	0	282	1,018
2035	817	497	1,314	285	0	285	1,029
2036	825	502	1,327	288	0	288	1,039
2037	833	508	1,341	291	0	291	1,050
2038	841	514	1,355	295	0	295	1,060
2039	849	520	1,369	298	0	298	1,071
2040	857	525	1,383	301	0	301	1,082
2041	866	531	1,397	304	0	304	1,093
2042	875	537	1,412	308	0	308	1,104
2043	884	543	1,427	311	0	311	1,115
2044	892	549	1,441	314	0	314	1,127
2045	901	555	1,456	318	0	318	1,138
2046	910	561	1,471	321	0	321	1,150
2047	919	567	1,485	324	0	324	1,161
2048	927	573	1,500	328	0	328	1,172
2049	936	578	1,515	331	0	331	1,184
2050	945	584	1,529	334	0	334	1,195
2051	954	590	1,545	338	0	338	1,207
2052	964	596	1,560	341	0	341	1,219
2053	973	602	1,575	344	0	344	1,231
2054	983	608	1,591	348	0	348	1,243
2055	992	614	1,606	351	0	351	1,255
2056	1,001	620	1,622	354	0	354	1,267
2057	1,011	626	1,637	358	0	358	1,279
2058	1,020	632	1,652	361	0	361	1,291
2059	1,030	638	1,668	364	0	364	1,303
2060	1,039	644	1,683	368	0	368	1,316
2061	1,049	650	1,699	371	0	371	1,328
2062	1,058	656	1,714	374	0	374	1,340
2063	1,068	662	1,730	378	0	378	1,352
2064	1,077	668	1,745	381	0	381	1,364
2065	1,087	674	1,761	384	0	384	1,377
2066	1,096	680	1,777	388	0	388	1,389
2067	1,106	686	1,792	391	0	391	1,401
2068	1,116	692	1,808	394	0	394	1,413
2069	1,125	698	1,823	398	0	398	1,426
2070	1,135	704	1,839	401	0	401	1,438

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Odessa's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	152	0	0	0
1	2015	118,968	158	(238)	434	673
2	2016	118,112	163	(474)	1,105	1,579
3	2017	117,255	169	(700)	1,109	1,816
4	2018	116,399	174	(935)	1,114	2,048
5-year Goal	2019	115,542	180	(1,160)	1,118	2,278
6	2020	114,686	179	(1,130)	1,122	2,252
7	2021	116,190	179	(1,124)	1,135	2,259
8	2022	117,694	178	(1,117)	1,148	2,265
9	2023	119,198	178	(1,109)	1,160	2,270
10-year Goal	2024	120,702	177	(1,103)	1,173	2,275

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Odessa's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	22.00	0	0	0
1	2015	118,968	22.00	0	434	434
2	2016	118,112	22.00	0	431	431
3	2017	117,255	22.00	0	428	428
4	2018	116,399	22.00	0	425	425
5-year Goal	2019	115,542	22.00	0	422	422
6	2020	114,686	21.80	8	419	410
7	2021	116,190	21.60	17	424	407
8	2022	117,694	21.40	26	430	404
9	2023	119,198	21.20	35	435	400
10-year Goal	2024	120,702	21.00	44	441	397

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 434 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 40% increase in 2012
        ii. 8% increase in 2015
    b. Estimated customer demand reduction of 9.6%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014		0
2015		0
2016	674	674
2017	681	681
2018	689	689
2019	696	696
2020	703	703
2021	711	711
2022	718	718
2023	725	725
2024	733	733
2025	740	740
2026	747	747
2027	755	755
2028	762	762
2029	769	769
2030	777	777
2031	785	785
2032	793	793
2033	801	801
2034	809	809
2035	817	817
2036	825	825
2037	833	833
2038	841	841
2039	849	849
2040	857	857
2041	866	866
2042	875	875
2043	884	884
2044	892	892
2045	901	901
2046	910	910
2047	919	919
2048	927	927
2049	936	936
2050	945	945
2051	954	954
2052	964	964
2053	973	973
2054	983	983
2055	992	992
2056	1,001	1,001
2057	1,011	1,011
2058	1,020	1,020
2059	1,030	1,030
2060	1,039	1,039
2061	1,049	1,049
2062	1,058	1,058
2063	1,068	1,068
2064	1,077	1,077
2065	1,087	1,087
2066	1,096	1,096
2067	1,106	1,106
2068	1,116	1,116
2069	1,125	1,125
2070	1,135	1,135

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	22.00	0
2015	118,968	12.00	434
2016	118,112	12.00	431
2017	117,255	12.00	428
2018	116,399	12.00	425
2019	115,542	12.00	422
2020	114,686	12.00	419
2021	116,190	12.00	424
2022	117,694	12.00	430
2023	119,198	12.00	435
2024	120,702	12.00	441

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.79% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 547 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	674	431	1,105	547	130	0	130	1,522
2017	681	428	1,109	553	130	0	130	1,533
2018	689	425	1,114	559	156	0	156	1,517
2019	696	422	1,118	565	181	0	181	1,501
2020	703	419	1,122	571	233	0	233	1,459
2021	711	424	1,135	577	237	0	237	1,475
2022	718	430	1,148	583	240	0	240	1,490
2023	725	435	1,160	589	244	0	244	1,505
2024	733	441	1,173	595	248	0	248	1,520
2025	740	446	1,186	601	251	0	251	1,536
2026	747	446	1,193	606	255	0	255	1,545
2027	755	452	1,206	612	258	0	258	1,560
2028	762	457	1,219	618	262	0	262	1,576
2029	769	463	1,232	624	265	0	265	1,591
2030	777	468	1,245	630	269	0	269	1,606
2031	785	473	1,258	637	272	0	272	1,623
2032	793	479	1,272	643	275	0	275	1,640
2033	801	485	1,286	650	279	0	279	1,657
2034	809	491	1,300	656	282	0	282	1,674
2035	817	497	1,314	663	285	0	285	1,692
2036	825	502	1,327	668	288	0	288	1,709
2037	833	508	1,341	676	291	0	291	1,726
2038	841	514	1,355	683	295	0	295	1,743
2039	849	520	1,369	689	298	0	298	1,760
2040	857	525	1,383	696	301	0	301	1,777

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	674	431	1,105	94	130	0	130	1,070
2017	681	428	1,109	95	130	0	130	1,075
2018	689	425	1,114	96	156	0	156	1,054
2019	696	422	1,118	97	181	0	181	1,033
2020	703	419	1,122	98	233	0	233	987
2021	711	424	1,135	99	237	0	237	997
2022	718	430	1,148	100	240	0	240	1,007
2023	725	435	1,160	101	244	0	244	1,016
2024	733	441	1,173	102	248	0	248	1,028
2025	740	446	1,186	103	251	0	251	1,038
2026	747	446	1,193	104	255	0	255	1,043
2027	755	452	1,206	105	258	0	258	1,053
2028	762	457	1,219	106	262	0	262	1,064
2029	769	463	1,232	107	265	0	265	1,074
2030	777	468	1,245	108	269	0	269	1,084
2031	785	473	1,258	110	272	0	272	1,096
2032	793	479	1,272	111	275	0	275	1,107
2033	801	485	1,286	112	279	0	279	1,119
2034	809	491	1,300	113	282	0	282	1,131
2035	817	497	1,314	114	285	0	285	1,143
2036	825	502	1,327	115	288	0	288	1,154
2037	833	508	1,341	116	291	0	291	1,166
2038	841	514	1,355	117	295	0	295	1,178
2039	849	520	1,369	119	298	0	298	1,189
2040	857	525	1,383	120	301	0	301	1,201

Statewide Water Conservation Quantification Project
City of San Angelo Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares San Angelo's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) San Angelo's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in San Angelo's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for San Angelo with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	429	110	539	95	0	95	444
2016	559	111	670	119	0	119	551
2017	692	112	804	119	0	119	685
2018	699	113	812	143	0	143	669
2019	705	114	819	166	0	166	653
2020	712	115	827	214	0	214	614
2021	719	117	836	217	0	217	619
2022	726	118	844	220	0	220	624
2023	733	119	852	223	0	223	629
2024	740	121	861	226	0	226	634
2025	747	122	869	230	0	230	639
2026	753	124	877	233	0	233	645
2027	760	125	886	236	0	236	650
2028	767	127	894	239	0	239	655
2029	774	128	902	242	0	242	660
2030	781	130	911	245	0	245	665
2031	784	131	915	247	0	247	668
2032	788	131	919	248	0	248	671
2033	791	132	923	249	0	249	674
2034	794	133	927	251	0	251	677
2035	798	134	931	252	0	252	679
2036	801	135	935	253	0	253	682
2037	804	135	939	255	0	255	685
2038	807	136	944	256	0	256	688
2039	811	137	948	257	0	257	691
2040	814	138	952	258	0	258	693
2041	818	139	957	260	0	260	697
2042	823	139	962	262	0	262	700
2043	827	140	967	263	0	263	704
2044	831	141	972	265	0	265	707
2045	835	142	977	266	0	266	711
2046	839	143	982	268	0	268	714
2047	844	144	987	270	0	270	718
2048	848	145	992	271	0	271	721
2049	852	145	997	273	0	273	725
2050	856	146	1,002	274	0	274	728
2051	861	147	1,008	276	0	276	732
2052	866	148	1,015	278	0	278	737
2053	872	149	1,021	279	0	279	741
2054	877	150	1,027	281	0	281	745
2055	882	151	1,033	283	0	283	750
2056	887	152	1,039	285	0	285	754
2057	892	153	1,045	286	0	286	758
2058	897	154	1,051	288	0	288	763
2059	902	154	1,057	290	0	290	767
2060	907	155	1,063	291	0	291	771
2061	913	156	1,069	293	0	293	776
2062	918	157	1,076	295	0	295	781
2063	924	158	1,082	297	0	297	785
2064	929	159	1,089	299	0	299	790
2065	935	160	1,095	300	0	300	795
2066	941	161	1,102	302	0	302	799
2067	946	162	1,108	304	0	304	804
2068	952	163	1,115	306	0	306	809
2069	957	164	1,121	307	0	307	814
2070	963	165	1,128	309	0	309	818

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how San Angelo's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	156	0	0	0
1	2015	100,450	155	44	539	495
2	2016	101,377	154	89	670	581
3	2017	102,303	152	134	804	669
4	2018	103,230	151	181	812	631
5-year Goal	2019	104,156	150	228	819	591
6	2020	105,083	149	268	827	559
7	2021	106,423	148	311	836	525
8	2022	107,762	147	354	844	490
9	2023	109,102	146	398	852	454
10-year Goal	2024	110,442	145	443	861	417

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how San Angelo's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	19.00	0	0	0
1	2015	100,450	18.60	15	110	95
2	2016	101,377	18.20	30	111	81
3	2017	102,303	17.80	45	112	67
4	2018	103,230	17.40	60	113	53
5-year Goal	2019	104,156	17.00	76	114	38
6	2020	105,083	16.60	92	115	23
7	2021	106,423	16.20	109	117	8
8	2022	107,762	15.80	126	118	(8)
9	2023	109,102	15.40	143	119	(24)
10-year Goal	2024	110,442	15.00	161	121	(40)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 110 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 11.75% increase in 2016
        ii. 11.75% increase in 2017
    b. Estimated customer demand reduction of 4.4%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

6. Twice-a-week Outdoor Watering Restriction Ordinance

a. Estimated savings of 7.58% of total utility demand (Hermitte and Mace 2012; Sierra Club-Lone Star Chapter and the National Wildlife Federation, 2015)
    i. All savings estimates grow each year at the same rate demand figures for the utility grow in the regional water plan.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	Watering Ordinance	TOTAL SAVINGS
2009			0
2010			0
2011			0
2012			0
2013			0
2014		425	424.6
2015		429	429.0
2016	126	433	559.1
2017	254	436	691.7
2018	257	442	698.6
2019	259	446	705.4
2020	262	451	712.3
2021	264	455	719.2
2022	267	459	726.0
2023	269	464	732.9
2024	272	468	739.8
2025	274	472	746.6
2026	277	477	753.5
2027	279	481	760.3
2028	282	485	767.2
2029	284	490	774.1
2030	287	494	780.9
2031	288	496	784.2
2032	289	498	787.6
2033	290	500	790.9
2034	292	503	794.2
2035	293	505	797.5
2036	294	507	800.8
2037	295	509	804.1
2038	297	511	807.5
2039	298	513	810.8
2040	299	515	814.1
2041	301	518	818.3
2042	302	520	822.5
2043	304	523	826.7
2044	305	526	830.9
2045	307	528	835.1
2046	308	531	839.4
2047	310	534	843.6
2048	311	536	847.8
2049	313	539	852.0
2050	314	542	856.2
2051	316	545	861.3
2052	318	548	866.4
2053	320	551	871.6
2054	322	555	876.7
2055	324	558	881.8
2056	326	561	886.9
2057	328	564	892.0
2058	329	568	897.1
2059	331	571	902.2
2060	333	574	907.4
2061	335	578	912.9
2062	337	581	918.4
2063	339	585	923.9
2064	341	588	929.5
2065	343	592	935.0
2066	345	595	940.5
2067	347	599	946.0
2068	349	602	951.6
2069	352	606	957.1
2070	354	609	962.6

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	19.00	0
2015	100,450	16.90	110
2016	101,377	16.90	111
2017	102,303	16.90	112
2018	103,230	16.90	113
2019	104,156	16.90	114
2020	105,083	16.90	115
2021	106,423	16.90	117
2022	107,762	16.90	118
2023	109,102	16.90	119
2024	110,442	16.90	121

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	559	111	670	77	119	0	119	628
2017	692	112	804	77	119	0	119	762
2018	699	113	812	78	143	0	143	747
2019	705	114	819	79	166	0	166	732
2020	712	115	827	80	214	0	214	693
2021	719	117	836	80	217	0	217	699
2022	726	118	844	81	220	0	220	705
2023	733	119	852	82	223	0	223	711
2024	740	121	861	83	226	0	226	717
2025	747	122	869	84	230	0	230	723
2026	753	124	877	84	233	0	233	729
2027	760	125	886	85	236	0	236	735
2028	767	127	894	86	239	0	239	741
2029	774	128	902	87	242	0	242	747
2030	781	130	911	87	245	0	245	753
2031	784	131	915	88	247	0	247	756
2032	788	131	919	88	248	0	248	759
2033	791	132	923	88	249	0	249	762
2034	794	133	927	89	251	0	251	765
2035	798	134	931	89	252	0	252	769
2036	801	135	935	90	253	0	253	772
2037	804	135	939	90	255	0	255	775
2038	807	136	944	90	256	0	256	778
2039	811	137	948	91	257	0	257	781
2040	814	138	952	91	258	0	258	784

Statewide Water Conservation Quantification Project
City of Snyder Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Snyder's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Snyder's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Snyder's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Snyder with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	0	0	11	0	11	(11)
2016	0	0	0	14	0	14	(14)
2017	0	0	0	14	0	14	(14)
2018	0	0	0	16	0	16	(16)
2019	0	0	0	19	0	19	(19)
2020	0	0	0	24	0	24	(24)
2021	0	0	0	25	0	25	(25)
2022	0	0	0	25	0	25	(25)
2023	0	0	0	26	0	26	(26)
2024	0	0	0	26	0	26	(26)
2025	0	0	0	26	0	26	(26)
2026	0	0	0	27	0	27	(27)
2027	0	0	0	27	0	27	(27)
2028	0	0	0	27	0	27	(27)
2029	0	0	0	28	0	28	(28)
2030	0	0	0	28	0	28	(28)
2031	0	0	0	28	0	28	(28)
2032	0	0	0	28	0	28	(28)
2033	0	0	0	29	0	29	(29)
2034	0	0	0	29	0	29	(29)
2035	0	0	0	29	0	29	(29)
2036	0	0	0	29	0	29	(29)
2037	0	0	0	30	0	30	(30)
2038	0	0	0	30	0	30	(30)
2039	0	0	0	30	0	30	(30)
2040	0	0	0	30	0	30	(30)
2041	0	0	0	31	0	31	(31)
2042	0	0	0	31	0	31	(31)
2043	0	0	0	31	0	31	(31)
2044	0	0	0	31	0	31	(31)
2045	0	0	0	31	0	31	(31)
2046	0	0	0	32	0	32	(32)
2047	0	0	0	32	0	32	(32)
2048	0	0	0	32	0	32	(32)
2049	0	0	0	32	0	32	(32)
2050	0	0	0	33	0	33	(33)
2051	0	0	0	33	0	33	(33)
2052	0	0	0	33	0	33	(33)
2053	0	0	0	33	0	33	(33)
2054	0	0	0	33	0	33	(33)
2055	0	0	0	33	0	33	(33)
2056	0	0	0	33	0	33	(33)
2057	0	0	0	34	0	34	(34)
2058	0	0	0	34	0	34	(34)
2059	0	0	0	34	0	34	(34)
2060	0	0	0	34	0	34	(34)
2061	0	0	0	35	0	35	(35)
2062	0	0	0	36	0	36	(36)
2063	0	0	0	37	0	37	(37)
2064	0	0	0	38	0	38	(38)
2065	0	0	0	39	0	39	(39)
2066	0	0	0	40	0	40	(40)
2067	0	0	0	41	0	41	(41)
2068	0	0	0	42	0	42	(42)
2069	0	0	0	43	0	43	(43)
2070	0	0	0	44	0	44	(44)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Snyder's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	139	0	0	0
1	2015	11,768	137	8	0	(8)
2	2016	12,151	135	16	0	(16)
3	2017	12,534	134	25	0	(25)
4	2018	12,916	132	34	0	(34)
5-year Goal	2019	13,299	130	44	0	(44)
6	2020	13,682	127	60	0	(60)
7	2021	13,888	124	76	0	(76)
8	2022	14,093	121	93	0	(93)
9	2023	14,299	118	110	0	(110)
10-year Goal	2024	14,504	115	127	0	(127)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Snyder's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	4.00	0	0	0
1	2015	11,768	4.60	(3)	0	3
2	2016	12,151	5.20	(5)	0	5
3	2017	12,534	5.80	(8)	0	8
4	2018	12,916	6.40	(11)	0	11
5-year Goal	2019	13,299	7.00	(15)	0	15
6	2020	13,682	6.60	(13)	0	13
7	2021	13,888	6.20	(11)	0	11
8	2022	14,093	5.80	(9)	0	9
9	2023	14,299	5.40	(7)	0	7
10-year Goal	2024	14,504	5.00	(5)	0	5

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 0 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	4.00	0
2015	11,768	4.00	0
2016	12,151	4.00	0
2017	12,534	4.00	0
2018	12,916	4.00	0
2019	13,299	4.00	0
2020	13,682	4.00	0
2021	13,868	4.00	0
2022	14,093	4.00	0
2023	14,299	4.00	0
2024	14,504	4.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region F savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 48 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	48	14	0	14	34
2017	0	0	0	49	14	0	14	35
2018	0	0	0	49	16	0	16	33
2019	0	0	0	50	19	0	19	31
2020	0	0	0	50	24	0	24	26
2021	0	0	0	51	25	0	25	26
2022	0	0	0	51	25	0	25	26
2023	0	0	0	52	26	0	26	26
2024	0	0	0	53	26	0	26	27
2025	0	0	0	53	26	0	26	27
2026	0	0	0	54	27	0	27	27
2027	0	0	0	54	27	0	27	27
2028	0	0	0	55	27	0	27	27
2029	0	0	0	56	28	0	28	28
2030	0	0	0	56	28	0	28	28
2031	0	0	0	56	28	0	28	28
2032	0	0	0	57	28	0	28	28
2033	0	0	0	57	29	0	29	28
2034	0	0	0	57	29	0	29	28
2035	0	0	0	57	29	0	29	28
2036	0	0	0	58	29	0	29	28
2037	0	0	0	58	30	0	30	28
2038	0	0	0	58	30	0	30	28
2039	0	0	0	59	30	0	30	29
2040	0	0	0	59	30	0	30	29

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	8	14	0	14	(6)
2017	0	0	0	9	14	0	14	(5)
2018	0	0	0	9	16	0	16	(8)
2019	0	0	0	9	19	0	19	(10)
2020	0	0	0	9	24	0	24	(16)
2021	0	0	0	9	25	0	25	(16)
2022	0	0	0	9	25	0	25	(16)
2023	0	0	0	9	26	0	26	(16)
2024	0	0	0	9	26	0	26	(17)
2025	0	0	0	9	26	0	26	(17)
2026	0	0	0	9	27	0	27	(17)
2027	0	0	0	10	27	0	27	(17)
2028	0	0	0	10	27	0	27	(18)
2029	0	0	0	10	28	0	28	(18)
2030	0	0	0	10	28	0	28	(18)
2031	0	0	0	10	28	0	28	(18)
2032	0	0	0	10	28	0	28	(18)
2033	0	0	0	10	29	0	29	(19)
2034	0	0	0	10	29	0	29	(19)
2035	0	0	0	10	29	0	29	(19)
2036	0	0	0	10	29	0	29	(19)
2037	0	0	0	10	30	0	30	(19)
2038	0	0	0	10	30	0	30	(20)
2039	0	0	0	10	30	0	30	(20)
2040	0	0	0	10	30	0	30	(20)

3. Water Rate Increase
    a. For every 10% increase, estimated savings could be 2% of utility total demand.
    b. Approximately 13 MG of savings per year with current demand
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	13	14	0	14	(1)
2017	0	0	0	13	14	0	14	(1)
2018	0	0	0	13	16	0	16	(3)
2019	0	0	0	13	19	0	19	(6)
2020	0	0	0	13	24	0	24	(11)
2021	0	0	0	13	25	0	25	(11)
2022	0	0	0	14	25	0	25	(12)
2023	0	0	0	14	26	0	26	(12)
2024	0	0	0	14	26	0	26	(12)
2025	0	0	0	14	26	0	26	(12)
2026	0	0	0	14	27	0	27	(12)
2027	0	0	0	14	27	0	27	(13)
2028	0	0	0	14	27	0	27	(13)
2029	0	0	0	15	28	0	28	(13)
2030	0	0	0	15	28	0	28	(13)
2031	0	0	0	15	28	0	28	(13)
2032	0	0	0	15	28	0	28	(14)
2033	0	0	0	15	29	0	29	(14)
2034	0	0	0	15	29	0	29	(14)
2035	0	0	0	15	29	0	29	(14)
2036	0	0	0	15	29	0	29	(14)
2037	0	0	0	15	30	0	30	(14)
2038	0	0	0	15	30	0	30	(14)
2039	0	0	0	15	30	0	30	(15)
2040	0	0	0	16	30	0	30	(15)

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

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City of Winters Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Winters's current water conservation activities and their quantified savings to two metrics: 1) Region F Water Plan's (Region F Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Winters's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Winters's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8 9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Winters with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0.4	17	18	2	0	2	16
2016	0.9	17	18	3	0	3	16
2017	0.9	17	18	3	0	3	16
2018	0.9	17	18	3	0	3	15
2019	0.9	17	18	4	0	4	15
2020	0.9	17	18	5	0	5	14
2021	0.9	17	18	5	0	5	14
2022	0.9	17	18	5	0	5	14
2023	0.9	17	18	5	0	5	14
2024	0.9	17	18	5	0	5	14
2025	0.9	18	18	5	0	5	14
2026	0.9	18	18	5	0	5	14
2027	0.9	18	19	5	0	5	14
2028	0.9	18	19	5	0	5	14
2029	0.9	18	19	5	0	5	14
2030	0.9	18	19	5	0	5	14
2031	0.8	18	19	5	0	5	14
2032	0.8	18	19	5	0	5	14
2033	0.8	18	19	5	0	5	14
2034	0.8	18	19	5	0	5	14
2035	0.8	18	19	5	0	5	14
2036	0.8	18	19	5	0	5	14
2037	0.8	18	19	5	0	5	14
2038	0.8	18	19	5	0	5	14
2039	0.8	18	19	5	0	5	14
2040	0.8	18	19	5	0	5	14
2041	0.8	18	19	5	0	5	14
2042	0.8	18	19	5	0	5	14
2043	0.8	18	19	5	0	5	14
2044	0.8	19	19	5	0	5	14
2045	0.8	19	19	5	0	5	14
2046	0.8	19	19	5	0	5	15
2047	0.8	19	19	5	0	5	15
2048	0.8	19	20	5	0	5	15
2049	0.8	19	20	5	0	5	15
2050	0.8	19	20	5	0	5	15
2051	0.8	19	20	5	0	5	15
2052	0.8	19	20	5	0	5	15
2053	0.8	19	20	5	0	5	15
2054	0.8	19	20	5	0	5	15
2055	0.8	19	20	5	0	5	15
2056	0.8	19	20	5	0	5	15
2057	0.8	19	20	5	0	5	15
2058	0.8	19	20	5	0	5	15
2059	0.8	19	20	5	0	5	15
2060	0.8	19	20	5	0	5	15
2061	0.8	19	20	5	0	5	15
2062	0.8	19	20	5	0	5	15
2063	0.8	19	20	5	0	5	15
2064	0.8	19	20	5	0	5	15
2065	0.8	19	20	5	0	5	15
2066	0.8	19	20	5	0	5	15
2067	0.8	19	20	5	0	5	15
2068	0.8	19	20	5	0	5	15
2069	0.8	19	20	5	0	5	15
2070	0.8	19	20	5	0	5	15

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Winters's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	111	0	0	0
1	2015	2,974	111	0	18	18
2	2016	2,969	111	0	18	18
3	2017	2,965	111	0	18	18
4	2018	2,960	111	0	18	18
5-year Goal	2019	2,956	111	0	18	18
6	2020	2,951	111	0	18	18
7	2021	2,962	111	0	18	18
8	2022	2,972	111	0	18	18
9	2023	2,983	111	0	18	18
10-year Goal	2024	2,993	111	0	18	18

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic 5-year average for total GPCD from the utility's most recently submitted 5-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Winters's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	17.00	0	0	0
1	2015	2,974	17.00	0	17	17
2	2016	2,969	17.00	0	17	17
3	2017	2,965	17.00	0	17	17
4	2018	2,960	17.00	0	17	17
5-year Goal	2019	2,956	17.00	0	17	17
6	2020	2,951	17.00	0	17	17
7	2021	2,962	17.00	0	17	17
8	2022	2,972	17.00	0	17	17
9	2023	2,983	17.00	0	17	17
10-year Goal	2024	2,993	17.00	0	17	17

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 17 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 2.7% increase in 2013
        ii. 3.6% increase in 2016
    b. Estimated customer demand reduction of 1.26%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013	0.36	0.4
2014	0.36	0.4
2015	0.36	0.4
2016	0.90	0.9
2017	0.90	0.9
2018	0.89	0.9
2019	0.89	0.9
2020	0.89	0.9
2021	0.88	0.9
2022	0.88	0.9
2023	0.88	0.9
2024	0.87	0.9
2025	0.87	0.9
2026	0.86	0.9
2027	0.86	0.9
2028	0.86	0.9
2029	0.85	0.9
2030	0.85	0.9
2031	0.85	0.8
2032	0.84	0.8
2033	0.84	0.8
2034	0.83	0.8
2035	0.83	0.8
2036	0.83	0.8
2037	0.82	0.8
2038	0.82	0.8
2039	0.81	0.8
2040	0.81	0.8
2041	0.81	0.8
2042	0.81	0.8
2043	0.81	0.8
2044	0.81	0.8
2045	0.81	0.8
2046	0.81	0.8
2047	0.81	0.8
2048	0.81	0.8
2049	0.81	0.8
2050	0.80	0.8
2051	0.80	0.8
2052	0.80	0.8
2053	0.80	0.8
2054	0.80	0.8
2055	0.80	0.8
2056	0.80	0.8
2057	0.80	0.8
2058	0.80	0.8
2059	0.80	0.8
2060	0.80	0.8
2061	0.80	0.8
2062	0.80	0.8
2063	0.80	0.8
2064	0.80	0.8
2065	0.80	0.8
2066	0.80	0.8
2067	0.80	0.8
2068	0.80	0.8
2069	0.80	0.8
2070	0.80	0.8

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	17.00	0
2015	2,974	1.00	17
2016	2,969	1.00	17
2017	2,965	1.00	17
2018	2,960	1.00	17
2019	2,956	1.00	17
2020	2,951	1.00	17
2021	2,962	1.00	17
2022	2,972	1.00	17
2023	2,983	1.00	17
2024	2,993	1.00	17

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region F savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 5 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	17	18	5	3	0	3	21
2017	1	17	18	5	3	0	3	21
2018	1	17	18	5	3	0	3	21
2019	1	17	18	5	4	0	4	20
2020	1	17	18	5	5	0	5	19
2021	1	17	18	5	5	0	5	19
2022	1	17	18	5	5	0	5	19
2023	1	17	18	5	5	0	5	19
2024	1	17	18	5	5	0	5	19
2025	1	18	18	5	5	0	5	19
2026	1	18	18	5	5	0	5	19
2027	1	18	19	5	5	0	5	19
2028	1	18	19	5	5	0	5	19
2029	1	18	19	5	5	0	5	19
2030	1	18	19	5	5	0	5	19
2031	1	18	19	5	5	0	5	19
2032	1	18	19	5	5	0	5	19
2033	1	18	19	5	5	0	5	19
2034	1	18	19	5	5	0	5	19
2035	1	18	19	5	5	0	5	19
2036	1	18	19	5	5	0	5	19
2037	1	18	19	5	5	0	5	19
2038	1	18	19	5	5	0	5	19
2039	1	18	19	5	5	0	5	19
2040	1	18	19	5	5	0	5	19

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	17	18	1	3	0	3	17
2017	1	17	18	1	3	0	3	17
2018	1	17	18	1	3	0	3	16
2019	1	17	18	1	4	0	4	16
2020	1	17	18	1	5	0	5	15
2021	1	17	18	1	5	0	5	15
2022	1	17	18	1	5	0	5	15
2023	1	17	18	1	5	0	5	15
2024	1	17	18	1	5	0	5	15
2025	1	18	18	1	5	0	5	15
2026	1	18	18	1	5	0	5	15
2027	1	18	19	1	5	0	5	15
2028	1	18	19	1	5	0	5	15
2029	1	18	19	1	5	0	5	15
2030	1	18	19	1	5	0	5	15
2031	1	18	19	1	5	0	5	15
2032	1	18	19	1	5	0	5	15
2033	1	18	19	1	5	0	5	15
2034	1	18	19	1	5	0	5	15
2035	1	18	19	1	5	0	5	15
2036	1	18	19	1	5	0	5	15
2037	1	18	19	1	5	0	5	15
2038	1	18	19	1	5	0	5	15
2039	1	18	19	1	5	0	5	15
2040	1	18	19	1	5	0	5	15

Region G Individual Reports

Statewide Water Conservation Quantification Project
City of Abilene Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Abilene's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Abilene's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Abilene's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Abilene with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	46	46	103	0	103	(57)
2016	250	46	296	129	0	129	167
2017	472	46	517	129	0	129	389
2018	472	46	518	154	0	154	364
2019	473	46	519	180	0	180	339
2020	474	46	520	231	0	231	289
2021	475	46	521	284	0	284	237
2022	476	46	522	337	0	337	185
2023	477	46	523	390	0	390	134
2024	478	47	525	443	0	443	82
2025	479	47	526	496	0	496	30
2026	480	47	527	548	0	548	(21)
2027	481	47	528	601	0	601	(73)
2028	482	47	529	654	0	654	(125)
2029	483	48	530	707	0	707	(177)
2030	484	48	531	760	0	760	(228)
2031	484	48	532	757	0	757	(225)
2032	485	48	533	754	0	754	(221)
2033	486	48	534	751	0	751	(217)
2034	487	49	535	749	0	749	(213)
2035	487	49	536	746	0	746	(210)
2036	488	49	537	743	0	743	(206)
2037	489	49	538	740	0	740	(202)
2038	490	49	539	738	0	738	(199)
2039	490	49	540	735	0	735	(195)
2040	491	50	541	732	0	732	(191)
2041	492	50	542	725	0	725	(184)
2042	493	50	543	719	0	719	(176)
2043	494	50	544	712	0	712	(169)
2044	494	50	545	706	0	706	(161)
2045	495	50	546	699	0	699	(154)
2046	496	50	547	693	0	693	(146)
2047	497	51	548	686	0	686	(139)
2048	498	51	548	680	0	680	(131)
2049	499	51	549	673	0	673	(124)
2050	499	51	550	666	0	666	(116)
2051	500	51	551	666	0	666	(115)
2052	501	51	552	666	0	666	(114)
2053	502	51	554	666	0	666	(112)
2054	503	51	555	666	0	666	(111)
2055	504	51	556	666	0	666	(110)
2056	505	52	557	665	0	665	(109)
2057	506	52	558	665	0	665	(108)
2058	507	52	559	665	0	665	(106)
2059	508	52	560	665	0	665	(105)
2060	509	52	561	665	0	665	(104)
2061	509	52	562	666	0	666	(104)
2062	510	52	562	667	0	667	(104)
2063	511	52	563	667	0	667	(104)
2064	512	52	564	668	0	668	(104)
2065	513	52	565	669	0	669	(104)
2066	513	53	566	670	0	670	(104)
2067	514	53	567	671	0	671	(104)
2068	515	53	568	672	0	672	(104)
2069	516	53	568	673	0	673	(104)
2070	516	53	569	674	0	674	(104)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Abilene's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	162	0	0	0
1	2015	124,893	162	0	46	46
2	2016	124,950	162	0	296	296
3	2017	125,007	162	0	517	517
4	2018	125,065	162	0	518	518
5-year Goal	2019	125,122	162	0	519	519
6	2020	125,179	162	18	520	502
7	2021	125,765	161	37	521	484
8	2022	126,350	161	55	522	467
9	2023	126,936	160	74	523	449
10-year Goal	2024	127,522	160	93	525	432

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Abilene's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	26.00	0	0	0
1	2015	124,893	26.00	0	46	46
2	2016	124,950	26.00	0	46	46
3	2017	125,007	26.00	0	46	46
4	2018	125,065	26.00	0	46	46
5-year Goal	2019	125,122	26.00	0	46	46
6	2020	125,179	26.00	0	46	46
7	2021	125,765	26.00	0	46	46
8	2022	126,350	26.00	0	46	46
9	2023	126,936	26.00	0	46	46
10-year Goal	2024	127,522	26.00	0	47	47

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 46 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 17% increase in 2016
        ii. 20% increase in 2017
    b. Estimated customer demand reduction of 6.4%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2012		0
2013		0
2014		0
2015		0
2016	250.0	250
2017	471.6	472
2018	472.5	472
2019	473.4	473
2020	474.3	474
2021	475.3	475
2022	476.2	476
2023	477.1	477
2024	478.1	478
2025	479.0	479
2026	479.9	480
2027	480.9	481
2028	481.8	482
2029	482.7	483
2030	483.6	484
2031	484.4	484
2032	485.1	485
2033	485.9	486
2034	486.6	487
2035	487.4	487
2036	488.2	488
2037	488.9	489
2038	489.7	490
2039	490.4	490
2040	491.2	491
2041	492.0	492
2042	492.8	493
2043	493.6	494
2044	494.5	494
2045	495.3	495
2046	496.1	496
2047	497.0	497
2048	497.8	498
2049	498.6	499
2050	499.5	499
2051	500.4	500
2052	501.3	501
2053	502.2	502
2054	503.2	503
2055	504.1	504
2056	505.0	505
2057	505.9	506
2058	506.9	507
2059	507.8	508
2060	508.7	509
2061	509.5	509
2062	510.3	510
2063	511.0	511
2064	511.8	512
2065	512.6	513
2066	513.4	513
2067	514.1	514
2068	514.9	515
2069	515.7	516
2070	516.5	516

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	12.00	0
2015	124,893	11.00	46
2016	124,950	11.00	46
2017	125,007	11.00	46
2018	125,065	11.00	46
2019	125,122	11.00	46
2020	125,179	11.00	46
2021	125,765	11.00	46
2022	126,350	11.00	46
2023	126,936	11.00	46
2024	127,522	11.00	47

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 557 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	250	46	296	557	129	0	129	724
2017	472	46	517	558	129	0	129	947
2018	472	46	518	560	154	0	154	923
2019	473	46	519	561	180	0	180	900
2020	474	46	520	562	231	0	231	850
2021	475	46	521	563	284	0	284	800
2022	476	46	522	564	337	0	337	749
2023	477	46	523	565	390	0	390	699
2024	478	47	525	566	443	0	443	648
2025	479	47	526	567	496	0	496	598
2026	480	47	527	568	548	0	548	547
2027	481	47	528	570	601	0	601	496
2028	482	47	529	571	654	0	654	446
2029	483	48	530	572	707	0	707	395
2030	484	48	531	573	760	0	760	345
2031	484	48	532	574	757	0	757	349
2032	485	48	533	575	754	0	754	354
2033	486	48	534	575	751	0	751	358
2034	487	49	535	576	749	0	749	363
2035	487	49	536	577	746	0	746	368
2036	488	49	537	578	743	0	743	372
2037	489	49	538	579	740	0	740	377
2038	490	49	539	580	738	0	738	381
2039	490	49	540	581	735	0	735	386
2040	491	50	541	582	732	0	732	390

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	250	46	296	99	129	0	129	266
2017	472	46	517	99	129	0	129	487
2018	472	46	518	99	154	0	154	463
2019	473	46	519	99	180	0	180	438
2020	474	46	520	99	231	0	231	388
2021	475	46	521	100	284	0	284	336
2022	476	46	522	100	337	0	337	285
2023	477	46	523	100	390	0	390	233
2024	478	47	525	100	443	0	443	182
2025	479	47	526	100	496	0	496	131
2026	480	47	527	100	548	0	548	79
2027	481	47	528	101	601	0	601	28
2028	482	47	529	101	654	0	654	(24)
2029	483	48	530	101	707	0	707	(75)
2030	484	48	531	101	760	0	760	(127)
2031	484	48	532	101	757	0	757	(123)
2032	485	48	533	102	754	0	754	(119)
2033	486	48	534	102	751	0	751	(115)
2034	487	49	535	102	749	0	749	(112)
2035	487	49	536	102	746	0	746	(108)
2036	488	49	537	102	743	0	743	(104)
2037	489	49	538	102	740	0	740	(100)
2038	490	49	539	103	738	0	738	(96)
2039	490	49	540	103	735	0	735	(92)
2040	491	50	541	103	732	0	732	(88)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Bethesda WSC Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Bethesda WSC's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Bethesda WSC's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Bethesda WSC's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Bethesda WSC with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	(20)	(20)	22	1	23	(43)
2016	0	(20)	(20)	27	2	29	(50)
2017	0	(21)	(21)	27	2	30	(50)
2018	0	(21)	(21)	33	3	35	(57)
2019	0	(22)	(22)	38	3	41	(63)
2020	0	(22)	(22)	49	3	52	(75)
2021	0	(23)	(23)	59	3	62	(85)
2022	0	(23)	(23)	69	3	72	(95)
2023	0	(23)	(23)	79	3	82	(106)
2024	0	(24)	(24)	89	3	92	(116)
2025	0	(24)	(24)	99	3	102	(126)
2026	0	(24)	(24)	109	3	112	(137)
2027	0	(25)	(25)	119	3	122	(147)
2028	0	(25)	(25)	129	3	132	(157)
2029	0	(25)	(25)	139	3	142	(168)
2030	0	(26)	(26)	149	3	152	(178)
2031	0	(26)	(26)	161	3	164	(191)
2032	0	(27)	(27)	174	3	176	(203)
2033	0	(27)	(27)	186	2	188	(215)
2034	0	(28)	(28)	198	2	200	(228)
2035	0	(28)	(28)	211	2	212	(240)
2036	0	(28)	(28)	223	1	224	(253)
2037	0	(29)	(29)	235	1	236	(265)
2038	0	(29)	(29)	247	1	248	(277)
2039	0	(30)	(30)	260	0	260	(290)
2040	0	(30)	(30)	272	0	272	(302)
2041	0	(31)	(31)	281	0	281	(311)
2042	0	(31)	(31)	289	0	289	(320)
2043	0	(32)	(32)	298	0	298	(330)
2044	0	(32)	(32)	307	0	307	(339)
2045	0	(33)	(33)	315	0	315	(348)
2046	0	(33)	(33)	324	0	324	(357)
2047	0	(34)	(34)	333	0	333	(366)
2048	0	(34)	(34)	341	0	341	(376)
2049	0	(35)	(35)	350	0	350	(385)
2050	0	(35)	(35)	359	0	359	(394)
2051	0	(36)	(36)	363	0	363	(399)
2052	0	(36)	(36)	368	0	368	(404)
2053	0	(37)	(37)	372	0	372	(409)
2054	0	(37)	(37)	377	0	377	(414)
2055	0	(38)	(38)	381	0	381	(419)
2056	0	(39)	(39)	386	0	386	(424)
2057	0	(39)	(39)	390	0	390	(430)
2058	0	(40)	(40)	395	0	395	(435)
2059	0	(40)	(40)	399	0	399	(440)
2060	0	(41)	(41)	404	0	404	(445)
2061	0	(41)	(41)	409	0	409	(450)
2062	0	(42)	(42)	414	0	414	(456)
2063	0	(43)	(43)	419	0	419	(461)
2064	0	(43)	(43)	423	0	423	(467)
2065	0	(44)	(44)	428	0	428	(472)
2066	0	(44)	(44)	433	0	433	(477)
2067	0	(45)	(45)	438	0	438	(483)
2068	0	(46)	(46)	443	0	443	(488)
2069	0	(46)	(46)	448	0	448	(494)
2070	0	(47)	(47)	452	0	452	(499)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Bethesda WSC's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	131	0	0	0
1	2015	30,420	130	8	(20)	(28)
2	2016	31,090	130	16	(20)	(36)
3	2017	31,760	129	24	(21)	(45)
4	2018	32,429	128	33	(21)	(54)
5-year Goal	2019	33,099	128	42	(22)	(64)
6	2020	33,769	127	48	(22)	(70)
7	2021	34,327	127	54	(23)	(76)
8	2022	34,884	126	60	(23)	(83)
9	2023	35,442	126	66	(23)	(89)
10-year Goal	2024	35,999	126	72	(24)	(96)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Bethesda WSC's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	5.20	0	0	0
1	2015	30,420	5.36	(2)	(20)	(18)
2	2016	31,090	5.52	(4)	(20)	(17)
3	2017	31,760	5.68	(6)	(21)	(15)
4	2018	32,429	5.84	(8)	(21)	(14)
5-year Goal	2019	33,099	6.00	(10)	(22)	(12)
6	2020	33,769	6.00	(10)	(22)	(12)
7	2021	34,327	6.00	(10)	(23)	(13)
8	2022	34,884	6.00	(10)	(23)	(13)
9	2023	35,442	6.00	(10)	(23)	(13)
10-year Goal	2024	35,999	6.00	(11)	(24)	(13)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 20 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
        i. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	5.20	0
2015	30,420	7.00	(20)
2016	31,090	7.00	(20)
2017	31,760	7.00	(21)
2018	32,429	7.00	(21)
2019	33,099	7.00	(22)
2020	33,769	7.00	(22)
2021	34,327	7.00	(23)
2022	34,884	7.00	(23)
2023	35,442	7.00	(23)
2024	35,999	7.00	(24)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region G savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 121 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(20)	(20)	121	27	2	29	72
2017	0	(21)	(21)	123	27	2	38	73
2018	0	(21)	(21)	125	33	3	35	68
2019	0	(22)	(22)	126	38	3	41	63
2020	0	(22)	(22)	128	48	3	52	53
2021	0	(23)	(23)	129	59	3	62	44
2022	0	(23)	(23)	131	69	3	72	35
2023	0	(23)	(23)	132	79	3	82	26
2024	0	(24)	(24)	134	89	3	92	18
2025	0	(24)	(24)	135	99	3	102	9
2026	0	(24)	(24)	137	109	3	112	(0)
2027	0	(25)	(25)	138	119	3	122	(9)
2028	0	(25)	(25)	140	129	3	132	(18)
2029	0	(25)	(25)	141	139	3	142	(27)
2030	0	(26)	(26)	143	149	3	152	(36)
2031	0	(26)	(26)	144	161	3	164	(46)
2032	0	(27)	(27)	146	174	3	176	(57)
2033	0	(27)	(27)	147	186	2	188	(68)
2034	0	(28)	(28)	149	198	2	200	(79)
2035	0	(28)	(28)	151	211	2	212	(90)
2036	0	(28)	(28)	152	223	1	224	(100)
2037	0	(29)	(29)	154	235	1	236	(111)
2038	0	(29)	(29)	155	247	1	248	(122)
2039	0	(30)	(30)	157	260	0	260	(133)
2040	0	(30)	(30)	158	272	0	272	(144)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(28)	(28)	21	27	2	29	(28)
2017	0	(21)	(21)	22	27	2	30	(29)
2018	0	(21)	(21)	22	33	3	35	(35)
2019	0	(22)	(22)	22	38	3	41	(41)
2020	0	(22)	(22)	23	49	3	52	(52)
2021	0	(23)	(23)	23	59	3	62	(62)
2022	0	(23)	(23)	23	69	3	72	(72)
2023	0	(23)	(23)	23	79	3	82	(82)
2024	0	(24)	(24)	24	89	3	92	(92)
2025	0	(24)	(24)	24	99	3	102	(103)
2026	0	(24)	(24)	24	109	3	112	(115)
2027	0	(25)	(25)	24	119	3	122	(123)
2028	0	(25)	(25)	25	129	3	132	(133)
2029	0	(25)	(25)	25	139	3	142	(143)
2030	0	(26)	(26)	25	149	3	152	(153)
2031	0	(26)	(26)	25	161	3	164	(165)
2032	0	(27)	(27)	26	174	3	176	(177)
2033	0	(27)	(27)	26	186	2	188	(189)
2034	0	(28)	(28)	26	198	2	200	(201)
2035	0	(28)	(28)	27	211	2	212	(214)
2036	0	(28)	(28)	27	223	1	224	(226)
2037	0	(29)	(29)	27	235	1	236	(238)
2038	0	(29)	(29)	27	247	1	248	(250)
2039	0	(30)	(30)	28	260	0	260	(262)
2040	0	(30)	(30)	28	272	0	272	(274)

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 32 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(10)	(20)	32	27	2	29	(18)
2017	0	(21)	(21)	32	27	2	30	(18)
2018	0	(21)	(21)	33	33	3	35	(24)
2019	0	(22)	(22)	33	38	3	41	(30)
2020	0	(22)	(22)	34	49	3	52	(41)
2021	0	(23)	(23)	34	59	3	62	(51)
2022	0	(23)	(23)	34	69	3	72	(61)
2023	0	(23)	(23)	35	79	3	82	(71)
2024	0	(24)	(24)	35	89	3	92	(81)
2025	0	(24)	(24)	36	99	3	102	(91)
2026	0	(24)	(34)	36	109	3	112	(101)
2027	0	(25)	(25)	36	119	3	122	(111)
2028	0	(25)	(25)	37	129	3	132	(121)
2029	0	(25)	(25)	37	139	3	142	(131)
2030	0	(26)	(26)	38	149	3	152	(140)
2031	0	(26)	(26)	38	161	3	164	(152)
2032	0	(27)	(27)	38	174	3	176	(164)
2033	0	(27)	(27)	39	186	2	188	(176)
2034	0	(28)	(28)	39	198	2	200	(188)
2035	0	(28)	(28)	40	211	2	212	(200)
2036	0	(28)	(28)	40	223	1	224	(212)
2037	0	(29)	(29)	41	235	1	236	(224)
2038	0	(29)	(29)	41	247	1	248	(236)
2039	0	(30)	(30)	41	260	0	260	(248)
2040	0	(30)	(30)	42	272	0	272	(260)

4. Rain Barrels
    a. In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
    b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Brenham Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached,

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus,

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Brenham's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Brenham's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Brenham's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Brenham with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. **Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.**

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	0	0	28	0	28	(28)
2016	0	0	0	34	0	34	(34)
2017	0	0	0	34	0	34	(34)
2018	0	0	0	41	0	41	(41)
2019	0	0	0	48	0	48	(48)
2020	0	0	0	62	0	62	(62)
2021	0	0	0	73	0	73	(73)
2022	0	0	0	84	0	84	(84)
2023	0	0	0	95	0	95	(95)
2024	0	0	0	106	0	106	(106)
2025	0	0	0	118	0	118	(118)
2026	0	0	0	129	0	129	(129)
2027	0	0	0	140	0	140	(140)
2028	0	0	0	151	0	151	(151)
2029	0	0	0	162	0	162	(162)
2030	0	0	0	173	0	173	(173)
2031	0	0	0	185	0	185	(185)
2032	0	0	0	196	0	196	(196)
2033	0	0	0	208	0	208	(208)
2034	0	0	0	220	0	220	(220)
2035	0	0	0	232	0	232	(232)
2036	0	0	0	243	0	243	(243)
2037	0	0	0	255	0	255	(255)
2038	0	0	0	267	0	267	(267)
2039	0	0	0	278	0	278	(278)
2040	0	0	0	290	0	290	(290)
2041	0	0	0	303	0	303	(303)
2042	0	0	0	315	0	315	(315)
2043	0	0	0	328	0	328	(328)
2044	0	0	0	340	0	340	(340)
2045	0	0	0	353	0	353	(353)
2046	0	0	0	365	0	365	(365)
2047	0	0	0	378	0	378	(378)
2048	0	0	0	390	0	390	(390)
2049	0	0	0	403	0	403	(403)
2050	0	0	0	415	0	415	(415)
2051	0	0	0	423	0	423	(423)
2052	0	0	0	430	0	430	(430)
2053	0	0	0	438	0	438	(438)
2054	0	0	0	445	0	445	(445)
2055	0	0	0	453	0	453	(453)
2056	0	0	0	461	0	461	(461)
2057	0	0	0	468	0	468	(468)
2058	0	0	0	476	0	476	(476)
2059	0	0	0	483	0	483	(483)
2060	0	0	0	491	0	491	(491)
2061	0	0	0	493	0	493	(493)
2062	0	0	0	494	0	494	(494)
2063	0	0	0	496	0	496	(496)
2064	0	0	0	497	0	497	(497)
2065	0	0	0	499	0	499	(499)
2066	0	0	0	500	0	500	(500)
2067	0	0	0	502	0	502	(502)
2068	0	0	0	503	0	503	(503)
2069	0	0	0	505	0	505	(505)
2070	0	0	0	506	0	506	(506)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Brenham's quantified savings from its implemented activities compare with 5- and 10- year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	182	0	0	0
1	2015	16,579	179	19	0	(19)
2	2016	16,734	176	39	0	(39)
3	2017	16,889	172	59	0	(59)
4	2018	17,045	169	80	0	(80)
5-year Goal	2019	17,200	166	100	0	(100)
6	2020	17,355	164	114	0	(114)
7	2021	17,508	162	128	0	(128)
8	2022	17,661	160	142	0	(142)
9	2023	17,814	158	156	0	(156)
10-year Goal	2024	17,967	156	171	0	(171)

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Brenham's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	10.00	0	0	0
1	2015	16,579	10.00	0	0	0
2	2016	16,734	10.00	0	0	0
3	2017	16,889	10.00	0	0	0
4	2018	17,045	10.00	0	0	0
5-year Goal	2019	17,200	10.00	0	0	0
6	2020	17,355	9.80	1	0	(1)
7	2021	17,508	9.60	3	0	(3)
8	2022	17,661	9.40	4	0	(4)
9	2023	17,814	9.20	5	0	(5)
10-year Goal	2024	17,967	9.00	7	0	(7)

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.

- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 10 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.

[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	10.00	0
2015	16,579	10.00	0
2016	16,734	10.00	0
2017	16,889	10.00	0
2018	17,045	10.00	0
2019	17,200	10.00	0
2020	17,355	10.00	0
2021	17,508	10.00	0
2022	17,661	10.00	0
2023	17,814	10.00	0
2024	17,967	10.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 6.95% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
    b. Savings could be 90 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	90	34	0	34	56
2017	0	0	0	90	34	0	34	56
2018	0	0	0	91	41	0	41	50
2019	0	0	0	92	48	0	48	44
2020	0	0	0	92	62	0	62	30
2021	0	0	0	93	73	0	73	20
2022	0	0	0	94	84	0	84	9
2023	0	0	0	94	95	0	95	(1)
2024	0	0	0	95	106	0	106	(11)
2025	0	0	0	96	118	0	118	(22)
2026	0	0	0	96	129	0	129	(32)
2027	0	0	0	97	140	0	140	(43)
2028	0	0	0	97	151	0	151	(53)
2029	0	0	0	98	162	0	162	(64)
2030	0	0	0	99	173	0	173	(74)
2031	0	0	0	99	185	0	185	(86)
2032	0	0	0	100	196	0	196	(97)
2033	0	0	0	100	208	0	208	(108)
2034	0	0	0	100	220	0	220	(119)
2035	0	0	0	101	232	0	232	(131)
2036	0	0	0	101	243	0	243	(142)
2037	0	0	0	102	255	0	255	(153)
2038	0	0	0	102	267	0	267	(165)
2039	0	0	0	102	278	0	278	(176)
2040	0	0	0	103	290	0	290	(187)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	17	34	0	34	(17)
2017	0	0	0	17	34	0	34	(17)
2018	0	0	0	18	41	0	41	(24)
2019	0	0	0	18	48	0	48	(31)
2020	0	0	0	18	62	0	62	(44)
2021	0	0	0	18	73	0	73	(55)
2022	0	0	0	18	84	0	84	(66)
2023	0	0	0	18	95	0	95	(77)
2024	0	0	0	18	106	0	106	(88)
2025	0	0	0	18	118	0	118	(99)
2026	0	0	0	19	129	0	129	(110)
2027	0	0	0	19	140	0	140	(121)
2028	0	0	0	19	151	0	151	(132)
2029	0	0	0	19	162	0	162	(143)
2030	0	0	0	19	173	0	173	(154)
2031	0	0	0	19	185	0	185	(166)
2032	0	0	0	19	196	0	196	(177)
2033	0	0	0	19	208	0	208	(189)
2034	0	0	0	19	220	0	220	(200)
2035	0	0	0	19	232	0	232	(212)
2036	0	0	0	20	243	0	243	(224)
2037	0	0	0	20	255	0	255	(235)
2038	0	0	0	20	267	0	267	(247)
2039	0	0	0	20	278	0	278	(259)
2040	0	0	0	20	290	0	290	(270)

3. Water Rate Increase
    a. For every 10% increase, estimated savings could be 2% of utility total demand.
    b. Approximately 26 MG of savings per year with current demand
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	0	0	26	34	0	34	(8)
2017	0	0	0	26	34	0	34	(8)
2018	0	0	0	26	41	0	41	(15)
2019	0	0	0	26	48	0	48	(22)
2020	0	0	0	27	62	0	62	(35)
2021	0	0	0	27	73	0	73	(46)
2022	0	0	0	27	84	0	84	(57)
2023	0	0	0	27	95	0	95	(68)
2024	0	0	0	27	106	0	106	(79)
2025	0	0	0	27	118	0	118	(90)
2026	0	0	0	28	129	0	129	(101)
2027	0	0	0	28	140	0	140	(112)
2028	0	0	0	28	151	0	151	(123)
2029	0	0	0	28	162	0	162	(134)
2030	0	0	0	28	173	0	173	(145)
2031	0	0	0	29	185	0	185	(156)
2032	0	0	0	29	196	0	196	(168)
2033	0	0	0	29	208	0	208	(179)
2034	0	0	0	29	220	0	220	(191)
2035	0	0	0	29	232	0	232	(202)
2036	0	0	0	29	243	0	243	(214)
2037	0	0	0	29	255	0	255	(226)
2038	0	0	0	29	267	0	267	(237)
2039	0	0	0	29	278	0	278	(249)
2040	0	0	0	30	290	0	290	(260)

4. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Brushy Creek MUD Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
    - County-Other (Rural/unincorporated areas of municipal water use)
    - Manufacturing
    - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Brushy Creek MUD's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Brushy Creek MUD's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Brushy Creek MUD's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Brushy Creek MUD with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	45	45	34	0	34	10
2016	0	43	43	43	0	43	1
2017	0	42	42	43	0	43	0
2018	0	41	41	51	0	51	(10)
2019	0	40	40	60	0	60	(20)
2020	0	39	39	77	0	77	(38)
2021	0	39	39	91	0	91	(52)
2022	0	39	39	105	0	105	(66)
2023	0	40	40	119	0	119	(80)
2024	0	40	40	133	0	133	(93)
2025	0	40	40	148	0	148	(107)
2026	0	41	41	162	0	162	(121)
2027	0	41	41	176	0	176	(135)
2028	0	41	41	190	0	190	(149)
2029	0	42	42	204	0	204	(163)
2030	0	42	42	218	0	218	(176)
2031	0	42	42	231	0	231	(189)
2032	0	42	42	244	0	244	(202)
2033	0	42	42	256	0	256	(214)
2034	0	42	42	269	0	269	(227)
2035	0	42	42	282	0	282	(240)
2036	0	42	42	294	0	294	(252)
2037	0	42	42	307	0	307	(265)
2038	0	42	42	320	0	320	(277)
2039	0	42	42	332	0	332	(290)
2040	0	42	42	345	0	345	(303)
2041	0	42	42	357	0	357	(314)
2042	0	42	42	368	0	368	(326)
2043	0	42	42	380	0	380	(338)
2044	0	42	42	392	0	392	(350)
2045	0	42	42	403	0	403	(361)
2046	0	42	42	415	0	415	(373)
2047	0	42	42	427	0	427	(385)
2048	0	42	42	438	0	438	(396)
2049	0	42	42	450	0	450	(408)
2050	0	42	42	462	0	462	(420)
2051	0	42	42	473	0	473	(431)
2052	0	42	42	484	0	484	(442)
2053	0	42	42	495	0	495	(453)
2054	0	42	42	505	0	505	(463)
2055	0	42	42	516	0	516	(474)
2056	0	42	42	527	0	527	(485)
2057	0	42	42	538	0	538	(496)
2058	0	42	42	549	0	549	(507)
2059	0	42	42	560	0	560	(518)
2060	0	42	42	571	0	571	(529)
2061	0	42	42	581	0	581	(539)
2062	0	42	42	591	0	591	(549)
2063	0	42	42	600	0	600	(558)
2064	0	42	42	610	0	610	(568)
2065	0	42	42	620	0	620	(578)
2066	0	42	42	630	0	630	(588)
2067	0	42	42	640	0	640	(598)
2068	0	42	42	649	0	649	(607)
2069	0	42	42	659	0	659	(617)
2070	0	42	42	669	0	669	(627)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Brushy Creek MUD's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	166	0	0	0
1	2015	20,387	162	31	46	15
2	2016	20,810	158	64	45	(19)
3	2017	21,232	153	98	44	(54)
4	2018	21,655	149	133	43	(90)
5-year Goal	2019	22,077	145	169	41	(128)
6	2020	22,500	144	181	40	(140)
7	2021	22,550	143	189	41	(149)
8	2022	22,600	142	198	41	(157)
9	2023	22,650	141	207	41	(165)
10-year Goal	2024	22,700	140	215	42	(174)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Brushy Creek MUD's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	29.00	0	0.0	0
1	2015	20,387	27.20	13	44.6	31
2	2016	20,810	25.40	27	43.4	16
3	2017	21,232	23.60	42	42.2	0
4	2018	21,655	21.80	57	41.0	(16)
5-year Goal	2019	22,077	20.00	73	39.8	(33)
6	2020	22,500	19.00	82	38.6	(44)
7	2021	22,550	18.00	91	39.0	(52)
8	2022	22,600	17.00	99	39.3	(60)
9	2023	22,650	16.00	107	39.6	(68)
10-year Goal	2024	22,700	15.00	116	40.0	(76)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 45 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	29.00	0
2015	20,387	23.00	45
2016	19,837	23.00	43
2017	19,287	23.00	42
2018	18,736	23.00	41
2019	18,186	23.00	40
2020	17,636	23.00	39
2021	17,792	23.00	39
2022	17,948	23.00	39
2023	18,105	23.00	40
2024	18,261	23.00	40

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    - **a.** Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        - i. Average Region G savings
        - ii. Specific percentage of outdoor usage unknown for your utility at this time
    - **b.** Savings could be 105 MG per year with current demand.
    - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	43	43	105	43	0	43	105
2017	0	42	42	105	43	0	43	105
2018	0	41	41	106	51	0	51	96
2019	0	40	40	107	60	0	60	87
2020	0	39	39	108	77	0	77	70
2021	0	39	39	109	91	0	91	57
2022	0	39	39	109	105	0	105	44
2023	0	40	40	110	119	0	119	31
2024	0	40	40	111	133	0	133	18
2025	0	40	40	112	148	0	148	5
2026	0	41	41	113	162	0	162	(6)
2027	0	41	41	114	176	0	176	(21)
2028	0	41	41	114	190	0	190	(34)
2029	0	42	42	115	204	0	204	(47)
2030	0	42	42	116	218	0	218	(60)
2031	0	42	42	116	231	0	231	(73)
2032	0	42	42	116	244	0	244	(86)
2033	0	42	42	116	256	0	256	(98)
2034	0	42	42	116	269	0	269	(111)
2035	0	42	42	116	282	0	282	(124)
2036	0	42	42	115	294	0	294	(137)
2037	0	42	42	115	307	0	307	(149)
2038	0	42	42	115	320	0	320	(162)
2039	0	42	42	115	332	0	332	(175)
2040	0	42	42	115	345	0	345	(188)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	43	43	18	43	0	43	19
2017	0	42	42	19	43	0	43	18
2018	0	41	41	19	51	0	51	9
2019	0	40	40	19	60	0	60	(1)
2020	0	39	39	19	77	0	77	(19)
2021	0	39	39	19	91	0	91	(33)
2022	0	39	39	19	105	0	105	(47)
2023	0	40	40	19	119	0	119	(60)
2024	0	40	40	20	133	0	133	(74)
2025	0	40	40	20	148	0	148	(88)
2026	0	41	41	30	162	0	162	(101)
2027	0	41	41	20	176	0	176	(115)
2028	0	41	41	20	190	0	190	(128)
2029	0	42	42	20	204	0	204	(142)
2030	0	42	42	20	218	0	218	(156)
2031	0	42	42	20	231	0	231	(168)
2032	0	42	42	20	244	0	244	(181)
2033	0	42	42	20	256	0	256	(194)
2034	0	42	42	20	269	0	269	(206)
2035	0	42	42	20	282	0	282	(219)
2036	0	42	42	20	294	0	294	(232)
2037	0	42	42	20	307	0	307	(244)
2038	0	42	42	20	320	0	320	(257)
2039	0	42	42	20	332	0	332	(270)
2040	0	42	42	20	345	0	345	(282)

3. Water Rate Increase
    a. For every 10% increase, estimated savings could be 2% of utility total demand.
    b. Approximately 28 MG of savings per year with current demand
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	43	43	28	43	0	43	28
2017	0	42	42	28	43	0	43	27
2018	0	41	41	28	51	0	51	18
2019	0	40	40	28	60	0	60	8
2020	0	39	39	28	77	0	77	(10)
2021	0	39	39	29	91	0	91	(23)
2022	0	39	39	29	105	0	105	(37)
2023	0	40	40	29	119	0	119	(52)
2024	0	40	40	29	133	0	133	(64)
2025	0	40	40	30	148	0	148	(78)
2026	0	41	41	30	162	0	162	(91)
2027	0	41	41	30	176	0	176	(105)
2028	0	41	41	30	190	0	190	(119)
2029	0	42	42	30	204	0	204	(132)
2030	0	42	42	31	218	0	218	(146)
2031	0	42	42	31	231	0	231	(158)
2032	0	42	42	31	244	0	244	(171)
2033	0	42	42	31	256	0	256	(184)
2034	0	42	42	31	269	0	269	(196)
2035	0	42	42	30	282	0	282	(209)
2036	0	42	42	30	294	0	294	(222)
2037	0	42	42	30	307	0	307	(234)
2038	0	42	42	30	320	0	320	(247)
2039	0	42	42	30	332	0	332	(260)
2040	0	42	42	30	345	0	345	(272)

4. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Bryan Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
    - County-Other (Rural/unincorporated areas of municipal water use)
    - Manufacturing
    - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Bryan's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Bryan's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Bryan's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Bryan with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	132	180	312	71	0	71	241
2016	131	183	314	89	0	89	224
2017	130	185	315	89	0	89	226
2018	129	188	317	107	0	107	210
2019	128	191	319	125	0	125	194
2020	128	194	322	161	0	161	161
2021	128	195	323	196	0	196	127
2022	129	196	325	231	0	231	94
2023	129	197	326	266	0	266	60
2024	130	198	328	301	0	301	26
2025	130	199	329	337	0	337	(7)
2026	131	200	331	372	0	372	(41)
2027	131	202	333	407	0	407	(75)
2028	131	203	334	442	0	442	(108)
2029	132	204	336	477	0	477	(142)
2030	132	205	337	513	0	513	(175)
2031	136	211	346	514	0	514	(168)
2032	139	216	355	515	0	515	(160)
2033	142	222	364	517	0	517	(153)
2034	146	228	373	518	0	518	(145)
2035	149	233	382	520	0	520	(137)
2036	152	239	391	521	0	521	(130)
2037	156	245	400	522	0	522	(122)
2038	159	250	409	524	0	524	(115)
2039	162	256	418	525	0	525	(107)
2040	166	262	427	527	0	527	(99)
2041	168	266	434	529	0	529	(95)
2042	171	270	441	532	0	532	(91)
2043	173	274	448	535	0	535	(87)
2044	176	279	455	537	0	537	(83)
2045	179	283	462	540	0	540	(78)
2046	181	287	468	542	0	542	(74)
2047	184	292	475	545	0	545	(70)
2048	186	296	482	548	0	548	(66)
2049	189	300	489	550	0	550	(61)
2050	191	304	496	553	0	553	(57)
2051	194	309	503	560	0	560	(57)
2052	197	313	510	566	0	566	(56)
2053	200	318	518	573	0	573	(55)
2054	203	322	525	579	0	579	(54)
2055	205	327	532	586	0	586	(54)
2056	208	331	540	593	0	593	(53)
2057	211	336	547	599	0	599	(52)
2058	214	340	554	606	0	606	(51)
2059	217	345	562	612	0	612	(51)
2060	219	349	569	619	0	619	(50)
2061	222	354	577	627	0	627	(50)
2062	225	359	585	635	0	635	(50)
2063	228	364	593	643	0	643	(50)
2064	232	369	600	651	0	651	(50)
2065	235	374	608	659	0	659	(50)
2066	238	379	616	667	0	667	(50)
2067	241	384	624	675	0	675	(50)
2068	244	388	632	682	0	682	(50)
2069	247	393	640	690	0	690	(50)
2070	250	398	648	698	0	698	(51)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Bryan's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	150	0	0	0
1	2015	82,118	148	60	312	252
2	2016	83,381	146	122	314	192
3	2017	84,644	144	185	315	130
4	2018	85,908	142	251	317	66
5-year Goal	2019	87,171	140	318	319	1
6	2020	88,434	139	368	322	(46)
7	2021	88,945	137	416	323	(92)
8	2022	89,456	136	464	325	(139)
9	2023	89,967	134	512	326	(186)
10-year Goal	2024	90,478	133	561	328	(234)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Bryan's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	**Baseline**	-	15.00	0	0	0
1	2015	82,118	14.20	24	180	156
2	2016	83,381	13.40	49	183	134
3	2017	84,644	12.60	74	185	111
4	2018	85,908	11.80	100	188	88
5-year Goal	2019	87,171	11.00	127	191	64
6	2020	88,434	11.00	129	194	65
7	2021	88,945	11.00	130	195	65
8	2022	89,456	11.00	131	196	65
9	2023	89,967	11.00	131	197	66
10-year Goal	2024	90,478	11.00	132	198	66

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 180 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Conservation Pricing**
    a. Tiered rate structure in place saves approximately 2.5% of total demand
    b. Savings is cumulative and based on more than one source[17] (U.S. EPA, 1998; TWDB, 2013)

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

6. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier, 2015)
    b. Conservative 5-year useful life for all items in kit
    c. 15% adoption rate assumed

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Rain Barrels	Conservation Pricing	WaterWise Take-home Kits	TOTAL SAVINGS
2009				0
2010	0.01			0
2011	0.03			0
2012	0.04			0
2013	0.05		2.44	2
2014	0.06	125.2	4.50	130
2015	0.08	125.6	6.49	132
2016	0.09	126.1	4.90	131
2017	0.09	126.5	3.30	130
2018	0.09	127.0	1.71	129
2019	0.09	127.4	0.60	128
2020	0.08	127.9		128
2021	0.06	128.3		128
2022	0.05	128.8		129
2023	0.04	129.2		129
2024	0.03	129.7		130
2025	0.01	130.1		130
2026		130.6		131
2027		131.0		131
2028		131.5		131
2029		131.9		132
2030		132.4		132
2031		135.7		136
2032		139.1		139
2033		142.4		142
2034		145.7		146
2035		149.1		149
2036		152.4		152
2037		155.7		156
2038		159.1		159
2039		162.4		162
2040		165.7		166
2041		168.3		168
2042		170.9		171
2043		173.4		173
2044		176.0		176
2045		178.6		179
2046		181.1		181
2047		183.7		184
2048		186.3		186
2049		188.8		189
2050		191.4		191
2051		194.2		194
2052		197.0		197
2053		199.8		200
2054		202.6		203
2055		205.4		205
2056		208.2		208
2057		211.0		211
2058		213.8		214
2059		216.6		217
2060		219.4		219
2061		222.4		222
2062		225.5		225
2063		228.5		228
2064		231.5		232
2065		234.6		235
2066		237.6		238
2067		240.6		241
2068		243.7		244
2069		246.7		247
2070		249.7		250

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	15.00	0
2015	82,118	9.00	180
2016	83,381	9.00	183
2017	84,644	9.00	185
2018	85,908	9.00	188
2019	87,171	9.00	191
2020	88,434	9.00	194
2021	88,945	9.00	195
2022	89,456	9.00	196
2023	89,967	9.00	197
2024	90,478	9.00	198

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 382 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	131	183	314	382	89	0	89	607
2017	130	185	315	384	89	0	89	610
2018	129	188	317	385	107	0	107	595
2019	128	191	319	386	125	0	125	580
2020	128	194	322	388	161	0	161	549
2021	128	195	323	389	196	0	196	516
2022	129	196	325	390	231	0	231	484
2023	129	197	326	392	266	0	266	452
2024	130	198	328	393	301	0	301	420
2025	130	199	329	395	337	0	337	387
2026	131	200	331	396	372	0	372	355
2027	131	202	333	397	407	0	407	323
2028	131	203	334	399	442	0	442	291
2029	132	204	336	400	477	0	477	258
2030	132	205	337	401	513	0	513	226
2031	136	211	346	412	514	0	514	244
2032	139	216	355	422	515	0	515	261
2033	142	222	364	432	517	0	517	279
2034	146	228	373	442	518	0	518	297
2035	149	233	382	452	520	0	520	315
2036	152	239	391	462	521	0	521	332
2037	156	245	400	472	522	0	522	350
2038	159	250	409	482	524	0	524	368
2039	162	256	418	492	525	0	525	385
2040	166	262	427	503	527	0	527	403

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[18]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[18] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	131	183	314	68	89	0	89	292
2017	130	185	315	68	89	0	89	294
2018	129	188	317	68	107	0	107	278
2019	128	191	319	68	125	0	125	262
2020	128	194	322	69	161	0	161	230
2021	128	195	323	69	196	0	196	196
2022	129	196	325	69	231	0	231	163
2023	129	197	326	69	266	0	266	129
2024	130	198	328	70	301	0	301	96
2025	130	199	329	70	337	0	337	63
2026	131	200	331	70	372	0	372	29
2027	131	202	333	70	407	0	407	(4)
2028	131	203	334	70	442	0	442	(38)
2029	132	204	336	71	477	0	477	(71)
2030	132	205	337	71	513	0	513	(104)
2031	136	211	346	73	514	0	514	(95)
2032	139	216	355	75	515	0	515	(86)
2033	142	222	364	76	517	0	517	(78)
2034	146	228	373	78	518	0	518	(67)
2035	149	233	382	80	520	0	520	(58)
2036	152	239	391	82	521	0	521	(48)
2037	156	245	400	83	522	0	522	(39)
2038	159	250	409	85	524	0	524	(29)
2039	162	256	418	87	525	0	525	(20)
2040	166	262	427	89	527	0	527	(11)

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 101 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[19] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[19] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	131	183	314	101	89	0	89	325
2017	130	185	315	101	89	0	89	327
2018	129	188	317	102	107	0	107	311
2019	128	191	319	102	125	0	125	296
2020	128	194	322	102	161	0	161	263
2021	128	195	323	103	196	0	196	230
2022	129	196	325	103	231	0	231	197
2023	129	197	326	103	266	0	266	163
2024	130	198	328	104	301	0	301	130
2025	130	199	329	104	337	0	337	97
2026	131	200	331	104	372	0	372	64
2027	131	202	333	105	407	0	407	30
2028	131	203	334	105	442	0	442	(3)
2029	132	204	336	106	477	0	477	(36)
2030	132	205	337	106	513	0	513	(69)
2031	136	211	346	109	514	0	514	(59)
2032	139	216	355	111	515	0	515	(49)
2033	142	222	364	114	517	0	517	(39)
2034	146	228	373	117	518	0	518	(28)
2035	149	233	382	119	520	0	520	(18)
2036	152	239	391	122	521	0	521	(8)
2037	156	245	400	125	522	0	522	2
2038	159	250	409	127	524	0	524	13
2039	162	256	418	130	525	0	525	23
2040	166	262	427	133	527	0	527	33

Statewide Water Conservation Quantification Project
City of Burleson Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Burleson's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Burleson's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Burleson's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Burleson with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	165	175	340	1	1	2	338
2016	173	175	349	1	1	2	347
2017	176	175	352	1	2	2	350
2018	179	176	355	1	2	3	352
2019	182	176	358	1	2	3	355
2020	185	176	361	1	2	4	357
2021	188	179	367	1	2	4	363
2022	191	182	373	2	2	4	369
2023	194	186	379	2	2	4	375
2024	197	189	386	2	2	4	381
2025	200	192	392	2	2	4	387
2026	203	195	398	2	2	5	393
2027	206	198	404	2	2	5	399
2028	208	202	410	3	2	5	405
2029	211	205	416	3	2	5	411
2030	214	208	422	3	2	5	417
2031	217	211	429	3	2	5	423
2032	220	215	435	3	2	6	430
2033	223	218	441	4	2	6	436
2034	227	221	448	4	2	6	442
2035	230	225	454	4	2	6	448
2036	233	228	460	4	2	6	454
2037	236	231	467	4	2	7	460
2038	239	234	473	4	2	7	466
2039	242	238	480	5	2	7	473
2040	245	241	486	5	2	7	479
2041	248	244	493	5	2	8	485
2042	252	248	499	6	2	8	491
2043	255	251	506	6	2	8	498
2044	258	255	513	6	2	9	504
2045	262	258	520	7	2	9	511
2046	265	262	527	7	2	10	517
2047	268	265	533	8	2	10	524
2048	272	269	540	8	2	10	530
2049	275	272	547	8	2	11	536
2050	278	276	554	9	2	11	543
2051	282	279	561	9	2	12	550
2052	285	283	568	10	2	12	556
2053	289	287	576	10	2	12	563
2054	293	290	583	11	2	13	570
2055	296	294	590	11	2	13	577
2056	300	297	597	12	2	14	583
2057	303	301	605	12	2	14	590
2058	307	305	612	12	2	15	597
2059	311	308	619	13	2	15	604
2060	314	312	626	13	2	16	611
2061	318	316	634	14	2	16	618
2062	322	320	642	14	2	17	625
2063	326	323	649	15	2	17	632
2064	330	327	657	15	2	17	639
2065	333	331	664	16	2	18	646
2066	337	335	672	16	2	18	654
2067	341	339	680	17	2	19	661
2068	345	342	687	17	2	19	668
2069	349	346	695	17	2	20	675
2070	352	350	702	18	2	20	682

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Burleson's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	133	0	0	0
1	2015	43,625	132	22	340	317
2	2016	43,660	130	45	349	304
3	2017	43,695	129	67	352	285
4	2018	43,731	127	89	355	265
5-year Goal	2019	43,766	126	112	358	246
6	2020	43,801	125	122	361	239
7	2021	44,605	125	134	367	234
8	2022	45,410	124	146	373	227
9	2023	46,214	124	159	379	221
10-year Goal	2024	47,019	123	172	386	214

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Burleson's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	15.00	0	0	0
1	2015	43,625	15.00	0	175	175
2	2016	43,660	15.00	0	175	175
3	2017	43,695	15.00	0	175	175
4	2018	43,731	15.00	0	176	176
5-year Goal	2019	43,766	15.00	0	176	176
6	2020	43,801	15.00	0	176	176
7	2021	44,605	15.00	0	179	179
8	2022	45,410	15.00	0	182	182
9	2023	46,214	15.00	0	186	186
10-year Goal	2024	47,019	15.00	0	189	189

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 175 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 3.75% increase in 2015
        ii. 1.0% increase in 2016
    b. Estimated customer demand reduction of 1.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Twice-a-week Outdoor Watering Restriction Ordinance**
    a. Estimated savings of 7.58% of total utility demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and the National Wildlife Federation, 2015) All savings estimates grow each year at the same rate demand figures for the utility grow in the regional water plan

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	2x Watering Ordinance	TOTAL SAVINGS
2009			0
2010			0
2011			0
2012			0
2013			0
2014		148	148
2015	13.9	151	165
2016	20.2	153	173
2017	20.6	156	176
2018	20.9	158	179
2019	21.2	161	182
2020	21.6	164	185
2021	21.9	166	188
2022	22.3	169	191
2023	22.6	171	194
2024	22.9	174	197
2025	23.3	176	200
2026	23.6	179	203
2027	24.0	182	206
2028	24.3	184	208
2029	24.6	187	211
2030	25.0	189	214
2031	25.3	192	217
2032	25.7	195	220
2033	26.0	197	223
2034	26.4	200	227
2035	26.8	203	230
2036	27.1	206	233
2037	27.5	208	236
2038	27.8	211	239
2039	28.2	214	242
2040	28.5	216	245
2041	28.9	219	248
2042	29.3	222	252
2043	29.7	225	255
2044	30.1	228	258
2045	30.5	231	262
2046	30.9	234	265
2047	31.3	237	268
2048	31.6	240	272
2049	32.0	243	275
2050	32.4	246	278
2051	32.8	249	282
2052	33.3	252	285
2053	33.7	255	289
2054	34.1	259	293
2055	34.5	262	296
2056	35.0	265	300
2057	35.4	268	303
2058	35.8	271	307
2059	36.2	274	311
2060	36.6	278	314
2061	37.1	281	318
2062	37.5	284	322
2063	38.0	288	326
2064	38.4	291	330
2065	38.9	294	333
2066	39.3	298	337
2067	39.7	301	341
2068	40.2	305	345
2069	40.6	308	349
2070	41.1	311	352

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	15.00	0
2015	43,625	4.00	175
2016	43,660	4.00	175
2017	43,695	4.00	175
2018	43,731	4.00	176
2019	43,766	4.00	176
2020	43,801	4.00	176
2021	44,605	4.00	179
2022	45,410	4.00	182
2023	46,214	4.00	186
2024	47,019	4.00	189

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	173	175	349	27	1	1	2	374
2017	176	175	352	28	1	2	2	377
2018	179	176	355	28	1	2	3	380
2019	182	176	358	28	1	2	3	383
2020	185	176	361	29	1	2	4	386
2021	188	179	367	29	1	2	4	393
2022	191	182	373	30	2	2	4	399
2023	194	186	379	30	2	2	4	406
2024	197	189	386	31	2	2	4	412
2025	200	192	392	31	2	2	4	419
2026	203	195	398	32	2	2	5	426
2027	206	198	404	32	2	2	5	431
2028	208	202	410	33	3	2	5	438
2029	211	205	416	33	3	2	5	444
2030	214	208	422	33	3	2	5	451
2031	217	211	429	34	3	2	5	457
2032	220	215	435	34	3	2	6	464
2033	223	218	441	35	4	2	6	471
2034	227	221	448	35	4	2	6	477
2035	230	225	454	36	4	2	6	484
2036	233	228	460	36	4	2	6	490
2037	236	231	467	37	4	2	7	497
2038	239	234	473	37	4	2	7	504
2039	242	238	480	38	5	2	7	510
2040	245	241	486	38	5	2	7	517

2. Rain Barrels
   a. In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Cedar Park Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Cedar Park's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Cedar Park's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Cedar Park's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Cedar Park with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year #	Year	Utility Population	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
4	2015	65,945	397	144	542	127	0	127	415
5	2016	68,970	403	151	554	158	0	158	396
6	2017	71,995	491	158	649	158	0	158	490
7	2018	75,019	495	164	660	190	0	190	469
8	2019	78,044	499	171	670	222	0	222	448
9	2020	81,069	503	178	681	285	0	285	396
10	2021	81,914	508	179	687	341	0	341	347
11	2022	82,759	513	181	694	396	0	396	298
12	2023	83,603	518	183	701	451	0	451	250
13	2024	84,448	522	185	707	507	0	507	200
14	2025	85,293	527	187	714	562	0	562	152
15	2026	86,138	532	189	720	617	0	617	103
16	2027	86,983	536	190	727	673	0	673	54
17	2028	87,827	541	192	734	728	0	728	6
18	2029	88,672	546	194	740	783	0	783	(43)
19	2030	89,517	551	196	747	839	0	839	(92)
20	2031	89,594	551	196	747	884	0	884	(137)
21	2032	89,671	552	196	748	930	0	930	(182)
22	2033	89,748	552	197	748	976	0	976	(228)
23	2034	89,825	552	197	749	1,022	0	1,022	(273)
24	2035	89,902	552	197	749	1,068	0	1,068	(319)
25	2036	89,979	553	197	750	1,114	0	1,114	(364)
26	2037	90,056	553	197	750	1,160	0	1,160	(410)
27	2038	90,133	553	197	751	1,206	0	1,206	(455)
28	2039	90,210	554	198	751	1,252	0	1,252	(501)
29	2040	90,287	554	198	752	1,298	0	1,298	(546)
30	2041	90,287	554	198	752	1,313	0	1,313	(561)
31	2042	90,287	554	198	752	1,327	0	1,327	(576)
32	2043	90,287	554	198	751	1,342	0	1,342	(591)
33	2044	90,287	554	198	751	1,357	0	1,357	(606)
34	2045	90,287	554	198	751	1,372	0	1,372	(621)
35	2046	90,287	553	198	751	1,387	0	1,387	(636)
36	2047	90,287	553	198	751	1,402	0	1,402	(651)
37	2048	90,287	553	198	751	1,417	0	1,417	(666)
38	2049	90,287	553	198	751	1,431	0	1,431	(681)
39	2050	90,287	553	198	751	1,446	0	1,446	(696)
40	2051	90,287	553	198	751	1,449	0	1,449	(698)
41	2052	90,287	553	198	751	1,452	0	1,452	(701)
42	2053	90,287	553	198	751	1,455	0	1,455	(704)
43	2054	90,287	553	198	751	1,457	0	1,457	(707)
44	2055	90,287	553	198	751	1,460	0	1,460	(709)
45	2056	90,287	553	198	751	1,463	0	1,463	(712)
46	2057	90,287	553	198	750	1,466	0	1,466	(715)
47	2058	90,287	553	198	750	1,468	0	1,468	(718)
48	2059	90,287	553	198	750	1,471	0	1,471	(721)
49	2060	90,287	553	198	750	1,474	0	1,474	(723)
50	2061	90,287	553	198	750	1,477	0	1,477	(726)
51	2062	90,287	553	198	750	1,480	0	1,480	(729)
52	2063	90,287	553	198	750	1,483	0	1,483	(732)
53	2064	90,287	553	198	750	1,486	0	1,486	(735)
54	2065	90,287	553	198	750	1,489	0	1,489	(738)
55	2066	90,287	552	198	750	1,492	0	1,492	(741)
56	2067	90,287	552	198	750	1,495	0	1,495	(745)
57	2068	90,287	552	198	750	1,498	0	1,498	(748)
58	2069	90,287	552	198	750	1,501	0	1,501	(751)
59	2070	90,287	552	198	750	1,504	0	1,504	(754)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Cedar Park's quantified savings from its implemented activities compare with 5- and 10- year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	169	0	0	0
1	2015	65,945	167	43	542	499
2	2016	68,970	165	91	554	464
3	2017	71,995	164	142	649	507
4	2018	75,019	162	197	660	462
5-year Goal	2019	78,044	160	256	670	414
6	2020	81,069	159	290	681	391
7	2021	81,914	158	317	687	370
8	2022	82,759	158	344	694	350
9	2023	83,603	157	372	701	328
10-year Goal	2024	84,448	156	401	707	306

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Cedar Park's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	**Baseline**	-	29.00	0	0	0
1	2015	65,945	27.60	34	144	111
2	2016	68,970	26.20	70	151	81
3	2017	71,995	24.80	110	158	47
4	2018	75,019	23.40	153	164	11
5-year Goal	2019	78,044	22.00	199	171	(28)
6	2020	81,069	21.80	213	178	(36)
7	2021	81,914	21.60	221	179	(42)
8	2022	82,759	21.40	230	181	(48)
9	2023	83,603	21.20	238	183	(55)
10-year Goal	2024	84,448	21.00	247	185	(62)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 144 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Advanced Metering Infrastructure (AMI) with Customer Engagement Portal**
    a. "You're running the sH2Ow"
    b. Implemented in 2017
    c. Estimated savings of 84.6 MG in 2017
        i. Specific utility results may vary based on portal features and notifications
    d. Assumes 20% of residential customers are using and saving water due to the portal (Westin Engineering, 2015)
    e. Assumes customers save 10% of total annual use due to the portal
        i. Savings estimate is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
    f. Residential customers' use makes up approximately 78% of all retail customers' use based on utility profile information submitted to the TWDB
    g. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.56% of total demand
    h. Savings are assumed to increase along with demand as connections increase each year[17]

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

5. **Twice-a-week Outdoor Watering Restriction Ordinance**
    a. Estimated savings of 7.37% of total utility demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and the National Wildlife Federation, 2015)
    b. All savings estimates grow each year at the same rate demand figures for the utility grow in the regional water plan.

6. **Outdoor Landscape Evaluations (SF)**
    a. 468 outdoor evaluations performed since 2014
    b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005; Whitcomb, 2000)
        i. Assumed 75% savings from typical indoor and outdoor survey when only outdoor watering is evaluated
    c. Approximately 22 gallons per day
    d. Greater savings during peak periods
    e. Lesser savings during off-peak periods
    f. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

7. **Rainwater Harvesting**
    a. In Region G, estimated savings of 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
    b. Estimated 10-year useful life for most barrels and systems

8. **Showerhead Distribution (SF)**
    a. Estimated 2,050 gallons per year per showerhead (A&N Technical Services, 2005)
    b. 5-year useful life
        i. If distributed after 2009, plumbing code will require that replacement is equally as efficient, so savings will carry forward indefinitely

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	2x Watering Ordinance	Rain Barrels	AMI with Customer Portal	Outdoor Audits	Low-flow Showerhead Rebate	TOTAL SAVINGS
2011	377				0.4	377
2012	381				0.7	382
2013	385				1.1	386
2014	389	0.43		0.6	1.8	392
2015	393	0.43		1.9	2.3	397
2016	397	0.43		3.2	2.8	403
2017	401	0.43	84.6	2.5	2.8	491
2018	405	0.43	85.5	1.7	2.8	495
2019	409	0.43	86.3	1.0	2.8	499
2020	413	0.43	87.1	0.4	2.8	503
2021	417	0.43	88.0		2.8	508
2022	421	0.43	88.8		2.8	513
2023	425	0.43	89.7		2.8	518
2024	429		90.5		2.8	522
2025	433		91.3		2.8	527
2026	437		92.2		2.8	532
2027	441		93.0		2.8	536
2028	445		93.9		2.8	541
2029	449		94.7		2.8	546
2030	453		95.5		2.8	551
2031	453		95.6		2.8	551
2032	453		95.7		2.8	552
2033	453		95.7		2.8	552
2034	454		95.8		2.8	552
2035	454		95.8		2.8	552
2036	454		95.9		2.8	553
2037	454		95.9		2.8	553
2038	455		96.0		2.8	553
2039	455		96.0		2.8	554
2040	455		96.1		2.8	554
2041	455		96.1		2.8	554
2042	455		96.1		2.8	554
2043	455		96.0		2.8	554
2044	455		96.0		2.8	554
2045	455		96.0		2.8	554
2046	455		96.0		2.8	553
2047	455		96.0		2.8	553
2048	455		96.0		2.8	553
2049	454		95.9		2.8	553
2050	454		95.9		2.8	553
2051	454		95.9		2.8	553
2052	454		95.9		2.8	553
2053	454		95.9		2.8	553
2054	454		95.9		2.8	553
2055	454		95.9		2.8	553
2056	454		95.9		2.8	553
2057	454		95.9		2.8	553
2058	454		95.9		2.8	553
2059	454		95.9		2.8	553
2060	454		95.8		2.8	553
2061	454		95.8		2.8	553
2062	454		95.8		2.8	553
2063	454		95.8		2.8	553
2064	454		95.8		2.8	553
2065	454		95.8		2.8	553
2066	454		95.8		2.8	552
2067	454		95.8		2.8	552
2068	454		95.8		2.8	552
2069	454		95.8		2.8	552
2070	454		95.8		2.8	552

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	29.00	0
2015	65,945	23.00	144
2016	68,970	23.00	151
2017	71,995	23.00	158
2018	75,019	23.00	164
2019	78,044	23.00	171
2020	81,069	23.00	178
2021	81,914	23.00	179
2022	82,759	23.00	181
2023	83,603	23.00	183
2024	84,448	23.00	185

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 108 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-1 for potential savings from this measure compared with the utility's conservation goals.

Table 6-1. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	403	151	554	397	158	0	158	793
2017	491	158	649	401	158	0	158	891
2018	495	164	660	405	190	0	190	874
2019	499	171	670	409	222	0	222	857
2020	503	178	681	413	285	0	285	809
2021	508	179	687	417	341	0	341	764
2022	513	181	694	421	396	0	396	719
2023	518	183	701	425	451	0	451	674
2024	522	185	707	429	507	0	507	629
2025	527	187	714	433	562	0	562	584
2026	532	189	720	437	617	0	617	540
2027	536	190	727	441	673	0	673	495
2028	541	192	734	445	728	0	728	450
2029	546	194	740	449	783	0	783	406
2030	551	196	747	453	839	0	839	361
2031	551	196	747	453	884	0	884	316
2032	552	196	748	453	930	0	930	271
2033	552	197	748	453	976	0	976	225
2034	552	197	749	454	1,022	0	1,022	180
2035	552	197	749	454	1,068	0	1,068	135
2036	553	197	750	454	1,114	0	1,114	90
2037	553	197	750	454	1,160	0	1,160	45
2038	553	197	751	455	1,206	0	1,206	(0)
2039	554	198	751	455	1,252	0	1,252	(46)
2040	554	198	752	455	1,298	0	1,298	(91)

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Statewide Water Conservation Quantification Project
City of College Station Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares College Station's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) College Station's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in College Station's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in million gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for College Station with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	14.2	236	250	98	0	98	152
2016	17.3	234	251	123	0	123	128
2017	16.5	231	248	123	0	123	125
2018	15.8	229	245	148	0	148	97
2019	15.3	226	241	172	0	172	69
2020	14.9	224	239	221	0	221	17
2021	14.7	230	245	283	0	283	(38)
2022	14.6	237	252	346	0	346	(94)
2023	14.6	244	258	408	0	408	(149)
2024	14.5	250	265	470	0	470	(205)
2025	14.5	257	272	532	0	532	(260)
2026	14.5	264	278	594	0	594	(316)
2027	14.5	271	285	656	0	656	(371)
2028	14.5	277	292	718	0	718	(426)
2029	14.5	284	298	780	0	780	(482)
2030	14.5	291	305	842	0	842	(537)
2031	14.5	293	307	871	0	871	(564)
2032	14.5	295	309	900	0	900	(591)
2033	14.5	297	311	928	0	928	(617)
2034	14.5	299	313	957	0	957	(644)
2035	14.5	301	315	986	0	986	(671)
2036	14.5	303	317	1,015	0	1,015	(697)
2037	14.5	305	319	1,043	0	1,043	(724)
2038	14.5	307	321	1,072	0	1,072	(751)
2039	14.5	309	323	1,101	0	1,101	(777)
2040	14.5	311	325	1,129	0	1,129	(804)
2041	14.5	316	330	1,141	0	1,141	(811)
2042	14.5	321	335	1,153	0	1,153	(817)
2043	14.5	326	340	1,164	0	1,164	(824)
2044	14.5	331	345	1,176	0	1,176	(831)
2045	14.5	336	350	1,188	0	1,188	(838)
2046	14.5	340	355	1,199	0	1,199	(844)
2047	14.5	345	360	1,211	0	1,211	(851)
2048	14.5	350	365	1,223	0	1,223	(858)
2049	14.5	355	370	1,234	0	1,234	(864)
2050	14.5	360	375	1,246	0	1,246	(871)
2051	14.5	366	380	1,263	0	1,263	(882)
2052	14.5	371	385	1,279	0	1,279	(894)
2053	14.5	376	391	1,296	0	1,296	(905)
2054	14.5	381	396	1,312	0	1,312	(916)
2055	14.5	387	401	1,329	0	1,329	(928)
2056	14.5	392	407	1,345	0	1,345	(939)
2057	14.5	397	412	1,362	0	1,362	(950)
2058	14.5	403	417	1,379	0	1,379	(961)
2059	14.5	408	423	1,395	0	1,395	(973)
2060	14.5	413	428	1,412	0	1,412	(984)
2061	14.5	419	434	1,431	0	1,431	(997)
2062	14.5	425	440	1,451	0	1,451	(1,011)
2063	14.5	431	445	1,470	0	1,470	(1,024)
2064	14.5	437	451	1,489	0	1,489	(1,038)
2065	14.5	443	457	1,509	0	1,509	(1,051)
2066	14.5	449	463	1,528	0	1,528	(1,065)
2067	14.5	454	469	1,547	0	1,547	(1,078)
2068	14.5	460	475	1,567	0	1,567	(1,092)
2069	14.5	466	481	1,586	0	1,586	(1,105)
2070	14.5	472	487	1,605	0	1,605	(1,119)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how College Station's quantified savings from its implemented activities compare with 5- and 10- year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	157	0	0	0
1	2015	107,889	155	79	250	172
2	2016	106,739	153	156	251	95
3	2017	105,589	151	231	248	16
4	2018	104,440	149	305	245	(60)
5-year Goal	2019	103,290	147	377	241	(136)
6	2020	102,140	146	425	239	(186)
7	2021	105,195	144	491	245	(246)
8	2022	108,250	143	561	252	(309)
9	2023	111,305	141	634	258	(375)
10-year Goal	2024	114,360	140	710	265	(445)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how College Station's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	9.00	0	0	0
1	2015	107,889	8.80	8	236	228
2	2016	106,739	8.60	16	234	218
3	2017	105,589	8.40	23	231	208
4	2018	104,440	8.20	30	229	198
5-year Goal	2019	103,290	8.00	38	226	189
6	2020	102,140	8.00	37	224	186
7	2021	105,195	8.00	38	230	192
8	2022	108,250	8.00	40	237	198
9	2023	111,305	8.00	41	244	203
10-year Goal	2024	114,360	8.00	42	250	209

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 236 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Outdoor Landscape Evaluations**
    a. 726 outdoor evaluations performed since 2010
    b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005; Whitcomb, 2000)
        i. Assumed 75% savings from typical indoor and outdoor survey when only outdoor watering is evaluated
    c. Approximately 22 gallons per day
    d. Greater savings during peak periods
    e. Lesser savings during off-peak periods
    f. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

5. **Rainwater Harvesting**
    a. In Region G, estimated savings of 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
    b. Estimated 10-year useful life for most barrels and systems

6. **High Efficiency (HE) Toilet Replacement Program (SF)**
    a. Estimated 10,390 gallons per year per toilet (A&N Technical Services, 2005)
    b. Savings carry on indefinitely because replacement toilet will be as efficient

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

7. **HE Toilet Replacement Program (MF)**
    a. Estimated 15,756 gallons per year per toilet (A&N Technical Services, 2005)
    b. 20-year useful life for fixture[17]
    c. Savings carry on indefinitely because replacement toilet will be as efficient

8. **HE Toilet Replacement Program (ICI)**
    a. Estimated 13,000 gallons per year per toilet (A&N Technical Services, 2005)
    b. 20-year useful life for fixture

[17] Plumbing code and efficiency standards effectively make the savings permanent, as new high-efficiency models will replace these toilets.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Rain Barrels	Outdoor Water Audits	HE Toilets (MF/ICI)	HE Toilets (SF)	TOTAL SAVINGS
2009					0
2010	0.01	0.80	1.0	0.2	2.0
2011	0.03	1.44	8.3	0.4	10.2
2012	0.10	1.92	8.3	0.7	11.1
2013	0.13	2.24	9.8	1.1	13.3
2014	0.15	2.40	9.8	1.4	13.8
2015	0.16	2.40	9.8	1.8	14.2
2016	0.18	2.61	12.6	1.9	17.3
2017	0.18	1.77	12.6	1.9	16.5
2018	0.18	1.08	12.6	1.9	15.8
2019	0.18	0.56	12.6	1.9	15.3
2020	0.16	0.20	12.6	1.9	14.9
2021	0.15		12.6	1.9	14.7
2022	0.08		12.6	1.9	14.6
2023	0.05		12.6	1.9	14.6
2024	0.03		12.6	1.9	14.5
2025	0.01		12.6	1.9	14.5
2026			12.6	1.9	14.5
2027			12.6	1.9	14.5
2028			12.6	1.9	14.5
2029			12.6	1.9	14.5
2030			12.6	1.9	14.5
2031			12.6	1.9	14.5
2032			12.6	1.9	14.5
2033			12.6	1.9	14.5
2034			12.6	1.9	14.5
2035			12.6	1.9	14.5
2036			12.6	1.9	14.5
2037			12.6	1.9	14.5
2038			12.6	1.9	14.5
2039			12.6	1.9	14.5
2040			12.6	1.9	14.5
2041			12.6	1.9	14.5
2042			12.6	1.9	14.5
2043			12.6	1.9	14.5
2044			12.6	1.9	14.5
2045			12.6	1.9	14.5
2046			12.6	1.9	14.5
2047			12.6	1.9	14.5
2048			12.6	1.9	14.5
2049			12.6	1.9	14.5
2050			12.6	1.9	14.5
2051			12.6	1.9	14.5
2052			12.6	1.9	14.5
2053			12.6	1.9	14.5
2054			12.6	1.9	14.5
2055			12.6	1.9	14.5
2056			12.6	1.9	14.5
2057			12.6	1.9	14.5
2058			12.6	1.9	14.5
2059			12.6	1.9	14.5
2060			12.6	1.9	14.5
2061			12.6	1.9	14.5
2062			12.6	1.9	14.5
2063			12.6	1.9	14.5
2064			12.6	1.9	14.5
2065			12.6	1.9	14.5
2066			12.6	1.9	14.5
2067			12.6	1.9	14.5
2068			12.6	1.9	14.5
2069			12.6	1.9	14.5
2070			12.6	1.9	14.5

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	9.00	0
2015	107,889	3.00	236
2016	106,739	3.00	234
2017	105,589	3.00	231
2018	104,440	3.00	229
2019	103,290	3.00	226
2020	102,140	3.00	224
2021	105,195	3.00	230
2022	108,250	3.00	237
2023	111,305	3.00	244
2024	114,360	3.00	250

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 6.95% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 388 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	234	251	388	123	0	123	516
2017	16	232	248	399	123	0	123	524
2018	16	229	245	411	148	0	148	508
2019	15	226	241	423	172	0	172	492
2020	15	224	239	434	221	0	221	452
2021	15	230	245	446	283	0	283	408
2022	15	237	252	458	346	0	346	364
2023	15	244	258	469	408	0	408	320
2024	15	250	265	481	470	0	470	276
2025	15	257	272	493	532	0	532	232
2026	15	264	278	504	594	0	594	189
2027	15	271	285	516	656	0	656	145
2028	15	277	292	528	718	0	718	101
2029	15	284	298	539	780	0	780	57
2030	15	291	305	551	842	0	842	14
2031	15	293	307	564	871	0	871	(10)
2032	15	295	309	557	900	0	900	(33)
2033	15	297	311	560	928	0	928	(57)
2034	15	299	313	564	957	0	957	(80)
2035	15	301	315	567	986	0	986	(104)
2036	15	303	317	570	1,015	0	1,015	(127)
2037	15	305	319	573	1,043	0	1,043	(151)
2038	15	307	321	576	1,072	0	1,072	(174)
2039	15	309	323	580	1,101	0	1,101	(198)
2040	15	311	325	583	1,129	0	1,129	(221)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[18]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[18] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	234	251	75	123	0	123	203
2017	16	231	248	77	123	0	123	202
2018	16	229	245	79	148	0	148	176
2019	15	226	241	82	172	0	172	151
2020	15	224	239	84	221	0	221	101
2021	15	230	245	86	283	0	283	48
2022	15	237	252	88	346	0	346	(6)
2023	15	244	258	90	408	0	408	(59)
2024	15	250	265	93	470	0	470	(112)
2025	15	257	272	95	532	0	532	(165)
2026	15	264	278	97	594	0	594	(218)
2027	15	271	285	99	656	0	656	(272)
2028	15	277	292	102	718	0	718	(325)
2029	15	284	298	104	780	0	780	(378)
2030	15	291	305	106	842	0	842	(431)
2031	15	293	307	107	871	0	871	(457)
2032	15	293	309	107	900	0	900	(483)
2033	15	297	311	108	928	0	928	(508)
2034	15	299	313	109	957	0	957	(535)
2035	15	301	315	109	986	0	986	(561)
2036	15	303	317	110	1,015	0	1,015	(587)
2037	15	305	319	111	1,043	0	1,043	(613)
2038	15	307	321	111	1,072	0	1,072	(639)
2039	15	309	323	112	1,101	0	1,101	(665)
2040	15	311	325	112	1,129	0	1,129	(692)

3. Water Rate Increase
    a. For every 10% increase, estimated savings could be 2% of utility total demand.
    b. Approximately 112 MG of savings per year with current demand
    c. Savings is cumulative and based on more than one source[19] (U.S. EPA, 1998; Whitcomb, 1999)
    d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	234	251	112	123	0	123	240
2017	16	231	248	115	123	0	123	240
2018	16	229	245	118	148	0	148	215
2019	15	226	241	122	172	0	172	191
2020	15	224	239	125	221	0	221	142
2021	15	230	245	128	283	0	283	90
2022	15	237	252	132	346	0	346	38
2023	15	244	258	135	408	0	408	(14)
2024	15	250	265	138	470	0	470	(66)
2025	15	257	272	142	532	0	532	(118)
2026	15	264	278	145	594	0	594	(171)
2027	15	271	285	148	656	0	656	(223)
2028	15	277	292	152	718	0	718	(275)
2029	15	284	298	155	780	0	780	(327)
2030	15	291	305	159	842	0	842	(379)
2031	15	293	307	158	871	0	871	(405)
2032	15	295	309	160	900	0	900	(430)
2033	15	297	311	161	928	0	928	(454)
2034	15	299	313	162	957	0	957	(482)
2035	15	301	315	163	988	0	988	(507)
2036	15	303	317	164	1,015	0	1,015	(533)
2037	15	305	319	165	1,043	0	1,043	(559)
2038	15	307	321	166	1,072	0	1,072	(585)
2039	15	309	323	167	1,101	0	1,101	(610)
2040	15	311	325	168	1,129	0	1,129	(636)

[19] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Statewide Water Conservation Quantification Project
City of Georgetown Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Georgetown's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Georgetown's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Georgetown's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Georgetown with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	85	450	535	137	0	137	398
2016	89	462	551	171	0	171	380
2017	91	474	565	171	0	171	394
2018	93	487	580	205	0	205	375
2019	95	499	594	239	0	239	355
2020	97	512	609	307	0	307	301
2021	99	525	624	383	0	383	241
2022	102	538	639	458	0	458	181
2023	104	551	655	533	0	533	121
2024	106	564	670	609	0	609	61
2025	108	577	685	684	0	684	1
2026	109	590	700	759	0	759	(60)
2027	112	603	715	835	0	835	(120)
2028	114	616	730	910	0	910	(179)
2029	116	630	746	985	0	985	(239)
2030	119	643	761	1,060	0	1,060	(299)
2031	121	659	780	1,154	0	1,154	(374)
2032	124	675	800	1,248	0	1,248	(448)
2033	127	692	819	1,342	0	1,342	(523)
2034	130	708	838	1,435	0	1,435	(597)
2035	133	724	857	1,529	0	1,529	(672)
2036	136	741	876	1,623	0	1,623	(746)
2037	139	757	896	1,716	0	1,716	(821)
2038	142	773	915	1,810	0	1,810	(895)
2039	144	790	934	1,904	0	1,904	(970)
2040	147	806	953	1,997	0	1,997	(1,044)
2041	150	823	974	2,120	0	2,120	(1,146)
2042	154	841	995	2,243	0	2,243	(1,248)
2043	157	859	1,015	2,365	0	2,365	(1,350)
2044	160	876	1,036	2,488	0	2,488	(1,452)
2045	163	894	1,057	2,611	0	2,611	(1,554)
2046	166	911	1,077	2,733	0	2,733	(1,656)
2047	169	929	1,098	2,856	0	2,856	(1,758)
2048	172	947	1,119	2,979	0	2,979	(1,860)
2049	176	964	1,140	3,101	0	3,101	(1,962)
2050	179	982	1,160	3,224	0	3,224	(2,063)
2051	182	1,002	1,184	3,305	0	3,305	(2,121)
2052	186	1,022	1,207	3,387	0	3,387	(2,179)
2053	189	1,041	1,231	3,468	0	3,468	(2,237)
2054	193	1,061	1,254	3,550	0	3,550	(2,295)
2055	197	1,081	1,278	3,631	0	3,631	(2,353)
2056	200	1,101	1,301	3,713	0	3,713	(2,411)
2057	204	1,121	1,325	3,794	0	3,794	(2,469)
2058	207	1,141	1,348	3,876	0	3,876	(2,527)
2059	211	1,161	1,372	3,957	0	3,957	(2,585)
2060	214	1,181	1,395	4,039	0	4,039	(2,643)
2061	218	1,202	1,420	4,128	0	4,128	(2,708)
2062	222	1,222	1,444	4,217	0	4,217	(2,773)
2063	225	1,243	1,468	4,306	0	4,306	(2,838)
2064	229	1,263	1,493	4,395	0	4,395	(2,903)
2065	233	1,284	1,517	4,485	0	4,485	(2,968)
2066	236	1,305	1,541	4,574	0	4,574	(3,033)
2067	240	1,325	1,565	4,663	0	4,663	(3,097)
2068	244	1,346	1,590	4,752	0	4,752	(3,162)
2069	248	1,367	1,614	4,841	0	4,841	(3,227)
2070	251	1,387	1,638	4,931	0	4,931	(3,292)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Georgetown's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	218	0	0	0
1	2015	87,091	210	242	535	293
2	2016	89,591	203	497	551	54
3	2017	92,090	195	766	565	(201)
4	2018	94,590	188	1,050	580	(470)
5-year Goal	2019	97,089	180	1,347	594	(752)
6	2020	99,589	176	1,527	609	(918)
7	2021	102,110	172	1,714	624	(1,090)
8	2022	104,631	168	1,910	639	(1,270)
9	2023	107,151	164	2,112	655	(1,457)
10-year Goal	2024	109,672	160	2,322	670	(1,652)

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Georgetown's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	45.00	0	0	0
1	2015	87,091	42.60	76	450	373
2	2016	89,591	40.20	157	462	305
3	2017	92,090	37.80	242	474	232
4	2018	94,590	35.40	331	487	155
5-year Goal	2019	97,089	33.00	425	499	74
6	2020	99,589	32.00	473	512	39
7	2021	102,110	31.00	522	525	3
8	2022	104,631	30.00	573	538	(35)
9	2023	107,151	29.00	626	551	(75)
10-year Goal	2024	109,672	28.00	681	564	(117)

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.

- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 450 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 7.0% increase in 2014

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.

b. Estimated customer demand reduction of 1.4%
c. Savings are cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
   a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
   b. All water loss reduction savings associated with this activity are detailed in Section 4, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
   c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 5 of this report.
      i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.
   d. Savings were not estimated for any customer engagement associated with Georgetown Utilities Analysis and Reporting Doorway (GUARD)
      i. For this report, it was uncertain what features, notifications, and frequency of communication with customers were in place, making savings difficult to estimate as a result.

6. **Outdoor Landscape Evaluations (SF)**
   a. 288 outdoor evaluations performed since 2015
   b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005)
      i. Assumed 65% savings from typical indoor and outdoor survey when only outdoor watering is evaluated (Whitcomb, 2000)
   c. Approximately 22 gallons per day
   d. Greater savings during peak periods
   e. Lesser savings during off-peak periods
   f. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

7. **Rain Barrels**
   a. Approximately 1,080 65-gallon barrels distributed since 2014
   b. In Region G, estimated savings of 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002)
      i. Estimated 10-year useful life for most barrels

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Rain Barrels	Water Rate Increase	Outdoor Audits	TOTAL SAVINGS
2012				0
2013				0
2014	0.4	82		82
2015	0.9	84	0.27	85
2016	1.3	87	0.81	89
2017	1.3	89	0.64	91
2018	1.3	91	0.46	93
2019	1.3	93	0.29	95
2020	1.3	96	0.12	97
2021	1.3	98		99
2022	1.3	100		102
2023	1.3	103		104
2024	0.9	105		106
2025	0.4	107		108
2026		109		109
2027		112		112
2028		114		114
2029		116		116
2030		119		119
2031		121		121
2032		124		124
2033		127		127
2034		130		130
2035		133		133
2036		136		136
2037		139		139
2038		142		142
2039		144		144
2040		147		147
2041		150		150
2042		154		154
2043		157		157
2044		160		160
2045		163		163
2046		166		166
2047		169		169
2048		172		172
2049		176		176
2050		179		179
2051		182		182
2052		186		186
2053		189		189
2054		193		193
2055		197		197
2056		200		200
2057		204		204
2058		207		207
2059		211		211
2060		214		214
2061		218		218
2062		222		222
2063		225		225
2064		229		229
2065		233		233
2066		236		236
2067		240		240
2068		244		244
2069		248		248
2070		251		251

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	45.00	0
2015	63,716	25.67	450
2016	65,474	25.67	462
2017	67,232	25.67	474
2018	68,991	25.67	487
2019	70,749	25.67	499
2020	72,507	25.67	512
2021	74,365	25.67	525
2022	76,223	25.67	538
2023	78,080	25.67	551
2024	79,938	25.67	564

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 469 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG)

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	89	462	551	469	171	0	171	849
2017	91	474	565	481	171	0	171	876
2018	93	487	580	494	205	0	205	868
2019	95	499	594	506	239	0	239	861
2020	97	512	609	518	307	0	307	820
2021	99	525	624	531	383	0	383	772
2022	102	538	639	543	458	0	458	724
2023	104	551	655	555	533	0	533	677
2024	106	564	670	568	609	0	609	629
2025	108	577	685	580	684	0	684	581
2026	109	590	700	592	759	0	759	533
2027	112	603	715	605	835	0	835	485
2028	114	616	730	617	910	0	910	437
2029	116	630	746	629	985	0	985	390
2030	119	643	761	642	1,060	0	1,060	342
2031	121	659	780	657	1,154	0	1,154	283
2032	124	675	800	673	1,248	0	1,248	225
2033	127	692	819	688	1,342	0	1,342	166
2034	130	708	838	704	1,435	0	1,435	107
2035	133	724	857	720	1,529	0	1,529	48
2036	136	741	876	735	1,623	0	1,623	(11)
2037	139	757	896	751	1,716	0	1,716	(70)
2038	142	773	915	767	1,810	0	1,810	(129)
2039	144	790	934	782	1,904	0	1,904	(187)
2040	147	806	953	798	1,997	0	1,997	(246)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	89	462	551	83	171	0	171	463
2017	91	474	565	85	171	0	171	480
2018	93	487	580	87	205	0	205	462
2019	95	499	594	89	239	0	239	445
2020	97	512	609	92	307	0	307	393
2021	99	525	624	94	383	0	383	335
2022	102	538	639	96	458	0	458	277
2023	104	551	655	98	533	0	533	220
2024	106	564	670	100	609	0	609	161
2025	108	577	685	103	684	0	684	103
2026	109	590	700	105	759	0	759	45
2027	112	603	715	107	835	0	835	(13)
2028	114	616	730	109	910	0	910	(70)
2029	116	630	746	111	985	0	985	(128)
2030	119	643	761	113	1,060	0	1,060	(186)
2031	121	659	780	116	1,154	0	1,154	(258)
2032	124	675	800	119	1,248	0	1,248	(329)
2033	127	692	819	122	1,342	0	1,342	(401)
2034	130	708	838	124	1,435	0	1,435	(473)
2035	133	724	857	127	1,529	0	1,529	(545)
2036	136	741	876	130	1,623	0	1,623	(616)
2037	139	757	896	133	1,716	0	1,716	(688)
2038	142	773	915	136	1,810	0	1,810	(760)
2039	144	790	934	138	1,904	0	1,904	(831)
2040	147	806	953	141	1,997	0	1,997	(903)

Statewide Water Conservation Quantification Project
City of Groesbeck Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association
- County-Wide WUGs:

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Other (Rural/unincorporated areas of municipal water use)
- Manufacturing
- Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Groesbeck's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Groesbeck's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Groesbeck's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Groesbeck with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	14	21	34	0	0	0	34
2016	14	21	34	0	0	0	34
2017	14	21	34	0	0	0	34
2018	13	21	34	0	0	0	34
2019	13	21	34	0	0	0	34
2020	13	21	34	1	0	1	34
2021	13	21	34	1	0	1	34
2022	13	21	34	1	0	1	34
2023	13	21	34	0	0	0	34
2024	13	21	34	0	0	0	34
2025	13	21	34	0	0	0	34
2026	13	21	34	0	0	0	34
2027	13	21	34	0	0	0	34
2028	13	21	34	0	0	0	34
2029	13	21	34	0	0	0	34
2030	13	21	34	0	0	0	34
2031	13	21	34	0	0	0	34
2032	13	21	34	0	0	0	34
2033	13	21	34	0	0	0	34
2034	13	21	34	0	0	0	34
2035	13	21	34	0	0	0	34
2036	13	21	34	0	0	0	34
2037	13	21	34	0	0	0	34
2038	13	21	34	0	0	0	34
2039	13	21	34	0	0	0	34
2040	13	21	34	0	0	0	34
2041	13	21	34	0	0	0	34
2042	13	21	34	0	0	0	34
2043	13	21	34	0	0	0	34
2044	13	21	34	0	0	0	34
2045	13	21	34	0	0	0	34
2046	13	21	34	0	0	0	34
2047	13	21	34	0	0	0	34
2048	13	21	34	0	0	0	34
2049	13	21	34	0	0	0	34
2050	13	21	34	0	0	0	34
2051	13	21	34	0	0	0	34
2052	13	21	34	0	0	0	34
2053	13	21	34	0	0	0	34
2054	13	21	34	0	0	0	34
2055	13	21	34	0	0	0	34
2056	13	21	34	0	0	0	34
2057	13	21	34	0	0	0	34
2058	13	21	34	0	0	0	34
2059	13	21	34	0	0	0	34
2060	13	21	35	0	0	0	35
2061	13	21	35	0	0	0	35
2062	13	21	35	0	0	0	35
2063	13	21	35	0	0	0	35
2064	13	21	35	0	0	0	35
2065	13	22	35	0	0	0	35
2066	13	22	35	0	0	0	35
2067	13	22	35	0	0	0	35
2068	13	22	35	0	0	0	35
2069	13	22	35	0	0	0	35
2070	13	22	35	0	0	0	35

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Groesbeck's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	157	0	0	0
1	2015	4,366	150	12	34	22
2	2016	4,368	142	24	34	11
3	2017	4,370	135	35	34	(1)
4	2018	4,373	127	47	34	(13)
5-year Goal	2019	4,375	120	59	34	(25)
6	2020	4,377	119	61	34	(26)
7	2021	4,381	118	62	34	(28)
8	2022	4,385	117	64	34	(30)
9	2023	4,390	116	66	34	(31)
10-year Goal	2024	4,394	115	67	34	(33)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Groesbeck's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	23.00	0	0	0
1	2015	4,366	22.00	2	21	19
2	2016	4,368	21.00	3	21	18
3	2017	4,370	20.00	5	21	16
4	2018	4,373	19.00	6	21	14
5-year Goal	2019	4,375	18.00	8	21	13
6	2020	4,377	17.00	10	21	11
7	2021	4,381	16.00	11	21	10
8	2022	4,385	15.00	13	21	8
9	2023	4,390	14.00	14	21	6
10-year Goal	2024	4,394	13.00	16	21	5

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 21 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 30% increase in 2014
    b. Estimated customer demand reduction of 6.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 4, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 5 of this report.
d. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2012		0
2013		0
2014	13.6	14
2015	13.6	14
2016	13.5	14
2017	13.5	14
2018	13.5	13
2019	13.5	13
2020	13.5	13
2021	13.4	13
2022	13.4	13
2023	13.4	13
2024	13.4	13
2025	13.3	13
2026	13.3	13
2027	13.3	13
2028	13.3	13
2029	13.3	13
2030	13.2	13
2031	13.2	13
2032	13.2	13
2033	13.2	13
2034	13.2	13
2035	13.2	13
2036	13.1	13
2037	13.1	13
2038	13.1	13
2039	13.1	13
2040	13.1	13
2041	13.1	13
2042	13.1	13
2043	13.0	13
2044	13.0	13
2045	13.0	13
2046	13.0	13
2047	13.0	13
2048	13.0	13
2049	13.0	13
2050	13.0	13
2051	13.0	13
2052	13.0	13
2053	13.0	13
2054	13.0	13
2055	13.0	13
2056	13.0	13
2057	13.0	13
2058	13.1	13
2059	13.1	13
2060	13.1	13
2061	13.1	13
2062	13.1	13
2063	13.1	13
2064	13.1	13
2065	13.1	13
2066	13.1	13
2067	13.1	13
2068	13.1	13
2069	13.1	13
2070	13.1	13

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	23.00	0
2015	4,366	10.00	21
2016	4,368	10.00	21
2017	4,370	10.00	21
2018	4,373	10.00	21
2019	4,375	10.00	21
2020	4,377	10.00	21
2021	4,381	10.00	21
2022	4,385	10.00	21
2023	4,390	10.00	21
2024	4,394	10.00	21

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region G savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 17 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	14	21	34	17	0	0	0	51
2017	14	21	34	17	0	0	0	51
2018	13	21	34	17	0	0	0	51
2019	13	21	34	17	0	0	0	51
2020	13	21	34	17	1	0	1	51
2021	13	21	34	17	1	0	1	51
2022	13	21	34	17	1	0	1	51
2023	13	21	34	17	0	0	0	51
2024	13	21	34	17	0	0	0	51
2025	13	21	34	17	0	0	0	51
2026	13	21	34	17	0	0	0	51
2027	13	21	34	17	0	0	0	51
2028	13	21	34	17	0	0	0	51
2029	13	21	34	17	0	0	0	51
2030	13	21	34	17	0	0	0	51
2031	13	21	34	17	0	0	0	51
2032	13	21	34	17	0	0	0	51
2033	13	21	34	17	0	0	0	51
2034	13	21	34	17	0	0	0	51
2035	13	21	34	17	0	0	0	51
2036	13	21	34	17	0	0	0	51
2037	13	21	34	17	0	0	0	51
2038	13	21	34	17	0	0	0	51
2039	13	21	34	17	0	0	0	51
2040	13	21	34	17	0	0	0	51

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	14	21	34	3	0	0	0	37
2017	14	21	34	3	0	0	0	37
2018	13	21	34	3	0	0	0	37
2019	13	21	34	3	0	0	0	37
2020	13	21	34	3	1	0	1	37
2021	13	21	34	3	1	0	1	37
2022	13	21	34	3	1	0	1	37
2023	13	21	34	3	0	0	0	37
2024	13	21	34	3	0	0	0	37
2025	13	21	34	3	0	0	0	37
2026	13	21	34	3	0	0	0	37
2027	13	21	34	3	0	0	0	37
2028	13	21	34	3	0	0	0	37
2029	13	21	34	3	0	0	0	37
2030	13	21	34	3	0	0	0	37
2031	13	21	34	3	0	0	0	37
2032	13	21	34	3	0	0	0	37
2033	13	21	34	3	0	0	0	37
2034	13	21	34	3	0	0	0	37
2035	13	21	34	3	0	0	0	37
2036	13	21	34	3	0	0	0	37
2037	13	21	34	3	0	0	0	37
2038	13	21	34	3	0	0	0	37
2039	13	21	34	3	0	0	0	37
2040	13	21	34	3	0	0	0	37

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Hewitt Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Hewitt's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Hewitt's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Hewitt's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Hewitt with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	19	52	71	3	0	3	68
2016	19	53	72	4	0	4	68
2017	20	54	73	4	0	4	70
2018	20	55	75	5	0	5	70
2019	20	56	76	6	0	6	70
2020	20	57	77	7	0	7	70
2021	21	58	78	8	0	8	71
2022	21	58	79	8	0	8	71
2023	21	59	80	8	0	8	72
2024	21	60	81	9	0	9	73
2025	22	61	82	9	0	9	73
2026	22	62	84	10	0	10	74
2027	22	63	85	10	0	10	75
2028	22	63	86	11	0	11	75
2029	23	64	87	11	0	11	76
2030	23	65	88	11	0	11	76
2031	23	66	89	11	0	11	77
2032	23	67	90	11	0	11	78
2033	23	67	91	11	0	11	79
2034	24	68	92	11	0	11	80
2035	24	69	93	11	0	11	81
2036	24	70	94	11	0	11	82
2037	24	70	95	11	0	11	83
2038	25	71	96	11	0	11	84
2039	25	72	97	11	0	11	85
2040	25	73	98	11	0	11	86
2041	25	73	99	11	0	11	87
2042	25	74	99	11	0	11	88
2043	26	75	100	11	0	11	89
2044	26	76	101	11	0	11	90
2045	26	76	102	11	0	11	91
2046	26	77	103	11	0	11	92
2047	27	78	104	11	0	11	93
2048	27	79	105	11	0	11	94
2049	27	79	106	11	0	11	95
2050	27	80	107	11	0	11	96
2051	28	81	108	11	0	11	97
2052	28	82	109	11	0	11	98
2053	28	82	110	11	0	11	99
2054	28	83	111	11	0	11	100
2055	29	84	112	11	0	11	101
2056	29	85	113	11	0	11	102
2057	29	85	114	11	0	11	103
2058	29	86	115	11	0	11	104
2059	30	87	116	11	0	11	105
2060	30	88	117	11	0	11	106
2061	30	88	118	11	0	11	107
2062	30	89	119	11	0	11	108
2063	31	90	120	11	0	11	109
2064	31	90	121	11	0	11	110
2065	31	91	122	11	0	11	111
2066	31	92	123	11	0	11	112
2067	32	93	124	11	0	11	113
2068	32	93	125	11	0	11	114
2069	32	94	126	11	0	11	115
2070	32	95	127	11	0	11	116

3.2 .Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Hewitt's quantified savings from its implemented activities compare with 5- and 10 year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	127	0	0	0
1	2015	14,252	126	7	71	64
2	2016	14,510	124	15	72	57
3	2017	14,768	123	23	73	51
4	2018	15,027	121	31	75	44
5-year Goal	2019	15,285	120	39	76	37
6	2020	15,543	118	51	77	26
7	2021	15,774	116	63	78	15
8	2022	16,004	114	76	79	3
9	2023	16,235	112	89	80	(9)
10-year Goal	2024	16,465	110	102	81	(21)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Hewitt's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	20.00	0	0	0
1	2015	14,252	20.80	(4)	52	56
2	2016	14,510	21.60	(8)	53	61
3	2017	14,768	22.40	(13)	54	67
4	2018	15,027	23.20	(18)	55	72
5-year Goal	2019	15,285	24.00	(22)	56	78
6	2020	15,543	23.60	(20)	57	77
7	2021	15,774	23.20	(18)	58	76
8	2022	16,004	22.80	(16)	58	75
9	2023	16,235	22.40	(14)	59	73
10-year Goal	2024	16,465	22.00	(12)	60	72

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 52 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 6.0% increase in 2014
        ii. 5.5% increase in 2015
    b. Estimated customer demand reduction of 2.3%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2012		0
2013		0
2014	9.8	9.8
2015	19.1	19.1
2016	19.3	19.3
2017	19.6	19.6
2018	19.8	19.8
2019	20.1	20.1
2020	20.3	20.3
2021	20.6	20.6
2022	20.8	20.8
2023	21.1	21.1
2024	21.3	21.3
2025	21.5	21.5
2026	21.8	21.8
2027	22.0	22.0
2028	22.3	22.3
2029	22.5	22.5
2030	22.8	22.8
2031	23.0	23.0
2032	23.2	23.2
2033	23.4	23.4
2034	23.6	23.6
2035	23.9	23.9
2036	24.1	24.1
2037	24.3	24.3
2038	24.5	24.5
2039	24.7	24.7
2040	25.0	25.0
2041	25.2	25.2
2042	25.4	25.4
2043	25.7	25.7
2044	25.9	25.9
2045	26.1	26.1
2046	26.4	26.4
2047	26.6	26.6
2048	26.8	26.8
2049	27.1	27.1
2050	27.3	27.3
2051	27.6	27.6
2052	27.8	27.8
2053	28.1	28.1
2054	28.3	28.3
2055	28.6	28.6
2056	28.8	28.8
2057	29.0	29.0
2058	29.3	29.3
2059	29.5	29.5
2060	29.8	29.8
2061	30.0	30.0
2062	30.3	30.3
2063	30.5	30.5
2064	30.8	30.8
2065	31.0	31.0
2066	31.3	31.3
2067	31.5	31.5
2068	31.8	31.8
2069	32.0	32.0
2070	32.3	32.3

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	20.00	0
2015	14,252	10.00	52
2016	14,510	10.00	53
2017	14,768	10.00	54
2018	15,027	10.00	55
2019	15,285	10.00	56
2020	15,543	10.00	57
2021	15,774	10.00	58
2022	16,004	10.00	58
2023	16,235	10.00	59
2024	16,465	10.00	60

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 64 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	19	53	72	64	4	0	4	132
2017	20	54	78	65	4	0	4	134
2018	20	55	75	65	5	0	5	135
2019	20	56	76	66	6	0	6	136
2020	20	57	77	67	7	0	7	137
2021	21	58	78	68	8	0	8	138
2022	21	58	79	69	8	0	8	140
2023	21	59	80	69	8	0	8	141
2024	21	60	81	70	9	0	9	143
2025	22	61	82	71	9	0	9	144
2026	22	62	84	72	10	0	10	146
2027	22	63	85	73	10	0	10	147
2028	22	63	86	73	11	0	11	149
2029	23	64	87	74	11	0	11	150
2030	23	65	88	73	11	0	11	151
2031	23	66	89	76	11	0	11	153
2032	23	67	90	76	11	0	11	155
2033	23	67	91	77	11	0	11	157
2034	24	68	92	78	11	0	11	158
2035	24	69	93	79	11	0	11	160
2036	24	70	94	79	11	0	11	162
2037	24	70	95	80	11	0	11	163
2038	25	71	96	81	11	0	11	165
2039	25	72	97	82	11	0	11	167
2040	25	73	98	82	11	0	11	168

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	19	53	72	11	4	0	4	80
2017	20	54	73	11	4	0	4	81
2018	20	55	75	12	5	0	5	81
2019	20	56	76	12	6	0	6	82
2020	20	57	77	12	7	0	7	82
2021	21	58	78	12	8	0	8	83
2022	21	58	79	12	8	0	8	83
2023	21	59	80	12	8	0	8	84
2024	21	60	81	12	9	0	9	85
2025	22	61	82	13	9	0	9	86
2026	22	62	84	13	10	0	10	87
2027	22	63	85	13	10	0	10	87
2028	22	63	86	13	11	0	11	88
2029	23	64	87	13	11	0	11	89
2030	23	65	88	13	11	0	11	90
2031	23	66	89	13	11	0	11	91
2032	23	67	90	14	11	0	11	92
2033	23	67	91	14	11	0	11	93
2034	24	68	92	14	11	0	11	94
2035	24	69	93	14	11	0	11	95
2036	24	70	94	14	11	0	11	96
2037	24	70	95	14	11	0	11	97
2038	25	71	96	14	11	0	11	98
2039	25	72	97	14	11	0	11	100
2040	25	73	98	15	11	0	11	101

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Kempner WSC Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Kempner WSC's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Kempner WSC's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Kempner WSC's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Kempner WSC with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	(62)	(62)	14	0	14	(76)
2016	0	(62)	(62)	18	0	18	(80)
2017	0	(62)	(62)	18	0	18	(80)
2018	0	(63)	(63)	22	0	22	(84)
2019	0	(63)	(63)	25	0	25	(88)
2020	0	(63)	(63)	33	0	33	(96)
2021	0	(64)	(64)	37	0	37	(101)
2022	0	(64)	(64)	42	0	42	(106)
2023	0	(64)	(64)	46	0	46	(110)
2024	0	(65)	(65)	51	0	51	(115)
2025	0	(65)	(65)	55	0	55	(120)
2026	0	(65)	(65)	60	0	60	(125)
2027	0	(65)	(65)	64	0	64	(130)
2028	0	(66)	(66)	69	0	69	(135)
2029	0	(66)	(66)	73	0	73	(139)
2030	0	(66)	(66)	78	0	78	(144)
2031	0	(67)	(67)	77	0	77	(144)
2032	0	(68)	(68)	77	0	77	(145)
2033	0	(68)	(68)	77	0	77	(145)
2034	0	(69)	(69)	76	0	76	(145)
2035	0	(70)	(70)	76	0	76	(145)
2036	0	(70)	(70)	75	0	75	(145)
2037	0	(71)	(71)	75	0	75	(146)
2038	0	(72)	(72)	74	0	74	(146)
2039	0	(72)	(72)	74	0	74	(146)
2040	0	(73)	(73)	73	0	73	(146)
2041	0	(74)	(74)	73	0	73	(147)
2042	0	(74)	(74)	73	0	73	(147)
2043	0	(75)	(75)	73	0	73	(148)
2044	0	(76)	(76)	73	0	73	(149)
2045	0	(76)	(76)	73	0	73	(149)
2046	0	(77)	(77)	73	0	73	(150)
2047	0	(78)	(78)	73	0	73	(150)
2048	0	(78)	(78)	73	0	73	(151)
2049	0	(79)	(79)	72	0	72	(151)
2050	0	(80)	(80)	72	0	72	(152)
2051	0	(80)	(80)	73	0	73	(153)
2052	0	(81)	(81)	73	0	73	(154)
2053	0	(81)	(81)	74	0	74	(155)
2054	0	(82)	(82)	74	0	74	(156)
2055	0	(83)	(83)	74	0	74	(157)
2056	0	(83)	(83)	75	0	75	(158)
2057	0	(84)	(84)	75	0	75	(159)
2058	0	(84)	(84)	75	0	75	(160)
2059	0	(85)	(85)	76	0	76	(161)
2060	0	(86)	(86)	76	0	76	(162)
2061	0	(86)	(86)	77	0	77	(163)
2062	0	(87)	(87)	77	0	77	(164)
2063	0	(87)	(87)	78	0	78	(165)
2064	0	(88)	(88)	78	0	78	(166)
2065	0	(89)	(89)	79	0	79	(167)
2066	0	(89)	(89)	79	0	79	(168)
2067	0	(90)	(90)	79	0	79	(169)
2068	0	(90)	(90)	80	0	80	(170)
2069	0	(91)	(91)	80	0	80	(171)
2070	0	(92)	(92)	81	0	81	(172)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Kempner WSC's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	168	0	0	0
1	2015	15,363	166	11	(62)	(73)
2	2016	15,450	164	23	(62)	(85)
3	2017	15,538	162	34	(62)	(96)
4	2018	15,625	160	46	(63)	(108)
5-year Goal	2019	15,713	158	57	(63)	(120)
6	2020	15,800	156	67	(63)	(130)
7	2021	15,871	155	76	(64)	(140)
8	2022	15,943	153	86	(64)	(150)
9	2023	16,014	152	96	(64)	(160)
10-year Goal	2024	16,086	150	106	(65)	(170)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Kempner WSC's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	**Baseline**	-	52.00	0	0	0
1	2015	15,363	47.60	25	(62)	(86)
2	2016	15,450	43.20	50	(62)	(112)
3	2017	15,538	38.80	75	(62)	(137)
4	2018	15,625	34.40	100	(63)	(163)
5-year Goal	2019	15,713	30.00	126	(63)	(189)
6	2020	15,800	28.80	134	(63)	(197)
7	2021	15,871	27.60	141	(64)	(205)
8	2022	15,943	26.40	149	(64)	(213)
9	2023	16,014	25.20	157	(64)	(221)
10-year Goal	2024	16,086	24.00	164	(65)	(229)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 62 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	52.00	0
2015	15,363	63.00	(62)
2016	15,450	63.00	(62)
2017	15,538	63.00	(62)
2018	15,625	63.00	(63)
2019	15,713	63.00	(63)
2020	15,800	63.00	(63)
2021	15,871	63.00	(64)
2022	15,943	63.00	(64)
2023	16,014	63.00	(64)
2024	16,086	63.00	(65)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs

- The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 61 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(62)	(62)	61	18	0	18	(19)
2017	0	(62)	(62)	61	18	0	18	(19)
2018	0	(63)	(63)	62	22	0	22	(22)
2019	0	(63)	(63)	63	25	0	25	(26)
2020	0	(63)	(63)	63	33	0	33	(33)
2021	0	(64)	(64)	64	37	0	37	(37)
2022	0	(64)	(64)	65	42	0	42	(43)
2023	0	(64)	(64)	65	46	0	46	(44)
2024	0	(65)	(65)	66	51	0	51	(49)
2025	0	(65)	(65)	67	55	0	55	(53)
2026	0	(65)	(65)	67	60	0	60	(58)
2027	0	(65)	(65)	68	64	0	64	(62)
2028	0	(66)	(66)	69	69	0	69	(66)
2029	0	(66)	(66)	69	73	0	73	(70)
2030	0	(66)	(66)	70	78	0	78	(74)
2031	0	(67)	(67)	70	77	0	77	(74)
2032	0	(68)	(68)	71	77	0	77	(74)
2033	0	(68)	(68)	72	77	0	77	(73)
2034	0	(69)	(69)	72	76	0	76	(73)
2035	0	(70)	(70)	73	76	0	76	(72)
2036	0	(70)	(70)	74	75	0	75	(72)
2037	0	(71)	(71)	74	75	0	75	(72)
2038	0	(72)	(72)	75	74	0	74	(71)
2039	0	(72)	(72)	75	74	0	74	(71)
2040	0	(73)	(73)	76	73	0	73	(70)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(62)	(62)	11	18	0	18	(69)
2017	0	(62)	(62)	11	18	0	18	(70)
2018	0	(63)	(63)	11	22	0	22	(73)
2019	0	(63)	(63)	11	25	0	25	(77)
2020	0	(63)	(63)	11	33	0	33	(85)
2021	0	(64)	(64)	11	37	0	37	(90)
2022	0	(64)	(64)	11	42	0	42	(94)
2023	0	(64)	(64)	12	46	0	46	(98)
2024	0	(65)	(65)	12	51	0	51	(104)
2025	0	(65)	(65)	12	55	0	55	(108)
2026	0	(65)	(65)	12	60	0	60	(113)
2027	0	(65)	(65)	12	64	0	64	(118)
2028	0	(66)	(66)	12	69	0	69	(122)
2029	0	(66)	(66)	12	73	0	73	(127)
2030	0	(66)	(66)	12	78	0	78	(132)
2031	0	(67)	(67)	12	77	0	77	(132)
2032	0	(68)	(68)	13	77	0	77	(132)
2033	0	(68)	(68)	13	77	0	77	(132)
2034	0	(69)	(69)	13	76	0	76	(132)
2035	0	(70)	(70)	13	76	0	76	(132)
2036	0	(70)	(70)	13	75	0	75	(132)
2037	0	(71)	(71)	13	75	0	75	(133)
2038	0	(72)	(72)	13	74	0	74	(135)
2039	0	(72)	(72)	13	74	0	74	(134)
2040	0	(73)	(73)	13	73	0	73	(133)

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 16 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	(62)	(62)	16	18	0	18	(64)
2017	0	(62)	(62)	16	18	0	18	(64)
2018	0	(63)	(63)	16	22	0	22	(68)
2019	0	(63)	(63)	17	25	0	25	(72)
2020	0	(63)	(63)	17	33	0	33	(79)
2021	0	(64)	(64)	17	37	0	37	(84)
2022	0	(64)	(64)	17	42	0	42	(89)
2023	0	(64)	(64)	17	46	0	46	(93)
2024	0	(65)	(65)	17	51	0	51	(98)
2025	0	(65)	(65)	18	55	0	55	(103)
2026	0	(65)	(65)	18	60	0	60	(107)
2027	0	(65)	(65)	18	64	0	64	(112)
2028	0	(66)	(66)	18	69	0	69	(116)
2029	0	(66)	(66)	18	73	0	73	(121)
2030	0	(66)	(66)	18	78	0	78	(126)
2031	0	(67)	(67)	19	77	0	77	(125)
2032	0	(68)	(68)	19	77	0	77	(126)
2033	0	(68)	(68)	19	77	0	77	(126)
2034	0	(69)	(69)	19	76	0	76	(126)
2035	0	(70)	(70)	19	76	0	76	(126)
2036	0	(70)	(70)	19	75	0	75	(126)
2037	0	(71)	(71)	20	75	0	75	(126)
2038	0	(72)	(72)	20	74	0	74	(126)
2039	0	(72)	(72)	20	74	0	74	(126)
2040	0	(73)	(73)	20	73	0	73	(126)

4. Rain Barrels
   a. In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

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1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Lampasas' current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Lampasas' own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Lampasas' most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Lampasas with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	11.2	(76)	(65)	4	0	4	(68)
2016	11.3	(75)	(64)	5	0	5	(69)
2017	11.4	(75)	(63)	5	0	5	(68)
2018	11.5	(74)	(63)	6	0	6	(68)
2019	11.6	(74)	(62)	7	0	7	(69)
2020	11.7	(73)	(61)	9	0	9	(70)
2021	11.7	(74)	(62)	9	0	9	(71)
2022	11.8	(74)	(63)	9	0	9	(71)
2023	11.9	(75)	(63)	9	0	9	(72)
2024	12.0	(76)	(64)	9	0	9	(73)
2025	12.1	(77)	(65)	9	0	9	(74)
2026	12.2	(78)	(65)	9	0	9	(74)
2027	12.2	(78)	(66)	9	0	9	(75)
2028	12.3	(79)	(67)	9	0	9	(76)
2029	12.4	(80)	(67)	9	0	9	(76)
2030	12.5	(81)	(68)	9	0	9	(77)
2031	12.6	(81)	(69)	9	0	9	(78)
2032	12.6	(82)	(69)	9	0	9	(78)
2033	12.7	(82)	(70)	9	0	9	(79)
2034	12.7	(83)	(70)	9	0	9	(79)
2035	12.8	(84)	(71)	9	0	9	(80)
2036	12.9	(84)	(71)	9	0	9	(80)
2037	12.9	(85)	(72)	9	0	9	(81)
2038	13.0	(85)	(72)	9	0	9	(81)
2039	13.1	(86)	(73)	9	0	9	(82)
2040	13.1	(87)	(73)	9	0	9	(82)
2041	13.2	(87)	(74)	9	0	9	(83)
2042	13.3	(88)	(75)	9	0	9	(84)
2043	13.4	(88)	(75)	9	0	9	(84)
2044	13.4	(89)	(76)	9	0	9	(85)
2045	13.5	(90)	(76)	9	0	9	(85)
2046	13.6	(90)	(77)	9	0	9	(86)
2047	13.7	(91)	(77)	9	0	9	(86)
2048	13.7	(91)	(78)	9	0	9	(87)
2049	13.8	(92)	(78)	9	0	9	(87)
2050	13.9	(93)	(79)	9	0	9	(88)
2051	14.0	(93)	(79)	9	0	9	(88)
2052	14.0	(94)	(80)	9	0	9	(89)
2053	14.1	(94)	(80)	9	0	9	(89)
2054	14.2	(95)	(81)	9	0	9	(90)
2055	14.3	(95)	(81)	9	0	9	(90)
2056	14.4	(96)	(82)	9	0	9	(91)
2057	14.4	(96)	(82)	9	0	9	(91)
2058	14.5	(97)	(82)	9	0	9	(91)
2059	14.6	(97)	(83)	9	0	9	(92)
2060	14.7	(98)	(83)	9	0	9	(92)
2061	14.7	(99)	(84)	9	0	9	(93)
2062	14.8	(99)	(84)	9	0	9	(93)
2063	14.9	(99)	(85)	9	0	9	(94)
2064	15.0	(100)	(85)	9	0	9	(94)
2065	15.0	(100)	(85)	9	0	9	(94)
2066	15.1	(101)	(86)	9	0	9	(95)
2067	15.2	(101)	(86)	9	0	9	(95)
2068	15.2	(102)	(87)	9	0	9	(96)
2069	15.3	(102)	(87)	9	0	9	(96)
2070	15.4	(103)	(87)	9	0	9	(96)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Lampasas quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	178	0	0	0
1	2015	7,687	176	5	(65)	(70)
2	2016	7,630	174	10	(64)	(74)
3	2017	7,573	173	15	(63)	(78)
4	2018	7,516	171	20	(63)	(82)
5-year Goal	2019	7,459	169	25	(62)	(86)
6	2020	7,402	167	29	(61)	(90)
7	2021	7,480	165	34	(62)	(96)
8	2022	7,558	164	40	(63)	(102)
9	2023	7,636	162	45	(63)	(108)
10-year Goal	2024	7,714	160	51	(64)	(115)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Lampasas' most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	7.00	0	0	0
1	2015	7,687	6.98	0	(76)	(76)
2	2016	7,630	6.96	0	(75)	(75)
3	2017	7,573	6.94	0	(75)	(75)
4	2018	7,516	6.92	0	(74)	(74)
5-year Goal	2019	7,459	6.90	0	(74)	(74)
6	2020	7,402	6.82	0	(73)	(73)
7	2021	7,480	6.74	1	(74)	(74)
8	2022	7,558	6.66	1	(74)	(75)
9	2023	7,636	6.58	1	(75)	(76)
10-year Goal	2024	7,714	6.50	1	(76)	(77)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 76 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 15% increase in 2014
    b. Estimated customer demand reduction of 3.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014		0
2015	11.2	11.2
2016	11.3	11.3
2017	11.4	11.4
2018	11.5	11.5
2019	11.6	11.6
2020	11.7	11.7
2021	11.7	11.7
2022	11.8	11.8
2023	11.9	11.9
2024	12.0	12.0
2025	12.1	12.1
2026	12.2	12.2
2027	12.2	12.2
2028	12.3	12.3
2029	12.4	12.4
2030	12.5	12.5
2031	12.6	12.6
2032	12.6	12.6
2033	12.7	12.7
2034	12.7	12.7
2035	12.8	12.8
2036	12.9	12.9
2037	12.9	12.9
2038	13.0	13.0
2039	13.1	13.1
2040	13.1	13.1
2041	13.2	13.2
2042	13.3	13.3
2043	13.4	13.4
2044	13.4	13.4
2045	13.5	13.5
2046	13.6	13.6
2047	13.7	13.7
2048	13.7	13.7
2049	13.8	13.8
2050	13.9	13.9
2051	14.0	14.0
2052	14.0	14.0
2053	14.1	14.1
2054	14.2	14.2
2055	14.3	14.3
2056	14.4	14.4
2057	14.4	14.4
2058	14.5	14.5
2059	14.6	14.6
2060	14.7	14.7
2061	14.7	14.7
2062	14.8	14.8
2063	14.9	14.9
2064	15.0	15.0
2065	15.0	15.0
2066	15.1	15.1
2067	15.2	15.2
2068	15.2	15.2
2069	15.3	15.3
2070	15.4	15.4

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	7.00	0
2015	7,687	34.00	(76)
2016	7,630	34.00	(75)
2017	7,573	34.00	(75)
2018	7,516	34.00	(74)
2019	7,459	34.00	(74)
2020	7,402	34.00	(73)
2021	7,480	34.00	(74)
2022	7,558	34.00	(74)
2023	7,636	34.00	(75)
2024	7,714	34.00	(76)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 29 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	11	(75)	(64)	29	5	0	5	(40)
2017	11	(75)	(63)	29	5	0	5	(39)
2018	11	(74)	(63)	29	6	0	6	(39)
2019	12	(74)	(62)	29	7	0	7	(40)
2020	12	(73)	(61)	29	9	0	9	(41)
2021	12	(74)	(62)	30	9	0	9	(41)
2022	12	(74)	(63)	30	9	0	9	(42)
2023	12	(75)	(63)	30	9	0	9	(42)
2024	12	(76)	(64)	30	9	0	9	(43)
2025	12	(77)	(65)	31	9	0	9	(43)
2026	12	(78)	(65)	31	9	0	9	(44)
2027	12	(78)	(66)	31	9	0	9	(44)
2028	12	(79)	(67)	31	9	0	9	(45)
2029	12	(80)	(67)	31	9	0	9	(45)
2030	12	(81)	(68)	32	9	0	9	(46)
2031	13	(81)	(69)	32	9	0	9	(46)
2032	13	(82)	(69)	32	9	0	9	(46)
2033	13	(82)	(70)	32	9	0	9	(47)
2034	13	(83)	(70)	32	9	0	9	(47)
2035	13	(84)	(71)	32	9	0	9	(47)
2036	13	(84)	(71)	33	9	0	9	(48)
2037	13	(85)	(72)	33	9	0	9	(48)
2038	13	(85)	(72)	33	9	0	9	(49)
2039	13	(86)	(73)	33	9	0	9	(49)
2040	13	(87)	(73)	33	9	0	9	(49)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	11	(75)	(64)	5.1	5	0	5	(64)
2017	11	(75)	(63)	5.1	5	0	5	(63)
2018	11	(74)	(63)	5.1	6	0	6	(63)
2019	12	(74)	(62)	5.2	7	0	7	(64)
2020	12	(73)	(61)	5.2	9	0	9	(65)
2021	12	(74)	(62)	5.2	9	0	9	(65)
2022	12	(74)	(62)	5.3	9	0	9	(66)
2023	12	(75)	(63)	5.3	9	0	9	(67)
2024	12	(75)	(64)	5.4	9	0	9	(68)
2025	12	(77)	(65)	5.4	9	0	9	(68)
2026	12	(78)	(65)	5.4	9	0	9	(69)
2027	12	(78)	(66)	5.5	9	0	9	(70)
2028	12	(79)	(67)	5.5	9	0	9	(70)
2029	12	(80)	(67)	5.5	9	0	9	(71)
2030	12	(81)	(68)	5.6	9	0	9	(72)
2031	13	(81)	(69)	5.6	9	0	9	(72)
2032	13	(82)	(69)	5.6	9	0	9	(73)
2033	13	(82)	(70)	5.7	9	0	9	(73)
2034	13	(83)	(70)	5.7	9	0	9	(74)
2035	13	(84)	(71)	5.7	9	0	9	(74)
2036	13	(84)	(71)	5.8	9	0	9	(75)
2037	13	(85)	(72)	5.8	9	0	9	(75)
2038	13	(85)	(72)	5.8	9	0	9	(76)
2039	13	(86)	(73)	5.8	9	0	9	(76)
2040	13	(87)	(73)	5.9	9	0	9	(77)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Leander Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Leander's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Leander's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Leander's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in million gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Leander with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0.6	0	1	0	0	0	1
2016	66.3	0	66	0	0	0	66
2017	74.5	0	74	0	0	0	74
2018	82.6	0	83	0	0	0	83
2019	90.8	0	91	0	0	0	91
2020	99.0	0	99	0	0	0	99
2021	107.1	0	107	0	0	0	107
2022	115.3	0	115	0	0	0	115
2023	123.5	0	123	0	0	0	123
2024	131.7	0	132	0	0	0	132
2025	139.8	0	140	0	0	0	140
2026	148.0	0	148	0	0	0	148
2027	156.2	0	156	0	0	0	156
2028	164.3	0	164	0	0	0	164
2029	172.5	0	173	0	0	0	173
2030	180.7	0	181	0	0	0	181
2031	192.8	0	193	0	0	0	193
2032	204.9	0	205	0	0	0	205
2033	217.0	0	217	0	0	0	217
2034	229.2	0	229	0	0	0	229
2035	241.3	0	241	0	0	0	241
2036	253.4	0	253	0	0	0	253
2037	265.5	0	266	0	0	0	266
2038	277.6	0	278	0	0	0	278
2039	289.7	0	290	0	0	0	290
2040	301.9	0	302	0	0	0	302
2041	316.3	0	316	0	0	0	316
2042	330.7	0	331	0	0	0	331
2043	345.1	0	345	0	0	0	345
2044	359.5	0	360	0	0	0	360
2045	373.9	0	374	0	0	0	374
2046	388.4	0	388	0	0	0	388
2047	402.8	0	403	0	0	0	403
2048	417.2	0	417	0	0	0	417
2049	431.6	0	432	0	0	0	432
2050	446.0	0	446	0	0	0	446
2051	455.8	0	456	0	0	0	456
2052	465.6	0	466	0	0	0	466
2053	475.4	0	475	0	0	0	475
2054	485.2	0	485	0	0	0	485
2055	495.0	0	495	0	0	0	495
2056	504.8	0	505	0	0	0	505
2057	514.6	0	515	0	0	0	515
2058	524.4	0	524	0	0	0	524
2059	534.2	0	534	0	0	0	534
2060	544.0	0	544	0	0	0	544
2061	554.8	0	555	0	0	0	555
2062	565.6	0	566	0	0	0	566
2063	576.4	0	576	0	0	0	576
2064	587.2	0	587	0	0	0	587
2065	598.0	0	598	0	0	0	598
2066	608.8	0	609	0	0	0	609
2067	619.6	0	620	0	0	0	620
2068	630.4	0	630	0	0	0	630
2069	641.2	0	641	0	0	0	641
2070	652.0	0	652	0	0	0	652

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Leander's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	137	0	0	0
1	2015	38,321	137	0	1	1
2	2016	40,769	137	0	66	66
3	2017	43,217	137	0	74	74
4	2018	45,666	137	0	83	83
5-year Goal	2019	48,114	137	0	91	91
6	2020	50,562	136	15	99	84
7	2021	54,944	135	32	107	75
8	2022	59,325	135	52	115	63
9	2023	63,707	134	74	123	49
10-year Goal	2024	68,088	133	99	132	32

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Leander's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	22.00	0	0	0
1	2015	38,321	22.00	0	0	0
2	2016	40,769	22.00	0	0	0
3	2017	43,217	22.00	0	0	0
4	2018	45,666	22.00	0	0	0
5-year Goal	2019	48,114	22.00	0	0	0
6	2020	50,562	21.80	4	0	(4)
7	2021	54,944	21.60	8	0	(8)
8	2022	59,325	21.40	13	0	(13)
9	2023	63,707	21.20	19	0	(19)
10-year Goal	2024	68,088	21.00	25	0	(25)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 0 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5. **HE Toilet Replacement Program (ICI)**
    a. 31 toilets replaced
    b. Estimated 15,750 gallons per year per toilet (A&N Technical Services, 2005)
    c. 20-year useful life for fixture[17]

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Plumbing code and efficiency standards effectively make the savings permanent, as new high-efficiency models will replace these toilets.

6. **Low-flush Urinal Replacement Program (ICI)**
    a. 13 urinals replaced with 1/2 gallon-per-flush model
    b. Estimated 6,200 gallons per year per toilet (A&N Technical Services, 2005)
    c. 20-year useful life for fixture[18]

[18] Plumbing code and efficiency standards effectively make the savings permanent, as new high-efficiency models will replace these toilets.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterSmart Software	Low-Flush Urinal (ICI)	HE Toilets (ICI)	TOTAL SAVINGS
2012				0
2013		0.08	0.49	0.6
2014		0.08	0.49	0.6
2015		0.08	0.49	0.6
2016	66	0.08	0.49	66.3
2017	74	0.08	0.49	74.5
2018	82	0.08	0.49	82.6
2019	90	0.08	0.49	90.8
2020	98	0.08	0.49	99.0
2021	107	0.08	0.49	107.1
2022	115	0.08	0.49	115.3
2023	123	0.08	0.49	123.5
2024	131	0.08	0.49	131.7
2025	139	0.08	0.49	139.8
2026	147	0.08	0.49	148.0
2027	156	0.08	0.49	156.2
2028	164	0.08	0.49	164.3
2029	172	0.08	0.49	172.5
2030	180	0.08	0.49	180.7
2031	192	0.08	0.49	192.8
2032	204	0.08	0.49	204.9
2033	216	0.08	0.49	217.0
2034	229	0.08	0.49	229.2
2035	241	0.08	0.49	241.3
2036	253	0.08	0.49	253.4
2037	265	0.08	0.49	265.5
2038	277	0.08	0.49	277.6
2039	289	0.08	0.49	289.7
2040	301	0.08	0.49	301.9
2041	316	0.08	0.49	316.3
2042	330	0.08	0.49	330.7
2043	345	0.08	0.49	345.1
2044	359	0.08	0.49	359.5
2045	373	0.08	0.49	373.9
2046	388	0.08	0.49	388.4
2047	402	0.08	0.49	402.8
2048	417	0.08	0.49	417.2
2049	431	0.08	0.49	431.6
2050	445	0.08	0.49	446.0
2051	455	0.08	0.49	455.8
2052	465	0.08	0.49	465.6
2053	475	0.08	0.49	475.4
2054	485	0.08	0.49	485.2
2055	494	0.08	0.49	495.0
2056	504	0.08	0.49	504.8
2057	514	0.08	0.49	514.6
2058	524	0.08	0.49	524.4
2059	534	0.08	0.49	534.2
2060	543	0.08	0.49	544.0
2061	554	0.08	0.49	554.8
2062	565	0.08	0.49	565.6
2063	576	0.08	0.49	576.4
2064	587	0.08	0.49	587.2
2065	597	0.08	0.49	598.0
2066	608	0.08	0.49	608.8
2067	619	0.08	0.49	619.6
2068	630	0.08	0.49	630.4
2069	641	0.08	0.49	641.2
2070	651	0.08	0.49	652.0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	20.00	0
2015	37,889	20.00	0
2016	38,525	20.00	0
2017	39,162	20.00	0
2018	39,798	20.00	0
2019	40,435	20.00	0
2020	41,071	20.00	0
2021	43,919	20.00	0
2022	46,767	20.00	0
2023	49,615	20.00	0
2024	52,463	20.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region G savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 100 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	66	0	66	100	0	0	0	166
2017	74	0	74	112	0	0	0	186
2018	83	0	83	124	0	0	0	207
2019	91	0	91	137	0	0	0	228
2020	99	0	99	149	0	0	0	248
2021	107	0	107	162	0	0	0	269
2022	115	0	115	174	0	0	0	289
2023	123	0	123	186	0	0	0	310
2024	132	0	132	199	0	0	0	330
2025	140	0	140	211	0	0	0	351
2026	148	0	148	223	0	0	0	371
2027	156	0	156	236	0	0	0	392
2028	164	0	164	248	0	0	0	413
2029	173	0	173	261	0	0	0	433
2030	181	0	181	273	0	0	0	454
2031	193	0	193	291	0	0	0	484
2032	205	0	205	310	0	0	0	515
2033	217	0	217	328	0	0	0	545
2034	229	0	229	347	0	0	0	576
2035	241	0	241	365	0	0	0	606
2036	253	0	253	383	0	0	0	637
2037	266	0	266	402	0	0	0	667
2038	278	0	278	420	0	0	0	698
2039	290	0	290	438	0	0	0	728
2040	302	0	302	457	0	0	0	759

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	66	0	66	18	0	0	0	84
2017	74	0	74	20	0	0	0	94
2018	83	0	83	22	0	0	0	105
2019	91	0	91	24	0	0	0	115
2020	99	0	99	26	0	0	0	125
2021	107	0	107	29	0	0	0	136
2022	115	0	115	31	0	0	0	146
2023	123	0	123	33	0	0	0	156
2024	132	0	132	35	0	0	0	167
2025	140	0	140	37	0	0	0	177
2026	148	0	148	40	0	0	0	188
2027	156	0	156	42	0	0	0	198
2028	164	0	164	44	0	0	0	208
2029	173	0	173	46	0	0	0	219
2030	181	0	181	48	0	0	0	229
2031	193	0	193	52	0	0	0	244
2032	205	0	205	55	0	0	0	260
2033	217	0	217	58	0	0	0	275
2034	229	0	229	61	0	0	0	290
2035	241	0	241	65	0	0	0	306
2036	253	0	253	68	0	0	0	321
2037	266	0	266	71	0	0	0	337
2038	278	0	278	74	0	0	0	352
2039	290	0	290	77	0	0	0	367
2040	302	0	302	81	0	0	0	383

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 26 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[20] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[20] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	66	0	66	26	0	0	0	93
2017	74	0	74	30	0	0	0	104
2018	83	0	83	33	0	0	0	115
2019	91	0	91	36	0	0	0	127
2020	99	0	99	39	0	0	0	138
2021	107	0	107	43	0	0	0	150
2022	115	0	115	46	0	0	0	161
2023	123	0	123	49	0	0	0	173
2024	132	0	132	52	0	0	0	184
2025	140	0	140	56	0	0	0	196
2026	148	0	148	59	0	0	0	207
2027	156	0	156	62	0	0	0	218
2028	164	0	164	66	0	0	0	230
2029	173	0	173	69	0	0	0	241
2030	181	0	181	72	0	0	0	253
2031	193	0	193	77	0	0	0	270
2032	205	0	205	82	0	0	0	287
2033	217	0	217	87	0	0	0	304
2034	229	0	229	91	0	0	0	321
2035	241	0	241	96	0	0	0	338
2036	253	0	253	101	0	0	0	355
2037	266	0	266	106	0	0	0	371
2038	278	0	278	111	0	0	0	388
2039	290	0	290	116	0	0	0	405
2040	302	0	302	121	0	0	0	422

4. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Possum Kingdom WSC Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Possum Kingdom WSC's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Possum Kingdom WSC's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Possum Kingdom WSC's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in million gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Possum Kingdom WSC with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	9.3	17	26	8	0	8	19
2016	9.4	19	29	10	0	10	19
2017	9.4	22	31	10	0	10	22
2018	9.5	24	34	12	0	12	22
2019	9.6	27	36	13	0	13	23
2020	9.6	29	39	17	0	17	22
2021	9.7	30	39	20	0	20	20
2022	9.7	30	40	22	0	22	18
2023	9.8	30	40	24	0	24	15
2024	9.9	30	40	27	0	27	13
2025	9.9	30	40	29	0	29	11
2026	10.0	31	41	32	0	32	9
2027	10.0	31	41	34	0	34	7
2028	10.1	31	41	36	0	36	5
2029	10.2	31	41	39	0	39	3
2030	10.2	31	42	41	0	41	1
2031	10.3	32	42	43	0	43	(2)
2032	10.3	32	42	46	0	46	(4)
2033	10.3	32	42	48	0	48	(6)
2034	10.4	32	43	50	0	50	(8)
2035	10.4	32	43	53	0	53	(10)
2036	10.5	33	43	55	0	55	(12)
2037	10.5	33	43	57	0	57	(14)
2038	10.5	33	44	60	0	60	(16)
2039	10.6	33	44	62	0	62	(18)
2040	10.6	34	44	65	0	65	(20)
2041	10.7	34	44	67	0	67	(22)
2042	10.7	34	45	69	0	69	(25)
2043	10.7	34	45	72	0	72	(27)
2044	10.8	35	45	74	0	74	(29)
2045	10.8	35	46	76	0	76	(31)
2046	10.9	35	46	79	0	79	(33)
2047	10.9	35	46	81	0	81	(35)
2048	10.9	36	47	84	0	84	(37)
2049	11.0	36	47	86	0	86	(39)
2050	11.0	36	47	88	0	88	(41)
2051	11.0	36	47	91	0	91	(43)
2052	11.1	37	48	93	0	93	(45)
2053	11.1	37	48	95	0	95	(47)
2054	11.1	37	48	98	0	98	(49)
2055	11.2	38	49	100	0	100	(51)
2056	11.2	38	49	102	0	102	(53)
2057	11.2	38	49	105	0	105	(55)
2058	11.3	38	50	107	0	107	(57)
2059	11.3	39	50	109	0	109	(59)
2060	11.3	39	50	111	0	111	(61)
2061	11.4	39	51	114	0	114	(63)
2062	11.4	40	51	116	0	116	(65)
2063	11.4	40	51	118	0	118	(67)
2064	11.4	40	52	120	0	120	(69)
2065	11.5	40	52	123	0	123	(71)
2066	11.5	41	52	125	0	125	(73)
2067	11.5	41	52	127	0	127	(75)
2068	11.5	41	53	129	0	129	(76)
2069	11.6	42	53	131	0	131	(78)
2070	11.6	42	53	134	0	134	(80)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Possum Kingdom WSC's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	300	0	0	0
1	2015	2,433	300	0	26	26
2	2016	2,795	300	0	29	29
3	2017	3,156	300	0	31	31
4	2018	3,518	300	0	34	34
5-year Goal	2019	3,879	300	0	36	36
6	2020	4,241	300	0	39	39
7	2021	4,270	300	0	39	39
8	2022	4,299	300	0	40	40
9	2023	4,328	300	0	40	40
10-year Goal	2024	4,357	300	0	40	40

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Possum Kingdom WSC's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	45.00	0	0	0
1	2015	2,433	45.00	0	17	17
2	2016	2,795	45.00	0	19	19
3	2017	3,156	45.00	0	22	22
4	2018	3,518	45.00	0	24	24
5-year Goal	2019	3,879	45.00	0	27	27
6	2020	4,241	43.80	2	29	28
7	2021	4,270	42.60	4	30	26
8	2022	4,299	41.40	6	30	24
9	2023	4,328	40.20	8	30	22
10-year Goal	2024	4,357	39.00	10	30	21

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 17 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 13.5% increase in 2014
        ii. 5.0% increase in 2015
    b. Estimated customer demand reduction of 3.64%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI)**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2012		0
2013		0
2014	6.8	6.8
2015	9.3	9.3
2016	9.4	9.4
2017	9.4	9.4
2018	9.5	9.5
2019	9.6	9.6
2020	9.6	9.6
2021	9.7	9.7
2022	9.7	9.7
2023	9.8	9.8
2024	9.9	9.9
2025	9.9	9.9
2026	10.0	10.0
2027	10.0	10.0
2028	10.1	10.1
2029	10.2	10.2
2030	10.2	10.2
2031	10.3	10.3
2032	10.3	10.3
2033	10.3	10.3
2034	10.4	10.4
2035	10.4	10.4
2036	10.5	10.5
2037	10.5	10.5
2038	10.5	10.5
2039	10.6	10.6
2040	10.6	10.6
2041	10.7	10.7
2042	10.7	10.7
2043	10.7	10.7
2044	10.8	10.8
2045	10.8	10.8
2046	10.9	10.9
2047	10.9	10.9
2048	10.9	10.9
2049	11.0	11.0
2050	11.0	11.0
2051	11.0	11.0
2052	11.1	11.1
2053	11.1	11.1
2054	11.1	11.1
2055	11.2	11.2
2056	11.2	11.2
2057	11.2	11.2
2058	11.3	11.3
2059	11.3	11.3
2060	11.3	11.3
2061	11.4	11.4
2062	11.4	11.4
2063	11.4	11.4
2064	11.4	11.4
2065	11.5	11.5
2066	11.5	11.5
2067	11.5	11.5
2068	11.5	11.5
2069	11.6	11.6
2070	11.6	11.6

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	45.00	0
2015	2,433	26.00	17
2016	2,795	26.00	19
2017	3,156	26.00	22
2018	3,518	26.00	24
2019	3,879	26.00	27
2020	4,241	26.00	29
2021	4,270	26.00	30
2022	4,299	26.00	30
2023	4,328	26.00	30
2024	4,357	26.00	30

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region G savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 20 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG)

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	9	19	29	20	10	0	10	39
2017	9	22	31	20	10	0	10	41
2018	10	24	34	20	12	0	12	42
2019	10	27	36	20	13	0	13	43
2020	10	29	39	20	17	0	17	42
2021	10	30	39	20	20	0	20	40
2022	10	30	40	20	22	0	22	38
2023	10	30	40	20	24	0	24	36
2024	10	30	40	21	27	0	27	34
2025	10	30	40	21	29	0	29	32
2026	10	31	41	21	32	0	32	30
2027	10	31	41	21	34	0	34	28
2028	10	31	41	21	36	0	36	26
2029	10	31	41	21	39	0	39	24
2030	10	31	42	21	41	0	41	22
2031	10	32	42	21	43	0	43	20
2032	10	32	42	21	46	0	46	18
2033	10	32	42	21	48	0	48	16
2034	10	32	43	22	50	0	50	14
2035	10	32	43	22	53	0	53	12
2036	10	33	43	22	55	0	55	10
2037	11	33	43	22	57	0	57	8
2038	11	33	44	22	60	0	60	6
2039	11	33	44	22	62	0	62	4
2040	11	34	44	22	65	0	65	2

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	9	19	29	3	10	0	10	23
2017	9	22	31	3	10	0	10	28
2018	10	24	34	3	12	0	12	26
2019	10	27	36	4	13	0	13	27
2020	10	29	39	4	17	0	17	25
2021	10	30	39	4	20	0	20	23
2022	10	30	40	4	22	0	22	21
2023	10	30	40	4	24	0	24	19
2024	10	30	40	4	27	0	27	17
2025	10	30	40	4	29	0	29	15
2026	10	31	41	4	32	0	32	13
2027	10	31	41	4	34	0	34	11
2028	10	31	41	4	36	0	36	9
2029	10	31	41	4	39	0	39	6
2030	10	31	42	4	41	0	41	4
2031	10	32	42	4	43	0	43	2
2032	10	32	42	4	46	0	46	0
2033	10	32	42	4	48	0	48	(2)
2034	10	32	43	4	50	0	50	(4)
2035	10	32	43	4	53	0	53	(6)
2036	10	33	43	4	55	0	55	(8)
2037	11	33	43	4	57	0	57	(10)
2038	11	33	44	4	60	0	60	(12)
2039	11	33	44	4	62	0	62	(14)
2040	11	34	44	4	65	0	65	(15)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
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1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Robinson's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Robinson's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Robinson's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Robinson with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	14.5	(4)	10	13	0	13	(3)
2016	29.6	(4)	25	16	0	16	9
2017	30.1	(4)	26	16	0	16	9
2018	30.7	(4)	26	20	0	20	6
2019	31.2	(5)	27	23	0	23	4
2020	31.8	(5)	27	30	0	30	(3)
2021	32.3	(5)	28	37	0	37	(9)
2022	32.9	(5)	28	44	0	44	(16)
2023	33.4	(5)	29	52	0	52	(23)
2024	33.9	(5)	29	59	0	59	(30)
2025	34.5	(5)	29	66	0	66	(37)
2026	35.0	(5)	30	74	0	74	(44)
2027	35.6	(5)	30	81	0	81	(51)
2028	36.1	(5)	31	88	0	88	(58)
2029	36.7	(5)	31	96	0	96	(64)
2030	37.2	(6)	32	103	0	103	(71)
2031	37.7	(6)	32	109	0	109	(77)
2032	38.2	(6)	32	115	0	115	(83)
2033	38.7	(6)	33	122	0	122	(89)
2034	39.2	(6)	33	128	0	128	(95)
2035	39.7	(6)	34	134	0	134	(100)
2036	40.1	(6)	34	140	0	140	(106)
2037	40.6	(6)	35	147	0	147	(112)
2038	41.1	(6)	35	153	0	153	(118)
2039	41.6	(6)	35	159	0	159	(124)
2040	42.1	(6)	36	165	0	165	(129)
2041	42.6	(6)	36	167	0	167	(130)
2042	43.1	(6)	37	168	0	168	(131)
2043	43.6	(7)	37	169	0	169	(132)
2044	44.1	(7)	37	171	0	171	(133)
2045	44.6	(7)	38	172	0	172	(134)
2046	45.1	(7)	38	173	0	173	(135)
2047	45.6	(7)	39	175	0	175	(136)
2048	46.2	(7)	39	176	0	176	(137)
2049	46.7	(7)	40	178	0	178	(138)
2050	47.2	(7)	40	179	0	179	(139)
2051	47.7	(7)	40	181	0	181	(140)
2052	48.2	(7)	41	183	0	183	(142)
2053	48.7	(7)	41	184	0	184	(143)
2054	49.3	(7)	42	186	0	186	(144)
2055	49.8	(8)	42	188	0	188	(146)
2056	50.3	(8)	43	190	0	190	(147)
2057	50.8	(8)	43	192	0	192	(149)
2058	51.4	(8)	44	194	0	194	(150)
2059	51.9	(8)	44	195	0	195	(151)
2060	52.4	(8)	44	197	0	197	(153)
2061	52.9	(8)	45	199	0	199	(154)
2062	53.4	(8)	45	201	0	201	(156)
2063	54.0	(8)	46	203	0	203	(157)
2064	54.5	(8)	46	205	0	205	(159)
2065	55.0	(8)	47	207	0	207	(160)
2066	55.5	(8)	47	209	0	209	(161)
2067	56.0	(9)	48	210	0	210	(163)
2068	56.6	(9)	48	212	0	212	(164)
2069	57.1	(9)	48	214	0	214	(166)
2070	57.6	(9)	49	216	0	216	(167)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Robinson's quantified savings from its implemented activities compare with 5- and 10- year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	140	0	0	0
1	2015	11,484	138	10	10	0
2	2016	11,720	135	21	25	5
3	2017	11,956	133	31	26	(6)
4	2018	12,193	130	43	26	(16)
5-year Goal	2019	12,429	128	54	27	(28)
6	2020	12,665	127	58	27	(31)
7	2021	12,914	127	62	28	(35)
8	2022	13,163	126	66	28	(38)
9	2023	13,413	126	70	29	(42)
10-year Goal	2024	13,662	125	75	29	(46)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Robinson's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	8.00	0	0	0
1	2015	11,484	7.80	1	(4)	(5)
2	2016	11,720	7.60	2	(4)	(6)
3	2017	11,956	7.40	3	(4)	(7)
4	2018	12,193	7.20	4	(4)	(8)
5-year Goal	2019	12,429	7.00	5	(5)	(9)
6	2020	12,665	7.00	5	(5)	(9)
7	2021	12,914	7.00	5	(5)	(9)
8	2022	13,163	7.00	5	(5)	(10)
9	2023	13,413	7.00	5	(5)	(10)
10-year Goal	2024	13,662	7.00	5	(5)	(10)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 4 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 10.0% increase in 2015
        ii. 10.0% increase in 2016
    b. Estimated customer demand reduction of 4.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0.0
2010		0.0
2011		0.0
2012		0.0
2013		0.0
2014		0.0
2015	14.5	14.5
2016	29.6	29.6
2017	30.1	30.1
2018	30.7	30.7
2019	31.2	31.2
2020	31.8	31.8
2021	32.3	32.3
2022	32.9	32.9
2023	33.4	33.4
2024	33.9	33.9
2025	34.5	34.5
2026	35.0	35.0
2027	35.6	35.6
2028	36.1	36.1
2029	36.7	36.7
2030	37.2	37.2
2031	37.7	37.7
2032	38.2	38.2
2033	38.7	38.7
2034	39.2	39.2
2035	39.7	39.7
2036	40.1	40.1
2037	40.6	40.6
2038	41.1	41.1
2039	41.6	41.6
2040	42.1	42.1
2041	42.6	42.6
2042	43.1	43.1
2043	43.6	43.6
2044	44.1	44.1
2045	44.6	44.6
2046	45.1	45.1
2047	45.6	45.6
2048	46.2	46.2
2049	46.7	46.7
2050	47.2	47.2
2051	47.7	47.7
2052	48.2	48.2
2053	48.7	48.7
2054	49.3	49.3
2055	49.8	49.8
2056	50.3	50.3
2057	50.8	50.8
2058	51.4	51.4
2059	51.9	51.9
2060	52.4	52.4
2061	52.9	52.9
2062	53.4	53.4
2063	54.0	54.0
2064	54.5	54.5
2065	55.0	55.0
2066	55.5	55.5
2067	56.0	56.0
2068	56.6	56.6
2069	57.1	57.1
2070	57.6	57.6

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	8.00	0
2015	11,484	9.00	(4)
2016	11,720	9.00	(4)
2017	11,956	9.00	(4)
2018	12,193	9.00	(4)
2019	12,429	9.00	(5)
2020	12,665	9.00	(5)
2021	12,914	9.00	(5)
2022	13,163	9.00	(5)
2023	13,413	9.00	(5)
2024	13,662	9.00	(5)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 8.42% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
    b. Savings could be 62 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	30	(4)	25	62	16	0	16	71
2017	30	(4)	26	63	16	0	16	73
2018	31	(4)	26	65	20	0	20	71
2019	31	(5)	27	66	23	0	23	69
2020	32	(5)	27	67	30	0	30	64
2021	32	(5)	28	68	37	0	37	59
2022	33	(5)	28	69	44	0	44	53
2023	33	(5)	29	70	52	0	52	47
2024	34	(5)	29	71	59	0	59	41
2025	34	(5)	29	73	66	0	66	36
2026	35	(5)	30	74	74	0	74	30
2027	36	(5)	30	75	81	0	81	24
2028	36	(5)	31	76	88	0	88	19
2029	37	(5)	31	77	96	0	96	13
2030	37	(6)	32	78	103	0	103	7
2031	38	(6)	32	79	109	0	109	2
2032	38	(6)	32	80	115	0	115	(3)
2033	39	(6)	33	81	122	0	122	(7)
2034	39	(6)	33	82	128	0	128	(12)
2035	40	(6)	34	83	134	0	134	(17)
2036	40	(6)	34	85	140	0	140	(22)
2037	41	(6)	35	86	147	0	147	(26)
2038	41	(6)	35	87	153	0	153	(31)
2039	42	(6)	35	88	159	0	159	(36)
2040	42	(6)	36	89	165	0	165	(41)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	30	(4)	25	10	16	0	16	19
2017	30	(4)	26	10	16	0	16	19
2018	31	(4)	26	10	20	0	20	17
2019	31	(5)	27	10	23	0	23	14
2020	32	(5)	27	11	30	0	30	8
2021	32	(5)	28	11	37	0	37	1
2022	33	(5)	28	11	44	0	44	(5)
2023	33	(5)	29	11	52	0	52	(12)
2024	34	(5)	29	11	59	0	59	(19)
2025	34	(5)	29	12	66	0	66	(25)
2026	35	(5)	30	12	74	0	74	(32)
2027	36	(5)	30	12	81	0	81	(39)
2028	36	(5)	31	12	88	0	88	(45)
2029	37	(5)	31	12	96	0	96	(52)
2030	37	(6)	32	12	103	0	103	(59)
2031	38	(6)	32	13	109	0	109	(64)
2032	38	(6)	32	13	115	0	115	(70)
2033	39	(6)	33	13	122	0	122	(76)
2034	39	(6)	33	13	128	0	128	(81)
2035	40	(6)	34	13	134	0	134	(87)
2036	40	(6)	34	13	140	0	140	(93)
2037	41	(6)	35	14	147	0	147	(98)
2038	41	(6)	35	14	153	0	153	(104)
2039	42	(6)	35	14	159	0	159	(110)
2040	42	(6)	36	14	165	0	165	(115)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Round Rock Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Round Rock's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Round Rock's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Round Rock's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Round Rock with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	245	154	399	77	0	77	322
2016	293	160	454	97	0	97	357
2017	297	167	464	97	0	97	368
2018	304	173	477	116	0	116	361
2019	310	179	489	135	0	135	354
2020	316	186	502	174	0	174	328
2021	323	190	513	161	0	161	353
2022	330	195	525	147	0	147	377
2023	336	199	536	134	0	134	401
2024	343	204	546	121	0	121	425
2025	348	208	557	108	0	108	449
2026	355	213	567	95	0	95	473
2027	361	217	579	82	0	82	497
2028	368	222	590	69	0	69	522
2029	375	226	602	56	0	56	546
2030	382	231	613	42	0	42	571
2031	391	235	626	73	0	73	553
2032	400	239	639	104	0	104	535
2033	408	243	651	134	0	134	517
2034	417	247	664	165	0	165	499
2035	426	251	677	196	0	196	482
2036	435	255	690	226	0	226	464
2037	443	259	703	257	0	257	446
2038	452	263	715	287	0	287	428
2039	461	267	728	318	0	318	410
2040	470	271	741	349	0	349	392
2041	479	277	757	406	0	406	350
2042	489	283	772	464	0	464	309
2043	498	289	788	521	0	521	267
2044	508	295	803	579	0	579	225
2045	518	301	819	636	0	636	183
2046	527	307	834	693	0	693	141
2047	537	313	850	751	0	751	99
2048	546	319	865	808	0	808	57
2049	556	325	881	866	0	866	15
2050	565	331	896	923	0	923	(27)
2051	576	338	914	1,004	0	1,004	(90)
2052	587	345	933	1,085	0	1,085	(153)
2053	598	353	951	1,166	0	1,166	(216)
2054	609	360	969	1,247	0	1,247	(278)
2055	620	367	987	1,328	0	1,328	(341)
2056	631	374	1,005	1,409	0	1,409	(404)
2057	642	382	1,024	1,490	0	1,490	(467)
2058	653	389	1,042	1,571	0	1,571	(530)
2059	664	396	1,060	1,652	0	1,652	(592)
2060	675	403	1,078	1,733	0	1,733	(655)
2061	686	410	1,096	1,836	0	1,836	(739)
2062	698	417	1,115	1,938	0	1,938	(823)
2063	709	424	1,133	2,040	0	2,040	(907)
2064	720	431	1,151	2,142	0	2,142	(991)
2065	732	438	1,169	2,245	0	2,245	(1,075)
2066	743	444	1,187	2,347	0	2,347	(1,159)
2067	754	451	1,206	2,449	0	2,449	(1,243)
2068	766	458	1,224	2,551	0	2,551	(1,327)
2069	777	465	1,242	2,654	0	2,654	(1,411)
2070	789	472	1,260	2,756	0	2,756	(1,495)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Round Rock's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	150	0	0	0
1	2015	105,405	148	77	399	322
2	2016	109,780	146	160	454	293
3	2017	114,155	144	250	464	214
4	2018	118,529	142	346	477	131
5-year Goal	2019	122,904	140	449	489	40
6	2020	127,279	140	465	502	37
7	2021	130,373	140	476	513	38
8	2022	133,467	140	487	525	38
9	2023	136,560	140	498	536	37
10-year Goal	2024	139,654	140	510	546	37

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Round Rock's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	16.00	0	0	0
1	2015	105,405	15.80	8	154	146
2	2016	109,780	15.60	16	160	144
3	2017	114,155	15.40	25	167	142
4	2018	118,529	15.20	35	173	138
5-year Goal	2019	122,904	15.00	45	179	135
6	2020	127,279	14.60	65	186	121
7	2021	130,373	14.20	86	190	105
8	2022	133,467	13.80	107	195	88
9	2023	136,560	13.40	130	199	70
10-year Goal	2024	139,654	13.00	153	204	51

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 154 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 3.0% increase in 2015
        ii. 3.0% increase in 2016
    b. Estimated customer demand reduction of 1.2%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Conservation Pricing**
    a. Tiered rate structure in place saves approximately 2.5% of total demand
    b. Savings is cumulative and based on more than one source[19] (U.S. EPA, 1998; TWDB, 2013)

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.
[19] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

6. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

7. **Outdoor Landscape Evaluations (SF)**
    a. 643 outdoor evaluations performed from 2009 – 2015
    b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005)
    c. Assumed 65% savings from typical indoor and outdoor survey when only outdoor watering is evaluated (Whitcomb, 2000)
    d. Approximately 22 gallons per day
    e. Greater savings during peak periods
    f. Lesser savings during off-peak periods
    g. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

8. **Rain Barrels**
    a. In Region G, estimated savings of 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002)
    b. Capacity rebated varied by year and was provided by staff
    c. Estimated 10-year useful life for most barrels and systems

9. **High Efficiency (HE) Toilet Replacement Program (SF)**
    a. 1,600 toilets replaced from 2010 – 2015
    b. Estimated 10,390 gallons per year per toilet (A&N Technical Services, 2005)
    c. Rebates per year provided by staff
    d. Savings carry on indefinitely because replacement toilet will be as efficient

10. **HE Toilet Replacement Program (MF)**
    a. 17 toilets replaced from 2014 – 2015
    b. Estimated 15,756 gallons per year per toilet (A&N Technical Services, 2005)
    c. Rebates per year provided by staff
    d. 20-year useful life for fixture[20]

[20] Plumbing code and efficiency standards effectively make the savings permanent, as new high-efficiency models will replace these toilets.

11. **Tank-type HE Toilet Replacement Program (ICI)**
    a. 13 toilets replaced in 2014
    b. Estimated 13,000 gallons per year per toilet (A&N Technical Services, 2005)
    c. Rebates per year provided by staff
    d. 20-year useful life for fixture[21]

12. **Clotheswasher Replacement Program (SF)**
    a. 272 rebates issued from 2012 – 2015
    b. Rebates per year provided by staff
    c. Estimated 7,030 gallons per year per washer (A&N, Technical Services 2005; THELMA, 1997)
    d. 11-year useful life

13. **Large Landscape Irrigation System Audits**
    a. 33 audits performed from 2009 – 2015
    b. Number of audits per year provided by staff
    c. Estimated savings of 164,500 gallons per year per audit
    d. Used EPA WaterSense Water Budget Tool Formula[22] with 87,120 sq. ft. as basis for large landscape hydrozone
    e. Savings assumed to last 5 years with no decay rate

14. **Irrigation Controller Rebate (SF)**
    a. Estimated savings of 11,340 gallons per year per controller
    b. Used EPA WaterSense Water Budget Tool Formula[23] with 4,000 sq. ft. as basis for landscape hydrozone
    c. Number of rebates per year provided by staff
        i. Savings assumed to last 10 years with no decay rate

[21] Plumbing code and efficiency standards effectively make the savings permanent, as new high-efficiency models will replace these toilets.
[22] $LWR_H = RTM\ [(ET_o \times K_L) - R_a] \times A \times C_u$
[23] $LWR_H = RTM\ [(ET_o \times K_L) - R_a] \times A \times C_u$

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Rate Increases	Conservation Pricing	Rain Barrels	Tank-type HE Toilets (ICI)	Valve-type HE Toilets (ICI)	Pre-rinse Spray Valves (ICI)	Outdoor Landscape Evaluations (SF)	HE Toilets (SF)	HE Toilets (MF)	HE Clothes Washer Rebates (SF)	Large Landscape Irrigation Evaluations	Irrigation Controller Rebates (SF)	TOTAL SAVINGS
2009		148					0.4				1		149
2010		152					1.1	4.1			2.1	0.1	160
2011		157					2.0	5.7			2.4	0.1	167
2012		162	0.3				2.5	9.0			4.5	0.1	178
2013		166	1.0				3.4	12.0		0.8	5.6	0.1	189
2014		171	2.2	0.2			2.2	14.7	0.1	1.5	4.5	0.1	197
2015	42	176	2.6	0.2			2.1	16.6	0.2	1.9	3.6	0.3	245
2016	87	180	2.6	0.2			1.3	16.6	0.2	1.9	3.3	0.3	293
2017	89	185	2.6	0.2			0.7	16.6	0.2	1.9	1.2	0.3	297
2018	91	190	2.6	0.2			1.0	16.6	0.2	1.9	0.2	0.3	304
2019	93	194	2.6	0.2			0.1	16.6	0.2	1.9	0.2	0.3	310
2020	95	199	2.6	0.2				16.6	0.2	1.9		0.3	316
2021	98	204	2.6	0.2				16.6	0.2	1.9		0.3	323
2022	100	208	2.6	0.2				16.6	0.2	1.9		0.3	330
2023	102	213	2.3	0.2				16.6	0.2	1.9		0.2	336
2024	104	217	1.6	0.2				16.6	0.2	1.9		0.2	343
2025	107	222	0.4	0.2				16.6	0.2	1.9		0.2	348
2026	109	227		0.2				16.6	0.2	1.9			355
2027	111	231		0.2				16.6	0.2	1.9			361
2028	113	236		0.2				16.6	0.2	1.9			368
2029	116	241		0.2				16.6	0.2	1.9			375
2030	118	245		0.2				16.6	0.2	1.9			382
2031	121	251		0.2				16.6	0.2	1.9			391
2032	123	257		0.2				16.6	0.2	1.9			400
2033	126	263		0.2				16.6	0.2	1.9			408
2034	129	269		0.2				16.6	0.2	1.9			417
2035	132	275		0.2				16.6	0.2	1.9			426
2036	135	281		0.2				16.6	0.2	1.9			435
2037	138	287		0.2				16.6	0.2	1.9			443
2038	141	293		0.2				16.6	0.2	1.9			452
2039	143	299		0.2				16.6	0.2	1.9			461
2040	146	305		0.2				16.6	0.2	1.9			470
2041	149	311		0.2				16.6	0.2	1.9			479
2042	152	318		0.2				16.6	0.2	1.9			489
2043	156	324		0.2				16.6	0.2	1.9			498
2044	159	330		0.2				16.6	0.2	1.9			508
2045	162	337		0.2				16.6	0.2	1.9			518
2046	165	343		0.2				16.6	0.2	1.9			527
2047	168	350		0.2				16.6	0.2	1.9			537
2048	171	356		0.2				16.6	0.2	1.9			546
2049	174	363		0.2				16.6	0.2	1.9			556
2050	177	369		0.2				16.6	0.2	1.9			565
2051	181	377		0.2				16.6	0.2	1.9			576
2052	184	384		0.2				16.6	0.2	1.9			587
2053	188	391		0.2				16.6	0.2	1.9			598
2054	191	399		0.2				16.6	0.2	1.9			609
2055	195	406		0.2				16.6	0.2	1.9			620
2056	199	414		0.2				16.6	0.2	1.9			631
2057	202	421		0.2				16.6	0.2	1.9			642
2058	206	428		0.2				16.6	0.2	1.9			653
2059	209	436		0.2				16.6	0.2	1.9			664
2060	213	443		0.2				16.6	0.2	1.9			675
2061	216	451		0.2				16.6	0.2	1.9			686
2062	220	459		0.2				16.6	0.2	1.9			698
2063	224	466		0.2				16.6	0.2	1.9			709
2064	228	474		0.2				16.6	0.2	1.9			720
2065	231	482		0.2				16.6	0.2	1.9			732
2066	235	489		0.2				16.6	0.2	1.9			743
2067	239	497		0.2				16.6	0.2	1.9			754
2068	242	505		0.2				16.6	0.2	1.9			766
2069	246	512		0.2				16.6	0.2	1.9			777
2070	250	520		0.2				16.6	0.2	1.9			789

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	16.00	0
2015	105,405	12.00	154
2016	109,780	12.00	160
2017	114,155	12.00	167
2018	118,529	12.00	173
2019	122,904	12.00	179
2020	127,279	12.00	186
2021	130,373	12.00	190
2022	133,467	12.00	195
2023	136,560	12.00	199
2024	139,654	12.00	204

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 8% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
    b. Savings could be 577 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	293	160	454	577	97	0	97	934
2017	297	167	464	592	97	0	97	960
2018	304	173	477	607	116	0	116	968
2019	310	179	489	622	135	0	135	976
2020	316	186	502	636	174	0	174	965
2021	323	190	513	651	161	0	161	1,004
2022	330	195	525	666	147	0	147	1,044
2023	336	199	536	681	134	0	134	1,082
2024	343	204	546	696	121	0	121	1,121
2025	348	208	557	711	108	0	108	1,159
2026	355	213	567	726	95	0	95	1,198
2027	361	217	579	740	82	0	82	1,238
2028	368	222	590	755	69	0	69	1,277
2029	375	226	602	770	56	0	56	1,316
2030	382	231	613	785	42	0	42	1,356
2031	391	235	626	804	73	0	73	1,357
2032	400	239	639	823	104	0	104	1,358
2033	408	243	651	842	134	0	134	1,359
2034	417	247	664	861	165	0	165	1,360
2035	426	251	677	880	196	0	196	1,361
2036	435	255	690	899	226	0	226	1,363
2037	443	259	703	918	257	0	257	1,364
2038	452	263	715	937	287	0	287	1,365
2039	461	267	728	956	318	0	318	1,366
2040	470	271	741	975	349	0	349	1,367

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[24]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[24] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	293	160	454	97	97	0	97	454
2017	297	167	464	99	97	0	97	467
2018	304	173	477	102	116	0	116	463
2019	310	179	489	104	135	0	135	458
2020	316	186	502	107	174	0	174	435
2021	323	190	513	109	161	0	161	462
2022	330	195	525	112	147	0	147	489
2023	336	199	536	114	134	0	134	516
2024	343	204	546	117	121	0	121	542
2025	348	208	557	119	108	0	108	568
2026	355	213	567	122	95	0	95	594
2027	361	217	579	124	82	0	82	621
2028	368	222	590	127	69	0	69	648
2029	375	226	602	129	56	0	56	675
2030	382	231	613	131	42	0	42	702
2031	391	235	626	135	73	0	73	687
2032	400	239	639	138	104	0	104	673
2033	408	243	651	141	134	0	134	658
2034	417	247	664	144	165	0	165	644
2035	426	251	677	147	196	0	196	629
2036	435	255	690	151	226	0	226	614
2037	443	259	703	154	257	0	257	600
2038	452	263	715	157	287	0	287	585
2039	461	267	728	160	318	0	318	570
2040	470	271	741	163	349	0	349	556

Statewide Water Conservation Quantification Project
City of Sweetwater Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Sweetwater's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Sweetwater's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Sweetwater's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Sweetwater with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	17.9	(8)	10	6	0	6	4
2016	17.9	(8)	10	7	0	7	3
2017	18.0	(8)	10	7	0	7	3
2018	18.0	(8)	10	8	0	8	1
2019	18.1	(8)	10	10	0	10	(0)
2020	18.1	(8)	10	13	0	13	(3)
2021	18.1	(8)	10	13	0	13	(3)
2022	18.2	(9)	10	13	0	13	(3)
2023	18.2	(9)	10	13	0	13	(3)
2024	18.3	(9)	10	13	0	13	(3)
2025	18.3	(9)	10	13	0	13	(3)
2026	18.3	(9)	10	13	0	13	(3)
2027	18.4	(9)	10	13	0	13	(3)
2028	18.4	(9)	10	13	0	13	(3)
2029	18.5	(9)	10	13	0	13	(3)
2030	18.5	(9)	10	13	0	13	(3)
2031	18.5	(9)	10	13	0	13	(3)
2032	18.5	(9)	10	13	0	13	(3)
2033	18.6	(9)	10	13	0	13	(3)
2034	18.6	(9)	10	13	0	13	(3)
2035	18.6	(9)	10	13	0	13	(3)
2036	18.6	(9)	10	13	0	13	(3)
2037	18.6	(9)	10	13	0	13	(3)
2038	18.7	(9)	9	13	0	13	(4)
2039	18.7	(9)	9	13	0	13	(4)
2040	18.7	(9)	9	13	0	13	(4)
2041	18.8	(9)	9	13	0	13	(4)
2042	18.8	(9)	10	13	0	13	(3)
2043	18.9	(9)	10	13	0	13	(3)
2044	19.0	(9)	10	13	0	13	(3)
2045	19.0	(9)	10	13	0	13	(3)
2046	19.1	(9)	10	13	0	13	(3)
2047	19.1	(9)	10	13	0	13	(3)
2048	19.2	(10)	10	13	0	13	(3)
2049	19.3	(10)	10	13	0	13	(3)
2050	19.3	(10)	10	13	0	13	(3)
2051	19.4	(10)	10	13	0	13	(3)
2052	19.4	(10)	10	13	0	13	(3)
2053	19.5	(10)	10	13	0	13	(3)
2054	19.5	(10)	10	13	0	13	(3)
2055	19.6	(10)	10	13	0	13	(3)
2056	19.6	(10)	10	13	0	13	(3)
2057	19.7	(10)	10	13	0	13	(3)
2058	19.7	(10)	10	13	0	13	(3)
2059	19.8	(10)	10	13	0	13	(3)
2060	19.8	(10)	10	13	0	13	(3)
2061	19.9	(10)	10	13	0	13	(3)
2062	19.9	(10)	10	13	0	13	(3)
2063	20.0	(10)	10	13	0	13	(3)
2064	20.0	(10)	10	13	0	13	(3)
2065	20.1	(10)	10	13	0	13	(3)
2066	20.1	(10)	10	13	0	13	(3)
2067	20.2	(10)	10	13	0	13	(3)
2068	20.2	(10)	10	13	0	13	(3)
2069	20.3	(10)	10	13	0	13	(3)
2070	20.3	(10)	10	13	0	13	(3)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Sweetwater's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	164	0		0
1	2015	10,943	164	1	10	9
2	2016	11,067	164	2	10	8
3	2017	11,191	163	2	10	7
4	2018	11,316	163	3	10	6
5-year Goal	2019	11,440	163	4	10	6
6	2020	11,564	162	7	10	3
7	2021	11,629	162	9	10	0
8	2022	11,694	161	12	10	(2)
9	2023	11,759	161	15	10	(5)
10-year Goal	2024	11,824	160	17	10	(8)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Sweetwater's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	29.00	0	0	0
1	2015	10,943	28.20	3	(8)	(11)
2	2016	11,067	27.40	6	(8)	(15)
3	2017	11,191	26.60	10	(8)	(18)
4	2018	11,316	25.80	13	(8)	(21)
5-year Goal	2019	11,440	25.00	17	(8)	(25)
6	2020	11,564	25.00	17	(8)	(25)
7	2021	11,629	25.00	17	(8)	(25)
8	2022	11,694	25.00	17	(9)	(26)
9	2023	11,759	25.00	17	(9)	(26)
10-year Goal	2024	11,824	25.00	17	(9)	(26)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 8 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 15.0% increase in 2015
    b. Estimated customer demand reduction of 3.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014		0
2015	17.9	17.9
2016	17.9	17.9
2017	18.0	18.0
2018	18.0	18.0
2019	18.1	18.1
2020	18.1	18.1
2021	18.1	18.1
2022	18.2	18.2
2023	18.2	18.2
2024	18.3	18.3
2025	18.3	18.3
2026	18.3	18.3
2027	18.4	18.4
2028	18.4	18.4
2029	18.5	18.5
2030	18.5	18.5
2031	18.5	18.5
2032	18.5	18.5
2033	18.6	18.6
2034	18.6	18.6
2035	18.6	18.6
2036	18.6	18.6
2037	18.6	18.6
2038	18.7	18.7
2039	18.7	18.7
2040	18.7	18.7
2041	18.8	18.8
2042	18.8	18.8
2043	18.9	18.9
2044	19.0	19.0
2045	19.0	19.0
2046	19.1	19.1
2047	19.1	19.1
2048	19.2	19.2
2049	19.3	19.3
2050	19.3	19.3
2051	19.4	19.4
2052	19.4	19.4
2053	19.5	19.5
2054	19.5	19.5
2055	19.6	19.6
2056	19.6	19.6
2057	19.7	19.7
2058	19.7	19.7
2059	19.8	19.8
2060	19.8	19.8
2061	19.9	19.9
2062	19.9	19.9
2063	20.0	20.0
2064	20.0	20.0
2065	20.1	20.1
2066	20.1	20.1
2067	20.2	20.2
2068	20.2	20.2
2069	20.3	20.3
2070	20.3	20.3

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	29.00	0
2015	10,943	31.00	(8)
2016	11,067	31.00	(8)
2017	11,191	31.00	(8)
2018	11,316	31.00	(8)
2019	11,440	31.00	(8)
2020	11,564	31.00	(8)
2021	11,629	31.00	(8)
2022	11,694	31.00	(9)
2023	11,759	31.00	(9)
2024	11,824	31.00	(9)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 6.74% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 40 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	18	(8)	10	40	7	0	7	43
2017	18	(8)	10	40	7	0	7	43
2018	18	(8)	10	41	8	0	8	42
2019	18	(8)	10	41	10	0	10	40
2020	18	(8)	10	41	13	0	13	38
2021	18	(8)	10	41	13	0	13	38
2022	18	(9)	10	41	13	0	13	38
2023	18	(9)	10	41	13	0	13	38
2024	18	(9)	10	41	13	0	13	38
2025	18	(9)	10	41	13	0	13	38
2026	18	(9)	10	41	13	0	13	38
2027	18	(9)	10	41	13	0	13	38
2028	18	(9)	10	41	13	0	13	38
2029	18	(9)	10	41	13	0	13	38
2030	19	(9)	10	42	13	0	13	38
2031	19	(9)	10	42	13	0	13	38
2032	19	(9)	10	42	13	0	13	38
2033	19	(9)	10	42	13	0	13	38
2034	19	(9)	10	42	13	0	13	38
2035	19	(9)	10	42	13	0	13	38
2036	19	(9)	10	42	13	0	13	38
2037	19	(9)	10	42	13	0	13	38
2038	19	(9)	9	42	13	0	13	38
2039	19	(9)	9	42	13	0	13	38
2040	19	(9)	9	42	13	0	13	38

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	18	(8)	10	8	7	0	7	11
2017	18	(8)	10	8	7	0	7	11
2018	18	(8)	10	8	8	0	8	9
2019	18	(8)	10	8	10	0	10	8
2020	18	(8)	10	8	13	0	13	5
2021	18	(9)	10	8	13	0	13	5
2022	18	(9)	10	8	13	0	13	5
2023	18	(9)	10	8	13	0	13	5
2024	18	(9)	10	8	13	0	13	5
2025	18	(9)	10	8	13	0	13	5
2026	18	(9)	10	8	13	0	13	5
2027	18	(9)	10	8	13	0	13	5
2028	18	(9)	10	8	13	0	13	5
2029	18	(9)	10	8	13	0	13	5
2030	19	(9)	10	8	13	0	13	5
2031	19	(9)	10	8	13	0	13	5
2032	19	(9)	10	8	13	0	13	5
2033	19	(9)	10	8	13	0	13	5
2034	19	(9)	10	8	13	0	13	5
2035	19	(9)	10	8	13	0	13	5
2036	19	(9)	10	8	13	0	13	5
2037	19	(9)	10	8	13	0	13	5
2038	19	(9)	9	8	13	0	13	5
2039	19	(9)	9	8	13	0	13	5
2040	19	(9)	9	8	13	0	13	5

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Temple Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Temple's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Temple's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Temple's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Temple with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	165	26	192	132	0	132	59
2016	168	27	195	165	0	165	29
2017	170	27	198	165	0	165	32
2018	173	28	201	199	0	199	2
2019	175	28	204	232	0	232	(28)
2020	178	29	207	298	0	298	(91)
2021	180	29	210	357	0	357	(148)
2022	183	30	213	417	0	417	(204)
2023	185	30	215	476	0	476	(261)
2024	188	31	218	536	0	536	(317)
2025	190	31	221	595	0	595	(374)
2026	193	32	224	655	0	655	(431)
2027	195	32	227	714	0	714	(487)
2028	198	33	230	774	0	774	(544)
2029	200	33	233	833	0	833	(600)
2030	202	33	236	893	0	893	(657)
2031	205	34	239	967	0	967	(728)
2032	208	34	242	1,041	0	1,041	(799)
2033	211	35	246	1,115	0	1,115	(870)
2034	213	35	249	1,190	0	1,190	(941)
2035	216	36	252	1,264	0	1,264	(1,011)
2036	219	36	255	1,338	0	1,338	(1,082)
2037	222	37	259	1,412	0	1,412	(1,153)
2038	225	37	262	1,486	0	1,486	(1,224)
2039	227	38	265	1,560	0	1,560	(1,295)
2040	230	38	269	1,634	0	1,634	(1,366)
2041	233	39	272	1,723	0	1,723	(1,451)
2042	236	39	275	1,811	0	1,811	(1,536)
2043	239	40	279	1,899	0	1,899	(1,620)
2044	242	41	282	1,988	0	1,988	(1,705)
2045	245	41	286	2,076	0	2,076	(1,790)
2046	248	42	289	2,164	0	2,164	(1,875)
2047	251	42	293	2,252	0	2,252	(1,960)
2048	253	43	296	2,341	0	2,341	(2,045)
2049	256	43	299	2,429	0	2,429	(2,130)
2050	259	44	303	2,517	0	2,517	(2,214)
2051	262	44	306	2,617	0	2,617	(2,310)
2052	265	45	310	2,716	0	2,716	(2,406)
2053	268	45	313	2,815	0	2,815	(2,502)
2054	271	46	317	2,914	0	2,914	(2,598)
2055	274	46	320	3,014	0	3,014	(2,694)
2056	277	47	324	3,113	0	3,113	(2,790)
2057	280	47	327	3,212	0	3,212	(2,885)
2058	283	48	330	3,312	0	3,312	(2,981)
2059	286	48	334	3,411	0	3,411	(3,077)
2060	289	49	337	3,510	0	3,510	(3,173)
2061	292	49	341	3,545	0	3,545	(3,205)
2062	295	50	344	3,581	0	3,581	(3,236)
2063	298	50	348	3,616	0	3,616	(3,268)
2064	300	51	351	3,651	0	3,651	(3,300)
2065	303	51	354	3,686	0	3,686	(3,332)
2066	306	52	358	3,721	0	3,721	(3,363)
2067	309	52	361	3,756	0	3,756	(3,395)
2068	312	53	365	3,792	0	3,792	(3,427)
2069	315	53	368	3,827	0	3,827	(3,459)
2070	318	54	371	3,862	0	3,862	(3,490)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Temple's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	217	0	0	0
1	2015	72,277	207	259	192	(67)
2	2016	73,672	197	527	195	(332)
3	2017	75,067	188	806	198	(608)
4	2018	76,463	178	1,094	201	(893)
5-year Goal	2019	77,858	168	1,392	204	(1,189)
6	2020	79,253	166	1,464	207	(1,257)
7	2021	80,504	165	1,534	210	(1,324)
8	2022	81,754	163	1,605	213	(1,393)
9	2023	83,005	162	1,678	215	(1,463)
10-year Goal	2024	84,255	160	1,753	218	(1,535)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Temple's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	19.00	0	0	0
1	2015	72,277	18.20	21	26	5
2	2016	73,672	17.40	43	27	(16)
3	2017	75,067	16.60	66	27	(38)
4	2018	76,463	15.80	89	28	(61)
5-year Goal	2019	77,858	15.00	114	28	(85)
6	2020	79,253	14.80	121	29	(93)
7	2021	80,504	14.60	129	29	(100)
8	2022	81,754	14.40	137	30	(107)
9	2023	83,005	14.20	145	30	(115)
10-year Goal	2024	84,255	14.00	154	31	(123)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 26 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 14.0% increase in 2014
    b. Estimated customer demand reduction of 2.8%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013	160	160.0
2014	163	163.0
2015	165	165.5
2016	168	167.9
2017	170	170.4
2018	173	172.9
2019	175	175.3
2020	178	177.8
2021	180	180.3
2022	183	182.7
2023	185	185.2
2024	188	187.7
2025	190	190.1
2026	193	192.6
2027	195	195.1
2028	198	197.5
2029	200	200.0
2030	202	202.5
2031	205	205.2
2032	208	208.0
2033	211	210.7
2034	213	213.5
2035	216	216.3
2036	219	219.0
2037	222	221.8
2038	225	224.5
2039	227	227.3
2040	230	230.1
2041	233	233.0
2042	236	235.9
2043	239	238.8
2044	242	241.8
2045	245	244.7
2046	248	247.6
2047	251	250.5
2048	253	253.4
2049	256	256.4
2050	259	259.3
2051	262	262.2
2052	265	265.2
2053	268	268.1
2054	271	271.1
2055	274	274.0
2056	277	277.0
2057	280	279.9
2058	283	282.9
2059	286	285.8
2060	289	288.8
2061	292	291.7
2062	295	294.6
2063	298	297.5
2064	300	300.4
2065	303	303.3
2066	306	306.3
2067	309	309.2
2068	312	312.1
2069	315	315.0
2070	318	317.9

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	19.00	0
2015	72,277	18.00	26
2016	73,672	18.00	27
2017	75,067	18.00	27
2018	76,463	18.00	28
2019	77,858	18.00	28
2020	79,253	18.00	29
2021	80,504	18.00	29
2022	81,754	18.00	30
2023	83,005	18.00	30
2024	84,255	18.00	31

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 8% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   - **b.** Savings could be 480 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	168	27	195	480	165	0	165	509
2017	170	27	198	487	165	0	165	519
2018	173	28	201	494	199	0	199	496
2019	175	28	204	501	232	0	232	473
2020	178	29	207	508	298	0	298	417
2021	180	29	210	515	357	0	357	367
2022	183	30	213	522	417	0	417	318
2023	185	30	215	529	476	0	476	268
2024	188	31	218	536	536	0	536	219
2025	190	31	221	543	595	0	595	169
2026	193	32	224	550	655	0	655	120
2027	195	32	227	557	714	0	714	70
2028	198	33	230	564	774	0	774	21
2029	200	33	233	571	833	0	833	(29)
2030	202	33	236	578	893	0	893	(79)
2031	205	34	239	586	967	0	967	(142)
2032	208	34	242	594	1,041	0	1,041	(205)
2033	211	35	246	602	1,115	0	1,115	(268)
2034	213	35	249	610	1,190	0	1,190	(331)
2035	216	36	252	618	1,264	0	1,264	(394)
2036	219	36	255	626	1,338	0	1,338	(457)
2037	222	37	259	634	1,412	0	1,412	(520)
2038	225	37	262	642	1,486	0	1,486	(583)
2039	227	38	265	649	1,560	0	1,560	(646)
2040	230	38	269	657	1,634	0	1,634	(709)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	168	27	195	80	165	0	165	110
2017	170	27	198	82	165	0	165	114
2018	173	28	201	83	199	0	199	85
2019	175	28	204	84	232	0	232	56
2020	178	29	207	85	298	0	298	(0)
2021	180	29	210	86	357	0	357	(61)
2022	183	30	213	87	417	0	417	(117)
2023	185	30	215	89	476	0	476	(172)
2024	188	31	218	90	536	0	536	(228)
2025	190	31	221	91	595	0	595	(283)
2026	193	32	224	92	655	0	655	(339)
2027	195	32	227	93	714	0	714	(394)
2028	198	33	230	95	774	0	774	(449)
2029	200	33	233	96	833	0	833	(505)
2030	202	33	236	97	893	0	893	(560)
2031	205	34	239	98	967	0	967	(630)
2032	208	34	242	100	1,041	0	1,041	(699)
2033	211	35	246	101	1,115	0	1,115	(769)
2034	213	35	249	102	1,190	0	1,190	(838)
2035	216	36	252	103	1,264	0	1,264	(908)
2036	219	36	255	105	1,338	0	1,338	(978)
2037	222	37	259	106	1,412	0	1,412	(1,047)
2038	225	37	262	107	1,486	0	1,486	(1,117)
2039	227	38	265	109	1,560	0	1,560	(1,186)
2040	230	38	269	110	1,634	0	1,634	(1,256)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Waco Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Waco's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Waco's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Waco's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8 9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Waco with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	(966)	(966)	212	0	212	(1,178)
2016	163	(968)	(805)	265	0	265	(1,070)
2017	437	(970)	(533)	265	0	265	(798)
2018	440	(972)	(533)	318	0	318	(850)
2019	442	(974)	(532)	371	0	371	(903)
2020	444	(977)	(532)	476	0	476	(1,008)
2021	447	(984)	(537)	560	0	560	(1,097)
2022	449	(992)	(542)	644	0	644	(1,186)
2023	452	(999)	(547)	728	0	728	(1,275)
2024	454	(1,007)	(552)	812	0	812	(1,364)
2025	457	(1,014)	(558)	895	0	895	(1,453)
2026	459	(1,022)	(563)	979	0	979	(1,542)
2027	462	(1,029)	(568)	1,063	0	1,063	(1,631)
2028	464	(1,037)	(573)	1,147	0	1,147	(1,720)
2029	467	(1,045)	(578)	1,231	0	1,231	(1,808)
2030	469	(1,052)	(583)	1,314	0	1,314	(1,897)
2031	471	(1,059)	(587)	1,404	0	1,404	(1,991)
2032	474	(1,066)	(592)	1,493	0	1,493	(2,085)
2033	476	(1,072)	(596)	1,583	0	1,583	(2,179)
2034	478	(1,079)	(601)	1,673	0	1,673	(2,273)
2035	480	(1,086)	(605)	1,762	0	1,762	(2,367)
2036	483	(1,092)	(610)	1,852	0	1,852	(2,461)
2037	485	(1,099)	(614)	1,941	0	1,941	(2,555)
2038	487	(1,106)	(619)	2,031	0	2,031	(2,649)
2039	489	(1,112)	(623)	2,120	0	2,120	(2,743)
2040	491	(1,119)	(628)	2,210	0	2,210	(2,837)
2041	494	(1,126)	(632)	2,308	0	2,308	(2,939)
2042	496	(1,132)	(636)	2,405	0	2,405	(3,041)
2043	499	(1,139)	(640)	2,503	0	2,503	(3,143)
2044	501	(1,146)	(644)	2,601	0	2,601	(3,245)
2045	504	(1,153)	(649)	2,699	0	2,699	(3,347)
2046	507	(1,159)	(653)	2,797	0	2,797	(3,449)
2047	509	(1,166)	(657)	2,894	0	2,894	(3,551)
2048	512	(1,173)	(661)	2,992	0	2,992	(3,653)
2049	514	(1,179)	(665)	3,090	0	3,090	(3,755)
2050	517	(1,186)	(670)	3,188	0	3,188	(3,857)
2051	519	(1,193)	(674)	3,258	0	3,258	(3,932)
2052	522	(1,200)	(678)	3,328	0	3,328	(4,006)
2053	525	(1,206)	(681)	3,399	0	3,399	(4,080)
2054	528	(1,213)	(685)	3,469	0	3,469	(4,154)
2055	530	(1,220)	(689)	3,539	0	3,539	(4,229)
2056	533	(1,226)	(693)	3,610	0	3,610	(4,303)
2057	536	(1,233)	(697)	3,680	0	3,680	(4,377)
2058	539	(1,240)	(701)	3,751	0	3,751	(4,452)
2059	541	(1,246)	(705)	3,821	0	3,821	(4,526)
2060	544	(1,253)	(709)	3,891	0	3,891	(4,600)
2061	547	(1,260)	(713)	3,911	0	3,911	(4,624)
2062	550	(1,266)	(717)	3,931	0	3,931	(4,648)
2063	553	(1,273)	(720)	3,951	0	3,951	(4,672)
2064	555	(1,279)	(724)	3,971	0	3,971	(4,695)
2065	558	(1,286)	(728)	3,991	0	3,991	(4,719)
2066	561	(1,293)	(732)	4,011	0	4,011	(4,743)
2067	564	(1,299)	(736)	4,031	0	4,031	(4,767)
2068	566	(1,306)	(739)	4,051	0	4,051	(4,791)
2069	569	(1,312)	(743)	4,071	0	4,071	(4,815)
2070	572	(1,319)	(747)	4,091	0	4,091	(4,838)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Waco's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	225	0	0	0
1	2,015	132,356	224	39	(966)	(1,005)
2	2,016	132,639	223	77	(805)	(883)
3	2,017	132,921	223	116	(533)	(650)
4	2,018	133,204	222	156	(533)	(688)
5-year Goal	2,019	133,486	221	195	(532)	(727)
6	2,020	133,769	216	439	(532)	(971)
7	2,021	134,805	211	689	(537)	(1,226)
8	2,022	135,842	206	942	(542)	(1,484)
9	2,023	136,878	201	1,199	(547)	(1,746)
10-year Goal	2,024	137,914	196	1,460	(552)	(2,012)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Waco's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	19.00	0	0	0
1	2,015	132,356	18	29	(966)	(995)
2	2,016	132,639	18	58	(968)	(1,026)
3	2,017	132,921	17	87	(970)	(1,058)
4	2,018	133,204	17	117	(972)	(1,089)
5-year Goal	2,019	133,486	16	146	(974)	(1,121)
6	2,020	133,769	16	156	(977)	(1,133)
7	2,021	134,805	16	167	(984)	(1,151)
8	2,022	135,842	15	178	(992)	(1,170)
9	2,023	136,878	15	190	(999)	(1,189)
10-year Goal	2,024	137,914	15	201	(1,007)	(1,208)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 966 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 7.4% increase in 2016
        ii. 13.9% increase in 2017
    b. Estimated customer demand reduction of 4.2%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

6. Save Water Co. Commercial, Multi-family and Hotel Programs[19]

a. Project initiated in service area in 2016.
b. Save Water completed work on 326 multi-family units in 2016.
c. Average monthly savings of 1,024,357 gallons
d. Annualized savings of 12.3 MG for the life of the retrofitted fixtures
e. This study estimates a lifespan of 25 years for high-efficiency toilet replacements, five years for kitchen aerators and similar devices.
f. Save Water Co. performs monthly meter readings before and after installation to quantify savings.
    i. The company's work consists of identifying and repairing all leaks and drips, rebuilding existing toilets and replacing sink aerators.

[19] Savings figures and units serviced based on personal email communication with Kurt Goedrich, December 1, 2016.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	Save Water Co.	TOTAL SAVINGS
2012			0
2013			0
2014			0
2015			0
2016	151	12.3	163.1
2017	425	12.3	437.1
2018	427	12.3	439.6
2019	430	12.3	442.0
2020	432	12.3	444.5
2021	435	12.3	447.0
2022	437	12.3	449.4
2023	440	12.3	451.9
2024	442	12.3	454.4
2025	445	12.3	456.8
2026	447	12.3	459.3
2027	449	12.3	461.8
2028	452	12.3	464.2
2029	454	12.3	466.7
2030	457	12.3	469.1
2031	459	12.3	471.4
2032	461	12.3	473.6
2033	464	12.3	475.8
2034	466	12.3	478.1
2035	468	12.3	480.3
2036	470	12.3	482.5
2037	472	12.3	484.7
2038	475	12.3	487.0
2039	477	12.3	489.2
2040	479	12.3	491.4
2041	482	12.3	493.9
2042	484	12.3	496.5
2043	487	12.3	499.0
2044	489	12.3	501.5
2045	492	12.3	504.0
2046	494	12.3	506.5
2047	497	12.3	509.0
2048	499	12.3	511.5
2049	502	12.3	514.0
2050	504	12.3	516.6
2051	507	12.3	519.3
2052	510	12.3	522.1
2053	513	12.3	524.8
2054	515	12.3	527.6
2055	518	12.3	530.4
2056	521	12.3	533.1
2057	524	12.3	535.9
2058	526	12.3	538.7
2059	529	12.3	541.4
2060	532	12.3	544.2
2061	535	12.3	547.0
2062	537	12.3	549.8
2063	540	12.3	552.5
2064	543	12.3	555.3
2065	546	12.3	558.1
2066	549	12.3	560.9
2067	551	12.3	563.6
2068	554	12.3	566.4
2069	557	12.3	569.2
2070	560	12.3	571.9

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	19.00	0
2015	132,356	39.00	(966)
2016	132,639	39.00	(968)
2017	132,921	39.00	(970)
2018	133,204	39.00	(972)
2019	133,486	39.00	(974)
2020	133,769	39.00	(977)
2021	134,805	39.00	(984)
2022	135,842	39.00	(992)
2023	136,878	39.00	(999)
2024	137,914	39.00	(1,007)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 7.37% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   - **b.** Savings could be 741 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	163	(968)	(805)	741	265	0	265	(829)
2017	437	(970)	(533)	745	265	0	265	(52)
2018	440	(972)	(533)	750	318	0	318	(103)
2019	442	(974)	(532)	754	371	0	371	(149)
2020	444	(977)	(533)	758	476	0	476	(250)
2021	447	(984)	(537)	763	560	0	560	(339)
2022	449	(992)	(542)	767	644	0	644	(419)
2023	452	(999)	(547)	771	728	0	728	(504)
2024	454	(1,007)	(552)	776	812	0	812	(588)
2025	457	(1,014)	(558)	780	895	0	895	(673)
2026	459	(1,022)	(563)	784	979	0	979	(757)
2027	462	(1,029)	(568)	789	1,063	0	1,063	(842)
2028	464	(1,037)	(573)	793	1,147	0	1,147	(927)
2029	467	(1,045)	(578)	797	1,231	0	1,231	(1,011)
2030	469	(1,052)	(583)	802	1,314	0	1,314	(1,096)
2031	471	(1,059)	(587)	806	1,404	0	1,404	(1,186)
2032	474	(1,066)	(592)	809	1,493	0	1,493	(1,276)
2033	476	(1,072)	(596)	813	1,583	0	1,583	(1,366)
2034	478	(1,079)	(601)	817	1,673	0	1,673	(1,456)
2035	480	(1,088)	(608)	821	1,762	0	1,762	(1,546)
2036	483	(1,092)	(610)	825	1,852	0	1,852	(1,636)
2037	485	(1,099)	(614)	829	1,941	0	1,941	(1,726)
2038	487	(1,106)	(619)	833	2,031	0	2,031	(1,817)
2039	489	(1,112)	(623)	837	2,120	0	2,120	(1,907)
2040	491	(1,119)	(628)	841	2,210	0	2,210	(1,997)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[20]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[20] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	163	(968)	(805)	135	265	0	265	(935)
2017	437	(970)	(533)	136	265	0	265	(862)
2018	440	(972)	(533)	136	318	0	318	(714)
2019	442	(974)	(532)	137	371	0	371	(766)
2020	444	(977)	(532)	138	476	0	476	(871)
2021	447	(984)	(537)	139	560	0	560	(959)
2022	449	(992)	(542)	139	644	0	644	(1,047)
2023	452	(999)	(547)	140	728	0	728	(1,135)
2024	454	(1,007)	(552)	141	812	0	812	(1,223)
2025	457	(1,014)	(557)	142	895	0	895	(1,311)
2026	459	(1,022)	(563)	143	979	0	979	(1,399)
2027	462	(1,029)	(568)	143	1,063	0	1,063	(1,487)
2028	464	(1,037)	(573)	144	1,147	0	1,147	(1,575)
2029	467	(1,044)	(578)	145	1,231	0	1,231	(1,664)
2030	469	(1,052)	(583)	146	1,314	0	1,314	(1,752)
2031	471	(1,059)	(587)	146	1,404	0	1,404	(1,845)
2032	474	(1,066)	(592)	147	1,489	0	1,489	(1,934)
2033	476	(1,072)	(596)	148	1,583	0	1,583	(2,032)
2034	478	(1,079)	(601)	149	1,673	0	1,673	(2,125)
2035	480	(1,086)	(605)	149	1,762	0	1,762	(2,218)
2036	483	(1,092)	(610)	150	1,852	0	1,852	(2,311)
2037	485	(1,099)	(614)	151	1,941	0	1,941	(2,405)
2038	487	(1,106)	(619)	151	2,031	0	2,031	(2,498)
2039	489	(1,112)	(623)	152	2,120	0	2,120	(2,591)
2040	491	(1,119)	(628)	153	2,210	0	2,210	(2,685)

3. Rain Barrel
   - **a.** In Region G, utilities could save approximately 18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Woodway Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached,

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus,

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Woodway's current water conservation activities and their quantified savings to two metrics: 1) Region G Water Plan's (Brazos G Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Woodway's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Woodway's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Woodway with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	5.5	32	38	30	0	30	7
2016	22.1	32	54	38	0	38	17
2017	22.2	32	55	38	0	38	17
2018	22.4	33	55	45	0	45	10
2019	22.5	33	55	53	0	53	3
2020	22.7	33	56	68	0	68	(12)
2021	22.8	33	56	78	0	78	(21)
2022	23.0	34	57	88	0	88	(31)
2023	23.1	34	57	98	0	98	(40)
2024	23.3	34	57	107	0	107	(50)
2025	23.4	34	58	117	0	117	(59)
2026	23.5	35	58	127	0	127	(69)
2027	23.7	35	59	137	0	137	(78)
2028	23.8	35	59	147	0	147	(88)
2029	24.0	35	59	157	0	157	(97)
2030	24.1	36	60	167	0	167	(107)
2031	24.3	36	60	177	0	177	(117)
2032	24.4	36	61	188	0	188	(127)
2033	24.5	36	61	198	0	198	(137)
2034	24.7	37	61	209	0	209	(147)
2035	24.8	37	62	219	0	219	(157)
2036	24.9	37	62	229	0	229	(167)
2037	25.1	37	62	240	0	240	(177)
2038	25.2	38	63	250	0	250	(187)
2039	25.3	38	63	261	0	261	(198)
2040	25.5	38	64	271	0	271	(208)
2041	25.6	38	64	282	0	282	(219)
2042	25.7	39	64	294	0	294	(230)
2043	25.9	39	65	305	0	305	(241)
2044	26.0	39	65	317	0	317	(251)
2045	26.2	39	65	328	0	328	(262)
2046	26.3	39	66	339	0	339	(273)
2047	26.5	40	66	351	0	351	(284)
2048	26.6	40	67	362	0	362	(295)
2049	26.8	40	67	373	0	373	(306)
2050	26.9	40	67	385	0	385	(317)
2051	27.1	41	68	396	0	396	(329)
2052	27.2	41	68	408	0	408	(340)
2053	27.4	41	68	420	0	420	(351)
2054	27.5	41	69	432	0	432	(363)
2055	27.7	42	69	443	0	443	(374)
2056	27.8	42	70	455	0	455	(386)
2057	28.0	42	70	467	0	467	(397)
2058	28.1	42	70	479	0	479	(408)
2059	28.3	43	71	490	0	490	(420)
2060	28.4	43	71	502	0	502	(431)
2061	28.6	43	72	514	0	514	(443)
2062	28.7	43	72	526	0	526	(454)
2063	28.9	43	72	538	0	538	(466)
2064	29.0	44	73	550	0	550	(477)
2065	29.2	44	73	562	0	562	(489)
2066	29.3	44	73	574	0	574	(500)
2067	29.5	44	74	585	0	585	(512)
2068	29.6	45	74	597	0	597	(523)
2069	29.8	45	75	609	0	609	(535)
2070	29.9	45	75	621	0	621	(546)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Woodway's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	288	0	0	0
1	2015	8,777	285	9	38	29
2	2016	8,837	282	18	54	36
3	2017	8,896	280	27	55	27
4	2018	8,956	277	37	55	18
5-year Goal	2019	9,015	274	46	55	9
6	2020	9,075	271	56	56	0
7	2021	9,147	268	65	56	(9)
8	2022	9,219	266	75	57	(19)
9	2023	9,291	263	85	57	(28)
10-year Goal	2024	9,363	260	96	57	(38)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Woodway's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	63.00	0	0	0
1	2015	8,777	62.40	2	32	30
2	2016	8,837	61.80	4	32	28
3	2017	8,896	61.20	6	32	27
4	2018	8,956	60.60	8	33	25
5-year Goal	2019	9,015	60.00	10	33	23
6	2020	9,075	59.60	11	33	22
7	2021	9,147	59.20	13	33	21
8	2022	9,219	58.80	14	34	20
9	2023	9,291	58.40	16	34	18
10-year Goal	2024	9,363	58.00	17	34	17

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 32 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 2.7% increase in 2015
        ii. 7.1% increase in 2016
    b. Estimated customer demand reduction of 2.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	TOTAL SAVINGS
2009		0.0
2010		0.0
2011		0.0
2012		0.0
2013		0.0
2014		0.0
2015	5.5	5.5
2016	22.1	22.1
2017	22.2	22.2
2018	22.4	22.4
2019	22.5	22.5
2020	22.7	22.7
2021	22.8	22.8
2022	23.0	23.0
2023	23.1	23.1
2024	23.3	23.3
2025	23.4	23.4
2026	23.5	23.5
2027	23.7	23.7
2028	23.8	23.8
2029	24.0	24.0
2030	24.1	24.1
2031	24.3	24.3
2032	24.4	24.4
2033	24.5	24.5
2034	24.7	24.7
2035	24.8	24.8
2036	24.9	24.9
2037	25.1	25.1
2038	25.2	25.2
2039	25.3	25.3
2040	25.5	25.5
2041	25.6	25.6
2042	25.7	25.7
2043	25.9	25.9
2044	26.0	26.0
2045	26.2	26.2
2046	26.3	26.3
2047	26.5	26.5
2048	26.6	26.6
2049	26.8	26.8
2050	26.9	26.9
2051	27.1	27.1
2052	27.2	27.2
2053	27.4	27.4
2054	27.5	27.5
2055	27.7	27.7
2056	27.8	27.8
2057	28.0	28.0
2058	28.1	28.1
2059	28.3	28.3
2060	28.4	28.4
2061	28.6	28.6
2062	28.7	28.7
2063	28.9	28.9
2064	29.0	29.0
2065	29.2	29.2
2066	29.3	29.3
2067	29.5	29.5
2068	29.6	29.6
2069	29.8	29.8
2070	29.9	29.9

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction (MG)
Baseline	-	63.00	0
2015	8,777	53.00	32
2016	8,837	53.00	32
2017	8,896	53.00	32
2018	8,956	53.00	33
2019	9,015	53.00	33
2020	9,075	53.00	33
2021	9,147	53.00	33
2022	9,219	53.00	34
2023	9,291	53.00	34
2024	9,363	53.00	34

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 7.58% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region G savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 84 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	22	32	54	84	38	0	38	100
2017	22	32	55	84	38	0	38	101
2018	22	33	55	85	45	0	45	95
2019	23	33	55	85	53	0	53	88
2020	23	33	56	86	68	0	68	74
2021	23	33	56	86	78	0	78	65
2022	23	34	57	87	88	0	88	56
2023	23	34	57	88	98	0	98	47
2024	23	34	57	88	107	0	107	38
2025	23	34	58	89	117	0	117	29
2026	24	35	58	89	127	0	127	20
2027	24	35	59	90	137	0	137	11
2028	24	35	59	90	147	0	147	2
2029	24	35	59	91	157	0	157	(7)
2030	24	36	60	91	167	0	167	(15)
2031	24	36	60	92	177	0	177	(25)
2032	24	36	61	92	188	0	188	(35)
2033	25	36	61	93	198	0	198	(44)
2034	25	37	61	93	209	0	209	(54)
2035	25	37	62	94	219	0	219	(63)
2036	25	37	62	94	229	0	229	(73)
2037	25	37	62	95	240	0	240	(82)
2038	25	38	63	95	250	0	250	(92)
2039	25	38	63	96	261	0	261	(102)
2040	25	38	64	96	271	0	271	(111)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[19]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	22	32	54	15	38	0	38	31
2017	22	32	55	15	38	8	38	32
2018	22	33	55	15	45	0	45	25
2019	23	33	55	15	53	0	53	18
2020	23	33	56	15	68	0	68	9
2021	23	33	56	15	78	0	78	(6)
2022	23	34	57	15	88	0	88	(16)
2023	23	34	57	15	98	0	98	(25)
2024	23	34	57	16	107	0	107	(34)
2025	23	34	58	16	117	0	117	(44)
2026	24	35	58	16	127	0	127	(53)
2027	24	35	59	16	137	0	137	(63)
2028	24	35	59	16	147	0	147	(72)
2029	24	35	59	16	157	0	157	(82)
2030	24	36	60	16	167	0	167	(91)
2031	24	36	60	16	177	0	177	(101)
2032	24	36	61	16	188	0	188	(111)
2033	25	36	61	16	198	0	198	(121)
2034	25	37	61	17	209	0	209	(131)
2035	25	37	62	17	219	0	219	(141)
2036	25	37	62	17	229	0	229	(151)
2037	25	37	62	17	240	0	240	(161)
2038	25	38	63	17	250	0	250	(171)
2039	25	38	63	17	261	0	261	(181)
2040	25	38	64	17	271	0	271	(191)

3. Rain Barrels
   - **a.** In Region G, utilities could save approximately18.5 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Region H Individual Reports

Statewide Water Conservation Quantification Project
City of Baytown Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Baytown's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Baytown's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.

The 5- and 10-year goals in Baytown's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[5] are expressed in decreasing total GPCD[6] consumption and water loss GPCD.[7][8]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's

[5] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[6] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[7] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[8] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be include in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[9] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) In Regional Water Plan

Table 3-1 shows the 2070 outlook for Baytown with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, excluding savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes,

[9] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[10] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [11] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[11] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	16.6	213	230	11	20	31	198
2016	16.7	214	231	14	25	39	191
2017	15.1	215	230	14	30	44	186
2018	13.3	216	229	17	35	52	177
2019	11.3	217	228	19	41	60	168
2020	9.6	218	228	25	46	70	157
2021	7.9	219	227	29	50	79	148
2022	7.9	220	228	34	54	87	140
2023	7.9	221	229	38	58	96	133
2024	7.9	222	229	43	62	105	125
2025	7.9	222	230	47	66	113	117
2026	7.9	223	231	52	70	122	109
2027	7.9	223	231	56	74	130	101
2028	7.9	224	232	60	78	139	93
2029	7.9	224	232	65	82	147	85
2030	7.9	225	233	69	86	156	77
2031	7.9	226	233	73	90	163	70
2032	7.9	226	234	77	94	171	63
2033	7.9	227	235	81	97	179	56
2034	7.9	227	235	85	101	187	49
2035	7.9	228	236	89	105	194	42
2036	7.9	229	237	93	108	202	35
2037	7.9	229	237	97	112	210	28
2038	7.9	230	238	101	116	217	20
2039	7.9	231	238	105	120	225	13
2040	7.9	231	239	110	123	233	6
2041	7.9	232	240	113	126	239	1
2042	7.9	232	240	117	128	245	(4)
2043	7.9	233	241	121	130	251	(10)
2044	7.9	234	242	124	132	257	(15)
2045	7.9	234	242	128	135	263	(20)
2046	7.9	235	243	132	137	269	(26)
2047	7.9	236	244	135	139	275	(31)
2048	7.9	236	244	139	142	281	(36)
2049	7.9	237	245	143	144	287	(42)
2050	7.9	238	245	146	146	293	(47)
2051	7.9	238	246	150	147	297	(50)
2052	7.9	239	247	153	147	300	(54)
2053	7.9	240	247	157	148	304	(57)
2054	7.9	240	248	160	148	308	(60)
2055	7.9	241	249	164	148	312	(63)
2056	7.9	242	249	167	149	316	(66)
2057	7.9	242	250	171	149	320	(70)
2058	7.9	243	251	174	149	324	(73)
2059	7.9	244	252	178	150	328	(76)
2060	7.9	244	252	181	150	331	(79)
2061	7.9	245	253	184	151	335	(82)
2062	7.9	246	254	188	151	339	(85)
2063	7.9	246	254	191	152	342	(88)
2064	7.9	247	255	194	152	346	(91)
2065	7.9	248	256	197	152	350	(94)
2066	7.9	248	256	201	153	354	(97)
2067	7.9	249	257	204	153	357	(100)
2068	7.9	250	258	207	154	361	(103)
2069	7.9	251	258	211	154	365	(106)
2070	7.9	251	259	214	154	368	(109)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Baytown's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[12] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	149	0	0	0
1	2015	73,950	147	59	230	170
2	2016	74,298	145	119	231	111
3	2017	74,646	142	180	230	50
4	2018	74,993	140	241	229	-12
5-year Goal	2019	75,341	138	302	228	(74)
6	2020	75,689	137	326	228	(98)
7	2021	75,887	136	349	227	(122)
8	2022	76,084	136	372	228	(144)
9	2023	76,282	135	395	229	(166)
10-year Goal	2024	76,480	134	419	229	(189)

[12] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Baytown's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[13] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	30.00	0	0	0
1	2015	73,950	29.40	16	213	197
2	2016	74,298	28.80	33	214	181
3	2017	74,646	28.20	49	215	166
4	2018	74,993	27.60	66	216	150
5-year Goal	2019	75,341	27.00	82	217	134
6	2020	75,689	26.60	94	218	124
7	2021	75,887	26.20	105	219	114
8	2022	76,084	25.80	117	220	103
9	2023	76,282	25.40	128	221	93
10-year Goal	2024	76,480	25.00	140	222	82

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, we used a 50/50 split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[14]
    a. Savings of 213 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[15] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
    c. 15% adoption rate assumed

[14] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[15] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

6. **Save Water Co. Commercial, Multi-family and Hotel Programs**[16]
    a. Project initiated in service area in 2015
    b. Save Water completed work on 220 multi-family units in 2015
    c. Average monthly savings of 655,345 gallons
    d. Annualized savings of 7.86 MG for the life of the retrofitted fixtures
    e. This study estimates a lifespan of 25 years for high-efficiency toilet replacements, five years for kitchen aerators and similar devices.
    f. Save Water Co. performs monthly meter readings before and after installation to quantify savings.
        i. The company's work consists of identifying and repairing all leaks and drips, rebuilding existing toilets and replacing sink aerators.

[16] Savings figures and units serviced based on personal email communication with Kurt Goedrich, December 1, 2016.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	Save Water Co. Program	TOTAL SAVINGS
2009	1.8		1.8
2010	3.3		3.3
2011	5.1		5.1
2012	6.7		6.7
2013	8.5		8.5
2014	8.6		8.6
2015	8.8	7.9	16.6
2016	8.8	7.9	16.7
2017	7.2	7.9	15.1
2018	5.4	7.9	13.3
2019	3.5	7.9	11.3
2020	1.7	7.9	9.6
2021		7.9	7.9
2022		7.9	7.9
2023		7.9	7.9
2024		7.9	7.9
2025		7.9	7.9
2026		7.9	7.9
2027		7.9	7.9
2028		7.9	7.9
2029		7.9	7.9
2030		7.9	7.9
2031		7.9	7.9
2032		7.9	7.9
2033		7.9	7.9
2034		7.9	7.9
2035		7.9	7.9
2036		7.9	7.9
2037		7.9	7.9
2038		7.9	7.9
2039		7.9	7.9
2040		7.9	7.9
2041		7.9	7.9
2042		7.9	7.9
2043		7.9	7.9
2044		7.9	7.9
2045		7.9	7.9
2046		7.9	7.9
2047		7.9	7.9
2048		7.9	7.9
2049		7.9	7.9
2050		7.9	7.9
2051		7.9	7.9
2052		7.9	7.9
2053		7.9	7.9
2054		7.9	7.9
2055		7.9	7.9
2056		7.9	7.9
2057		7.9	7.9
2058		7.9	7.9
2059		7.9	7.9
2060		7.9	7.9
2061		7.9	7.9
2062		7.9	7.9
2063		7.9	7.9
2064		7.9	7.9
2065		7.9	7.9
2066		7.9	7.9
2067		7.9	7.9
2068		7.9	7.9
2069		7.9	7.9
2070		7.9	7.9

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	30.00	0
2015	72,899	22.00	213
2016	73,250	22.00	214
2017	73,600	22.00	215
2018	73,950	22.00	216
2019	74,298	22.00	217
2020	74,646	22.00	218
2021	74,993	22.00	219
2022	75,341	22.00	220
2023	75,689	22.00	221
2024	75,887	22.00	222

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 133 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	214	231	133	14	25	39	324
2017	15	215	230	133	14	30	44	318
2018	13	216	229	133	17	35	52	310
2019	11	217	228	132	19	41	60	301
2020	10	218	228	132	25	46	70	289
2021	8	219	227	132	29	50	79	280
2022	8	220	228	132	34	54	87	273
2023	8	221	229	132	38	58	96	265
2024	8	222	229	132	43	62	105	257
2025	8	222	230	132	47	66	113	249
2026	8	223	231	132	52	70	122	241
2027	8	223	231	132	56	74	130	233
2028	8	224	232	132	60	78	139	225
2029	8	224	232	131	65	82	147	217
2030	8	225	233	131	69	86	156	208
2031	8	226	233	131	73	90	163	201
2032	8	226	234	131	77	94	171	194
2033	8	227	235	131	81	97	179	187
2034	8	227	235	131	85	101	187	180
2035	8	228	236	131	89	105	194	173
2036	8	229	237	131	93	108	202	166
2037	8	229	237	131	97	112	210	159
2038	8	230	238	131	101	116	217	152
2039	8	231	238	131	105	120	225	145
2040	8	231	239	131	110	123	233	138

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	214	231	44	14	25	39	236
2017	15	215	230	44	14	30	44	230
2018	13	216	229	44	17	35	52	222
2019	11	217	228	44	19	41	60	213
2020	10	218	228	44	25	46	70	201
2021	9	219	227	44	29	50	79	192
2022	8	220	228	44	34	54	87	185
2023	8	221	229	44	38	58	96	177
2024	8	222	229	44	43	62	105	169
2025	8	222	230	44	47	66	113	161
2026	8	223	231	44	52	70	122	153
2027	8	223	231	44	56	74	130	145
2028	8	224	232	44	60	78	139	137
2029	8	224	232	44	65	82	147	129
2030	8	225	233	44	69	86	156	121
2031	8	226	233	44	73	90	163	114
2032	8	226	234	44	77	94	171	107
2033	8	227	235	44	81	97	179	100
2034	8	227	235	44	85	101	187	93
2035	8	228	236	44	89	105	194	86
2036	8	229	237	44	93	108	202	79
2037	8	229	237	44	97	112	210	72
2038	8	230	238	44	101	116	217	64
2039	8	231	238	44	105	120	225	57
2040	8	231	239	44	110	123	233	50

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 66 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] We estimate 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, we can determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	17	214	231	66	14	25	39	258
2017	15	215	230	66	14	30	44	252
2018	13	216	229	66	17	35	52	243
2019	11	217	228	66	19	41	60	235
2020	10	218	228	66	25	46	70	223
2021	9	218	227	66	29	50	79	214
2022	8	220	228	66	34	54	87	206
2023	8	221	229	66	38	58	96	199
2024	8	222	229	66	43	62	105	191
2025	8	222	230	66	47	66	113	183
2026	8	223	231	66	52	70	122	175
2027	8	223	231	66	56	74	130	167
2028	8	224	232	66	60	78	139	159
2029	8	224	232	66	65	82	147	151
2030	8	225	233	66	69	86	156	143
2031	8	226	233	66	73	90	163	136
2032	8	226	234	66	77	94	171	129
2033	8	227	235	66	81	97	179	121
2034	8	227	235	66	85	101	187	114
2035	8	228	236	66	89	105	194	107
2036	8	229	237	66	93	108	202	100
2037	8	229	237	66	97	112	210	93
2038	8	230	238	66	101	116	217	86
2039	8	231	238	66	105	120	225	79
2040	8	231	239	66	110	123	233	72

4. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Clute Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Clute's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Clute's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.

The 5- and 10-year goals in Clute's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[5] are expressed in decreasing total GPCD[6] consumption and water loss GPCD.[7] [8]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantifed. Individual households

[5] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[6] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[7] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[8] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

and businesses may be implementing conservation measures that are unknown and therefore cannot be include in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[9] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because we used a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) In Regional Water Plan

Table 3-1 shows the 2070 outlook for Clute with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, excluding savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, the study quantifies utility savings starting in 2012 for this comparison. The summary of these

[9] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[10] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[11] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[11] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	1.3	12.4	14	2	3	5	9
2016	1.3	12.4	14	3	4	6	7
2017	1.1	12.5	14	3	4	7	6
2018	0.8	12.5	13	3	5	8	5
2019	0.5	12.5	13	4	6	10	3
2020	0.3	12.5	13	5	7	11	1
2021	0	12.6	13	6	7	13	(0)
2022	0	12.6	13	7	8	14	(2)
2023	0	12.7	13	7	8	16	(3)
2024	0	12.7	13	8	9	17	(4)
2025	0	12.7	13	9	9	19	(6)
2026	0	12.8	13	10	10	20	(7)
2027	0	12.8	13	11	11	21	(9)
2028	0	12.9	13	12	11	23	(10)
2029	0	12.9	13	13	12	24	(11)
2030	0	13.0	13	13	12	26	(13)
2031	0	13.0	13	14	13	27	(14)
2032	0	13.0	13	15	13	28	(15)
2033	0	13.1	13	16	14	30	(16)
2034	0	13.1	13	16	15	31	(18)
2035	0	13.2	13	17	15	32	(19)
2036	0	13.2	13	18	16	33	(20)
2037	0	13.3	13	18	16	35	(21)
2038	0	13.3	13	19	17	36	(23)
2039	0	13.4	13	20	17	37	(24)
2040	0	13.4	13	21	18	38	(25)
2041	0	13.5	13	21	18	39	(26)
2042	0	13.5	14	22	18	40	(27)
2043	0	13.6	14	22	19	41	(27)
2044	0	13.6	14	23	19	42	(28)
2045	0	13.7	14	23	19	43	(29)
2046	0	13.7	14	24	19	44	(30)
2047	0	13.8	14	25	20	44	(31)
2048	0	13.8	14	25	20	45	(31)
2049	0	13.9	14	26	20	46	(32)
2050	0	13.9	14	26	21	47	(33)
2051	0	14.0	14	27	21	47	(34)
2052	0	14.0	14	27	21	48	(34)
2053	0	14.1	14	28	21	49	(35)
2054	0	14.1	14	28	21	49	(35)
2055	0	14.2	14	29	21	50	(36)
2056	0	14.2	14	29	21	50	(36)
2057	0	14.3	14	30	21	51	(37)
2058	0	14.3	14	30	21	51	(37)
2059	0	14.4	14	31	21	52	(38)
2060	0	14.4	14	31	21	52	(38)
2061	0	14.5	14	32	21	53	(38)
2062	0	14.6	15	32	21	53	(39)
2063	0	14.6	15	33	21	54	(39)
2064	0	14.7	15	33	21	54	(40)
2065	0	14.7	15	33	22	55	(40)
2066	0	14.8	15	34	22	55	(41)
2067	0	14.8	15	34	22	56	(41)
2068	0	14.9	15	35	22	56	(41)
2069	0	15.0	15	35	22	57	(42)
2070	0	15.0	15	36	22	57	(42)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Clute's quantified savings from its implemented activities compare with 5- and 10-year and goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[12] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	120	0	0	0
1	2015	11,328	115	19	14	(5)
2	2016	11,350	111	38	14	(24)
3	2017	11,373	106	57	14	(44)
4	2018	11,395	102	77	13	(63)
5-year Goal	2019	11,418	97	96	13	(83)
6	2020	11,440	95	104	13	(91)
7	2021	11,479	93	111	13	(99)
8	2022	11,518	92	119	13	(107)
9	2023	11,557	90	127	13	(115)
10-year Goal	2024	11,596	88	135	13	(123)

[12] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Clute's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[13] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	17.00	0	0	0
1	2015	11,328	15.00	8	12.4	4
2	2016	11,350	13.00	17	12.4	(4)
3	2017	11,373	11.00	25	12.5	(12)
4	2018	11,395	9.00	33	12.5	(21)
5-year Goal	2019	11,418	7.00	42	12.5	(29)
6	2020	11,440	6.60	43	12.5	(31)
7	2021	11,479	6.20	45	12.6	(33)
8	2022	11,518	5.80	47	12.6	(34)
9	2023	11,557	5.40	49	12.7	(36)
10-year Goal	2024	11,596	5.00	51	12.7	(38)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[14]
    a. Savings of 12.4 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[15] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[14] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[15] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	0.3	0.3
2010	0.5	0.5
2011	0.8	0.8
2012	1.0	1.0
2013	1.3	1.3
2014	1.3	1.3
2015	1.3	1.3
2016	1.3	1.3
2017	1.1	1.1
2018	0.8	0.8
2019	0.5	0.5
2020	0.3	0.3
2021		0
2022		0
2023		0
2024		0
2025		0
2026		0
2027		0
2028		0
2029		0
2030		0
2031		0
2032		0
2033		0
2034		0
2035		0
2036		0
2037		0
2038		0
2039		0
2040		0
2041		0
2042		0
2043		0
2044		0
2045		0
2046		0
2047		0
2048		0
2049		0
2050		0
2051		0
2052		0
2053		0
2054		0
2055		0
2056		0
2057		0
2058		0
2059		0
2060		0
2061		0
2062		0
2063		0
2064		0
2065		0
2066		0
2067		0
2068		0
2069		0
2070		0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	17.00	0
2015	11,328	14.00	12.4
2016	11,350	14.00	12.4
2017	11,373	14.00	12.5
2018	11,395	14.00	12.5
2019	11,418	14.00	12.5
2020	11,440	14.00	12.5
2021	11,479	14.00	12.6
2022	11,518	14.00	12.6
2023	11,557	14.00	12.7
2024	11,596	14.00	12.7

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region H savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 19 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	12	14	19	3	4	6	27
2017	1	12	14	19	3	4	7	26
2018	1	12	13	19	3	5	8	24
2019	1	13	13	19	4	6	10	23
2020	0	13	13	19	5	7	11	21
2021	0	13	13	19	6	7	13	19
2022	0	13	13	19	7	8	14	18
2023	0	13	13	19	7	8	16	16
2024	0	13	13	19	8	9	17	15
2025	0	13	13	19	9	9	19	13
2026	0	13	13	19	10	10	20	12
2027	0	13	13	19	11	11	21	11
2028	0	13	13	19	12	11	23	9
2029	0	13	13	19	13	12	24	8
2030	0	13	13	19	13	12	26	6
2031	0	13	13	19	14	13	27	5
2032	0	13	13	19	15	13	28	4
2033	0	13	13	19	16	14	30	3
2034	0	13	13	19	16	15	31	2
2035	0	13	13	19	17	15	32	0
2036	0	13	13	19	18	16	33	(1)
2037	0	13	13	19	18	16	35	(2)
2038	0	13	13	19	19	17	36	(3)
2039	0	13	13	19	20	17	37	(4)
2040	0	13	13	19	21	18	38	(6)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[16]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[16] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	12	14	6	3	4	6	14
2017	1	12	14	6	3	4	7	13
2018	1	12	13	6	3	5	8	11
2019	1	13	13	6	4	6	10	10
2020	0	13	13	6	5	7	11	8
2021	0	13	13	6	6	7	13	6
2022	0	13	13	6	7	8	14	5
2023	0	13	13	6	7	8	16	3
2024	0	13	13	6	8	9	17	2
2025	0	13	13	6	9	9	19	1
2026	0	13	13	6	10	10	20	(1)
2027	0	13	13	6	11	11	21	(2)
2028	0	13	13	6	12	11	23	(4)
2029	0	13	13	6	13	12	24	(5)
2030	0	13	13	6	13	12	26	(6)
2031	0	13	13	6	14	13	27	(8)
2032	0	13	13	6	15	13	28	(9)
2033	0	13	13	6	16	14	30	(10)
2034	0	13	13	6	16	15	31	(11)
2035	0	13	13	6	17	15	32	(12)
2036	0	13	13	6	18	16	33	(14)
2037	0	13	13	6	18	16	35	(15)
2038	0	13	13	6	19	17	36	(16)
2039	0	13	13	6	20	17	37	(17)
2040	0	13	13	6	21	18	38	(19)

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 10 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[17] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[17] The study estimated 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it was determined the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	12	14	10	3	4	6	17
2017	1	12	14	10	3	4	7	16
2018	1	12	13	10	3	5	8	15
2019	1	13	13	10	4	6	10	13
2020	0	13	13	10	5	7	11	11
2021	0	13	13	10	6	7	13	9
2022	0	13	13	10	7	8	14	8
2023	0	13	13	10	7	8	16	7
2024	0	13	13	10	8	9	17	5
2025	0	13	13	10	9	9	19	4
2026	0	13	13	10	10	10	20	2
2027	0	13	13	10	11	11	21	1
2028	0	13	13	10	12	11	23	(0)
2029	0	13	13	10	13	12	24	(2)
2030	0	13	13	10	13	12	26	(3)
2031	0	13	13	10	14	13	27	(4)
2032	0	13	13	10	15	13	28	(6)
2033	0	13	13	10	16	14	30	(7)
2034	0	13	13	10	16	15	31	(8)
2035	0	13	13	10	17	15	32	(9)
2036	0	13	13	10	18	16	33	(10)
2037	0	13	13	10	18	16	35	(12)
2038	0	13	13	10	19	17	36	(13)
2039	0	13	13	10	20	17	37	(14)
2040	0	13	13	10	21	18	38	(15)

4. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Conroe Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Conroe's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Conroe's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.

The 5- and 10-year goals in Conroe's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[5] are expressed in decreasing total GPCD [6] consumption and water loss GPCD.[7] [8]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households

[5] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[6] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[7] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[8] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[9] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because we used a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Conroe with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, excluding savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, the study quantifies utility savings starting in 2012 for this comparison. The summary of these

[9] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[10] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [11] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[11] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	505	210	715	16	0	16	699
2016	519	213	733	20	0	20	712
2017	527	217	744	20	0	20	724
2018	536	220	756	25	0	25	732
2019	545	224	769	29	0	29	740
2020	554	228	781	37	0	37	744
2021	563	232	795	44	0	44	752
2022	572	237	809	50	0	50	759
2023	582	241	823	57	0	57	766
2024	592	246	838	64	0	64	774
2025	602	250	852	71	0	71	781
2026	611	255	866	77	0	77	789
2027	622	259	882	84	0	84	797
2028	632	264	896	91	0	91	805
2029	642	269	910	98	0	98	812
2030	651	273	924	105	0	105	820
2031	659	277	937	110	0	110	826
2032	668	281	950	116	0	116	833
2033	677	285	963	122	0	122	841
2034	686	289	976	128	0	128	848
2035	695	293	989	134	0	134	855
2036	704	297	1,002	139	0	139	862
2037	713	302	1,015	145	0	145	870
2038	722	306	1,028	151	0	151	877
2039	731	310	1,041	157	0	157	884
2040	740	314	1,054	163	0	163	891
2041	749	318	1,066	173	0	173	893
2042	757	321	1,078	184	0	184	895
2043	765	325	1,090	194	0	194	896
2044	773	329	1,102	205	0	205	897
2045	782	333	1,114	215	0	215	899
2046	790	336	1,127	226	0	226	901
2047	799	340	1,139	236	0	236	903
2048	807	344	1,151	247	0	247	905
2049	816	348	1,163	257	0	257	906
2050	824	351	1,176	268	0	268	908
2051	834	355	1,189	271	0	271	919
2052	843	359	1,202	273	0	273	929
2053	852	363	1,216	276	0	276	939
2054	861	367	1,228	279	0	279	949
2055	870	371	1,241	282	0	282	959
2056	879	375	1,255	285	0	285	969
2057	888	379	1,268	288	0	288	980
2058	898	383	1,281	291	0	291	990
2059	907	388	1,295	294	0	294	1,000
2060	916	392	1,308	297	0	297	1,011
2061	926	396	1,322	299	0	299	1,023
2062	936	400	1,336	302	0	302	1,035
2063	946	404	1,351	304	0	304	1,047
2064	956	409	1,365	306	0	306	1,059
2065	966	413	1,379	308	0	308	1,071
2066	977	417	1,394	311	0	311	1,084
2067	987	422	1,409	313	0	313	1,096
2068	997	426	1,423	315	0	315	1,108
2069	1,007	430	1,437	317	0	317	1,120
2070	1,017	435	1,451	320	0	320	1,132

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Conroe's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[12] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	160	0	0	0
1	2016	73,088	159	21	733	711
2	2017	74,298	158	43	744	701
3	2018	75,507	158	66	756	690
4	2019	76,717	157	90	769	679
5-year Goal	2020	77,926	156	114	781	667
6	2021	79,485	155	139	795	656
7	2022	81,044	154	166	809	643
8	2023	82,603	154	193	823	630
9	2024	84,162	153	221	838	616
10-year Goal	2025	85,721	152	250	852	602

[12] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Conroe's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[13] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	17.00	0	0	0
1	2016	73,088	16.80	5	213	208
2	2017	74,298	16.60	11	217	206
3	2018	75,507	16.40	17	220	204
4	2019	76,717	16.20	22	224	202
5-year Goal	2020	77,926	16.00	28	228	199
6	2021	79,485	15.80	35	232	197
7	2022	81,044	15.60	41	237	195
8	2023	82,603	15.40	48	241	193
9	2024	84,162	15.20	55	246	190
10-year Goal	2025	85,721	15.00	63	250	188

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[14]
    a. Savings of 210 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[15] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[16]
        i. 4.0% increase in 2014
        ii. 2.0% increase in 2015
        iii. .6% increase in 2016
    b. Estimated customer demand reduction of 1.3%
    c. Savings is cumulative and based on more than one source[17] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Conservation Pricing**
    a. Tiered rate structure in place saves approximately 2.5% of total demand
    b. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; TWDB, 2013)

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[14] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[15] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[16] Correspondence with utility staff.
[17] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

6. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

7. **Twice-a-week Outdoor Watering Restriction Ordinance**
    a. Estimated savings of 4.0% of total utility demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and the National Wildlife Federation, 2015)
    b. All savings estimates grow each year at the same rate demand figures for the utility grow in the regional water plan.

8. **Kitchen Pre-rinse Spray Valves (ICI)**
    a. 106 replaced valves in 2010
    b. Estimated savings of 28,280 gallons per year per valve (CUWCC, 2004; SWB, 2007)
    c. 10-year useful life assumed

9. **Rain Barrels**
    a. In Region H, estimated savings of 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
    b. Estimated 10-year useful life for most barrels and systems

[18] The study estimates 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, the study can determine the savings for lower or higher percentage increases.

10. Outdoor Landscape Evaluations (SF)

a. 1,178 outdoor evaluations performed since 2011
b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005)
    i. Assumed 65% savings from typical indoor and outdoor survey when only outdoor watering is evaluated (Whitcomb, 2000)
c. Approximately 22 gallons per day
d. Greater savings during peak periods
e. Lesser savings during off-peak periods
f. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Conservation Pricing	Water Rate Increases	Rain Barrels	2x Watering Ordinance	Pre-rinse Spray Valves (ICI)	W.I.S.E. Guys Landscape Evaluations (SF)	TOTAL SAVINGS
2009							0
2010	89				3		92
2011	91				3	1.6	96
2012	93		0.4	330	3	2.8	429
2013	95		0.4	336	3	3.4	438
2014	97	31	0.4	343	3	4.0	479
2015	99	48	0.4	350	3	4.9	505
2016	101	53	0.4	357	3	4.9	519
2017	103	54	0.4	364	3	3.3	527
2018	105	55	0.4	371	3	2.0	536
2019	107	56	0.4	377	3	1.0	545
2020	109	57	0.4	384	3	0.3	554
2021	111	58	0.4	391	3		563
2022	113	59		398	3		572
2023	114	60		405	3		582
2024	116	61		412	3		592
2025	118	62		418	3		602
2026	120	63		425	3		611
2027	122	65		432	3		622
2028	124	66		439	3		632
2029	126	67		446	3		642
2030	128	68		452	3		651
2031	130	68		459	3		659
2032	131	69		465	3		668
2033	133	70		471	3		677
2034	135	71		477	3		686
2035	137	72		484	3		695
2036	139	73		490	3		704
2037	140	74		496	3		713
2038	142	75		502	3		722
2039	144	76		508	3		731
2040	146	77		515	3		740
2041	147	78		520	3		749
2042	149	79		526	3		757
2043	151	79		532	3		765
2044	152	80		538	3		773
2045	154	81		544	3		782
2046	155	82		550	3		790
2047	157	83		556	3		799
2048	159	84		562	3		807
2049	160	85		567	3		816
2050	162	86		573	3		824
2051	164	87		580	3		834
2052	166	88		586	3		843
2053	168	89		593	3		852
2054	169	89		599	3		861
2055	171	90		606	3		870
2056	173	91		612	3		879
2057	175	92		619	3		888
2058	177	93		625	3		898
2059	179	94		631	3		907
2060	180	95		638	3		916
2061	182	96		645	3		926
2062	184	97		652	3		936
2063	186	98		659	3		946
2064	188	99		666	3		956
2065	190	100		673	3		966
2066	192	102		680	3		977
2067	194	103		687	3		987
2068	196	104		694	3		997
2069	198	105		701	3		1,007
2070	200	106		708	3		1,017

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	17.00	0
2015	71,879	9.00	210
2016	73,088	9.00	213
2017	74,298	9.00	217
2018	75,507	9.00	220
2019	76,717	9.00	224
2020	77,926	9.00	228
2021	79,485	9.00	232
2022	81,044	9.00	237
2023	82,603	9.00	241
2024	84,162	9.00	246

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-1 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-1. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	519	213	733	54	20	0	20	765
2017	527	217	744	55	20	0	20	779
2018	536	220	756	56	25	0	25	788
2019	545	224	769	57	29	0	29	797
2020	554	228	781	58	37	0	37	803
2021	563	232	795	59	44	0	44	811
2022	572	237	809	60	50	0	50	819
2023	582	241	823	61	57	0	57	828
2024	592	246	838	62	64	0	64	836
2025	602	250	852	63	71	0	71	845
2026	611	255	866	64	77	0	77	853
2027	622	259	882	65	84	0	84	863
2028	632	264	896	67	91	0	91	871
2029	642	269	910	68	98	0	98	880
2030	651	273	924	69	105	0	105	888
2031	659	277	937	70	110	0	110	896
2032	668	281	950	70	116	0	116	904
2033	677	285	963	71	122	0	122	912
2034	686	289	976	72	128	0	128	920
2035	695	293	989	73	134	0	134	928
2036	704	297	1,002	74	139	0	139	937
2037	713	302	1,015	75	145	0	145	945
2038	722	306	1,028	76	151	0	151	953
2039	731	310	1,041	77	157	0	157	961
2040	740	314	1,054	78	163	0	163	969

1. Employ efforts to maintain water loss volumes near baseline level or below.
2. In the future, as your utility finds water and/or wastewater service rate increases necessary, such pricing signals should continue to be effective in reducing demand.

Statewide Water Conservation Quantification Project
City of Deer Park Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
    - County-Other (Rural/unincorporated areas of municipal water use)
    - Manufacturing
    - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Deer Park's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Deer Park's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Deer Park's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8 9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Deer Park with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	3.0	173	176	5	10	15	160
2016	3.8	173	177	6	13	19	158
2017	3.9	174	178	6	16	22	156
2018	4.0	174	178	7	18	26	152
2019	4.0	175	179	9	21	29	149
2020	3.3	175	178	11	23	35	144
2021	2.4	176	178	13	26	39	140
2022	1.6	177	178	15	28	43	135
2023	0.8	178	178	17	30	47	131
2024	0	179	179	20	32	52	127
2025	0	179	179	22	34	56	124
2026	0	180	180	24	36	60	120
2027	0	181	181	26	39	64	117
2028	0	182	182	28	41	69	113
2029	0	183	183	30	43	73	110
2030	0	184	184	32	45	77	107
2031	0	185	185	34	47	81	103
2032	0	185	185	36	49	85	100
2033	0	186	186	38	51	89	97
2034	0	187	187	40	53	93	94
2035	0	188	188	42	55	97	90
2036	0	188	188	44	57	101	87
2037	0	189	189	46	59	105	84
2038	0	190	190	48	61	109	81
2039	0	191	191	50	63	113	77
2040	0	192	192	52	65	117	74
2041	0	192	192	54	67	121	71
2042	0	193	193	56	69	125	68
2043	0	194	194	58	71	129	65
2044	0	194	194	60	73	133	62
2045	0	195	195	62	75	137	58
2046	0	196	196	63	77	140	55
2047	0	196	196	65	79	144	52
2048	0	197	197	67	81	148	49
2049	0	198	198	69	83	152	46
2050	0	199	199	71	85	156	43
2051	0	199	199	73	87	160	40
2052	0	200	200	75	89	163	36
2053	0	200	200	77	91	167	33
2054	0	201	201	78	93	171	30
2055	0	202	202	80	95	175	27
2056	0	202	202	82	96	179	24
2057	0	203	203	84	98	182	21
2058	0	204	204	86	100	186	17
2059	0	204	204	88	102	190	14
2060	0	205	205	90	104	194	11
2061	0	206	206	91	105	197	9
2062	0	206	206	93	107	200	7
2063	0	207	207	95	108	203	4
2064	0	208	208	97	109	206	2
2065	0	208	208	98	110	209	(0)
2066	0	209	209	100	111	212	(3)
2067	0	209	209	102	113	214	(5)
2068	0	210	210	104	114	217	(7)
2069	0	211	211	105	115	220	(10)
2070	0	211	211	107	116	223	(12)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Deer Park's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	144	0	0	0
1	2015	33,806	140	47	176	129
2	2016	33,896	136	94	177	83
3	2017	33,986	133	141	178	36
4	2018	34,075	129	189	178	(11)
5-year Goal	2019	34,165	125	237	179	(58)
6	2020	34,255	124	255	178	(77)
7	2021	34,427	122	274	178	(96)
8	2022	34,599	121	293	178	(115)
9	2023	34,771	119	312	178	(134)
10-year Goal	2024	34,943	118	332	179	(153)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Deer Park's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	**Baseline**	-	49.00	0	0	0
1	2015	33,806	44.20	59	173	114
2	2016	33,896	39.40	119	173	54
3	2017	33,986	34.60	179	174	(5)
4	2018	34,075	29.80	239	174	(65)
5-year Goal	2019	34,165	25.00	299	175	(125)
6	2020	34,255	23.60	318	175	(143)
7	2021	34,427	22.20	337	176	(161)
8	2022	34,599	20.80	356	177	(179)
9	2023	34,771	19.40	376	178	(198)
10-year Goal	2024	34,943	18.00	395	179	(217)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 173 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	0.8	0.8
2010	1.5	1.5
2011	2.3	2.3
2012	3.0	3.0
2013	3.8	3.8
2014	3.9	3.9
2015	4.0	4.0
2016	4.0	4.0
2017	3.3	3.3
2018	2.4	2.4
2019	1.6	1.6
2020	0.8	0.8
2021		0.0
2022		0.0
2023		0.0
2024		0.0
2025		0.0
2026		0.0
2027		0.0
2028		0.0
2029		0.0
2030		0.0
2031		0.0
2032		0.0
2033		0.0
2034		0.0
2035		0.0
2036		0.0
2037		0.0
2038		0.0
2039		0.0
2040		0.0
2041		0.0
2042		0.0
2043		0.0
2044		0.0
2045		0.0
2046		0.0
2047		0.0
2048		0.0
2049		0.0
2050		0.0
2051		0.0
2052		0.0
2053		0.0
2054		0.0
2055		0.0
2056		0.0
2057		0.0
2058		0.0
2059		0.0
2060		0.0
2061		0.0
2062		0.0
2063		0.0
2064		0.0
2065		0.0
2066		0.0
2067		0.0
2068		0.0
2069		0.0
2070		0.0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	49.00	0
2015	33,806	35.00	173
2016	33,896	35.00	173
2017	33,986	35.00	174
2018	34,075	35.00	174
2019	34,165	35.00	175
2020	34,255	35.00	175
2021	34,427	35.00	176
2022	34,599	35.00	177
2023	34,771	35.00	178
2024	34,943	35.00	179

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region H savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 56 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	4	173	177	56	6	13	19	213
2017	4	174	178	56	6	16	22	211
2018	4	174	178	56	7	18	26	208
2019	4	175	179	56	9	21	29	205
2020	3	175	178	56	11	23	35	200
2021	2	176	178	56	13	26	39	196
2022	2	177	178	56	15	28	43	191
2023	1	178	178	56	17	30	47	187
2024	0	179	179	56	20	32	52	183
2025	0	179	179	56	22	34	56	180
2026	0	180	180	56	24	36	60	177
2027	0	181	181	56	26	38	64	173
2028	0	182	182	57	28	41	69	170
2029	0	183	183	57	30	43	73	167
2030	0	184	184	57	32	45	77	163
2031	0	185	185	57	34	47	81	160
2032	0	185	185	57	36	49	85	157
2033	0	186	186	57	38	51	89	154
2034	0	187	187	57	40	53	93	151
2035	0	188	188	57	42	55	97	147
2036	0	188	188	57	44	57	101	144
2037	0	189	189	57	46	59	105	141
2038	0	190	190	57	48	61	109	138
2039	0	191	191	57	50	63	113	135
2040	0	192	192	57	52	65	117	132

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	4	173	177	19	6	13	19	176
2017	4	174	178	19	6	16	22	174
2018	4	174	178	19	7	19	26	171
2019	4	175	179	19	9	21	29	168
2020	3	175	178	19	11	23	35	162
2021	2	176	178	19	13	26	39	158
2022	2	177	178	19	15	28	43	154
2023	1	178	178	19	17	30	47	150
2024	0	179	179	19	20	32	52	146
2025	0	179	179	19	22	34	56	142
2026	0	180	180	19	24	38	60	138
2027	0	181	181	19	26	39	64	136
2028	0	182	182	19	28	41	68	132
2029	0	183	183	19	30	43	73	129
2030	0	184	184	19	32	45	77	126
2031	0	185	185	19	34	47	81	122
2032	0	185	185	19	36	49	85	119
2033	0	186	186	19	38	51	89	116
2034	0	187	187	19	40	53	93	113
2035	0	188	188	19	42	55	97	110
2036	0	188	188	19	44	57	101	106
2037	0	189	189	19	46	59	105	103
2038	0	190	190	19	48	61	109	100
2039	0	191	191	19	50	63	113	97
2040	0	192	192	19	52	65	117	93

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 28 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	4	173	177	28	6	13	19	186
2017	4	174	178	28	6	16	22	184
2018	4	174	178	28	7	18	26	180
2019	4	175	179	28	9	21	29	177
2020	3	175	178	28	11	23	35	172
2021	2	176	178	28	13	26	39	168
2022	2	177	178	28	15	28	43	163
2023	1	178	178	28	17	30	47	159
2024	0	179	179	28	20	32	52	155
2025	0	179	179	28	22	34	56	152
2026	0	180	180	28	24	36	60	148
2027	0	181	181	28	25	39	64	145
2028	0	182	182	28	28	41	69	142
2029	0	183	183	28	30	43	73	138
2030	0	184	184	28	32	45	77	135
2031	0	185	185	28	34	47	81	132
2032	0	185	185	28	36	49	85	129
2033	0	186	186	28	38	51	89	125
2034	0	187	187	28	40	53	93	122
2035	0	188	188	29	42	55	97	119
2036	0	188	188	29	44	57	101	116
2037	0	189	189	29	46	59	105	113
2038	0	190	190	29	48	61	109	109
2039	0	191	191	29	50	63	113	106
2040	0	192	192	29	52	65	117	103

4. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Friendswood Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were to be completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Friendswood's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Friendswood's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Friendswood's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Friendswood with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	5.2	(84)	(79)	4	0	4	(83)
2016	5.2	(84)	(79)	5	0	5	(84)
2017	4.3	(85)	(81)	5	0	5	(86)
2018	3.2	(86)	(82)	6	0	6	(88)
2019	2.0	(86)	(84)	7	0	7	(91)
2020	1.0	(87)	(86)	9	0	9	(95)
2021	0	(88)	(88)	11	0	11	(99)
2022	0	(89)	(89)	13	0	13	(102)
2023	0	(90)	(90)	15	0	15	(105)
2024	0	(91)	(91)	17	0	17	(108)
2025	0	(92)	(92)	19	0	19	(111)
2026	0	(93)	(93)	21	0	21	(114)
2027	0	(94)	(94)	23	0	23	(117)
2028	0	(95)	(95)	25	0	25	(120)
2029	0	(96)	(96)	27	0	27	(123)
2030	0	(96)	(96)	29	0	29	(126)
2031	0	(97)	(97)	31	0	31	(129)
2032	0	(98)	(98)	34	0	34	(132)
2033	0	(99)	(99)	36	0	36	(135)
2034	0	(100)	(100)	38	0	38	(138)
2035	0	(101)	(101)	40	0	40	(140)
2036	0	(102)	(102)	42	0	42	(143)
2037	0	(102)	(102)	44	0	44	(146)
2038	0	(103)	(103)	46	0	46	(149)
2039	0	(104)	(104)	48	0	48	(152)
2040	0	(105)	(105)	50	0	50	(155)
2041	0	(106)	(106)	52	0	52	(158)
2042	0	(107)	(107)	55	0	55	(162)
2043	0	(108)	(108)	57	0	57	(165)
2044	0	(109)	(109)	59	0	59	(168)
2045	0	(109)	(109)	62	0	62	(171)
2046	0	(110)	(110)	64	0	64	(174)
2047	0	(111)	(111)	66	0	66	(177)
2048	0	(112)	(112)	68	0	68	(181)
2049	0	(113)	(113)	71	0	71	(184)
2050	0	(114)	(114)	73	0	73	(187)
2051	0	(115)	(115)	75	0	75	(190)
2052	0	(116)	(116)	78	0	78	(194)
2053	0	(117)	(117)	80	0	80	(197)
2054	0	(118)	(118)	83	0	83	(200)
2055	0	(119)	(119)	85	0	85	(204)
2056	0	(120)	(120)	87	0	87	(207)
2057	0	(121)	(121)	90	0	90	(210)
2058	0	(121)	(121)	92	0	92	(213)
2059	0	(122)	(122)	94	0	94	(217)
2060	0	(123)	(123)	97	0	97	(220)
2061	0	(124)	(124)	99	0	99	(224)
2062	0	(125)	(125)	102	0	102	(227)
2063	0	(126)	(126)	105	0	105	(231)
2064	0	(127)	(127)	107	0	107	(235)
2065	0	(129)	(129)	110	0	110	(238)
2066	0	(130)	(130)	112	0	112	(242)
2067	0	(131)	(131)	115	0	115	(246)
2068	0	(132)	(132)	118	0	118	(249)
2069	0	(133)	(133)	120	0	120	(253)
2070	0	(134)	(134)	123	0	123	(257)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Friendswood's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	136	0	0	0
1	2015	38,248	135	8	(79)	(87)
2	2016	38,528	135	17	(79)	(96)
3	2017	38,808	134	25	(81)	(106)
4	2018	39,089	134	34	(82)	(117)
5-year Goal	2019	39,369	133	43	(84)	(127)
6	2020	39,649	132	52	(86)	(138)
7	2021	40,089	132	61	(88)	(149)
8	2022	40,529	131	71	(89)	(160)
9	2023	40,969	131	81	(90)	(170)
10-year Goal	2024	41,409	130	91	(91)	(181)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Friendswood's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	15.00	0	0	0
1	2015	38,248	15.00	0	(84)	(84)
2	2016	38,528	15.00	0	(84)	(84)
3	2017	38,808	15.00	0	(85)	(85)
4	2018	39,089	15.00	0	(86)	(86)
5-year Goal	2019	39,369	15.00	0	(86)	(86)
6	2020	39,649	15.00	0	(87)	(87)
7	2021	40,089	15.00	0	(88)	(88)
8	2022	40,529	15.00	0	(89)	(89)
9	2023	40,969	15.00	0	(90)	(90)
10-year Goal	2024	41,409	15.00	0	(91)	(91)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 84 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	1.1	1.1
2010	2.0	2.0
2011	3.0	3.0
2012	3.9	3.9
2013	5.0	5.0
2014	5.1	5.1
2015	5.2	5.2
2016	5.2	5.2
2017	4.3	4.3
2018	3.2	3.2
2019	2.0	2.0
2020	1.0	1.0
2021		0.0
2022		0.0
2023		0.0
2024		0.0
2025		0.0
2026		0.0
2027		0.0
2028		0.0
2029		0.0
2030		0.0
2031		0.0
2032		0.0
2033		0.0
2034		0.0
2035		0.0
2036		0.0
2037		0.0
2038		0.0
2039		0.0
2040		0.0
2041		0.0
2042		0.0
2043		0.0
2044		0.0
2045		0.0
2046		0.0
2047		0.0
2048		0.0
2049		0.0
2050		0.0
2051		0.0
2052		0.0
2053		0.0
2054		0.0
2055		0.0
2056		0.0
2057		0.0
2058		0.0
2059		0.0
2060		0.0
2061		0.0
2062		0.0
2063		0.0
2064		0.0
2065		0.0
2066		0.0
2067		0.0
2068		0.0
2069		0.0
2070		0.0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	15.00	0
2015	38,248	21.00	(84)
2016	38,528	21.00	(84)
2017	38,808	21.00	(85)
2018	39,089	21.00	(86)
2019	39,369	21.00	(86)
2020	39,649	21.00	(87)
2021	40,089	21.00	(88)
2022	40,529	21.00	(89)
2023	40,969	21.00	(90)
2024	41,409	21.00	(91)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 10.11% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 222 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	5	(84)	(79)	222	5	0	5	138
2017	4	(85)	(81)	224	5	0	5	138
2018	3	(86)	(82)	226	6	0	6	138
2019	2	(86)	(84)	228	7	0	7	137
2020	1	(87)	(86)	230	9	0	9	135
2021	0	(88)	(88)	232	11	0	11	133
2022	0	(89)	(89)	234	13	0	13	132
2023	0	(90)	(90)	236	15	0	15	131
2024	0	(91)	(91)	238	17	0	17	130
2025	0	(92)	(92)	240	19	0	19	129
2026	0	(93)	(93)	242	21	0	21	128
2027	0	(94)	(94)	244	23	0	23	127
2028	0	(95)	(95)	246	25	0	25	126
2029	0	(96)	(96)	248	27	0	27	125
2030	0	(96)	(96)	250	29	0	29	124
2031	0	(97)	(97)	252	31	0	31	123
2032	0	(98)	(98)	253	34	0	34	122
2033	0	(99)	(99)	255	36	0	36	121
2034	0	(100)	(100)	257	38	0	38	119
2035	0	(101)	(101)	259	40	0	40	118
2036	0	(102)	(102)	260	42	0	42	117
2037	0	(102)	(102)	262	44	0	44	116
2038	0	(103)	(103)	264	46	0	46	115
2039	0	(104)	(104)	266	48	0	48	114
2040	0	(105)	(105)	268	50	0	50	112

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	5	(84)	(79)	29	5	0	5	(50)
2017	4	(85)	(81)	30	5	0	5	(56)
2018	3	(86)	(82)	30	6	0	6	(59)
2019	2	(85)	(84)	30	7	0	7	(61)
2020	1	(87)	(86)	30	9	0	9	(64)
2021	0	(88)	(88)	31	11	0	11	(69)
2022	0	(89)	(89)	31	13	0	13	(71)
2023	0	(90)	(90)	31	15	0	15	(74)
2024	0	(91)	(91)	32	17	0	17	(76)
2025	0	(92)	(92)	32	19	0	19	(79)
2026	0	(93)	(93)	32	21	0	21	(82)
2027	0	(94)	(94)	32	23	0	23	(85)
2028	0	(95)	(95)	33	25	0	25	(87)
2029	0	(96)	(96)	33	27	0	27	(90)
2030	0	(96)	(96)	33	29	0	29	(93)
2031	0	(97)	(97)	33	31	0	31	(95)
2032	0	(98)	(98)	34	34	0	34	(98)
2033	0	(99)	(99)	34	36	0	36	(101)
2034	0	(100)	(100)	34	38	0	38	(103)
2035	0	(101)	(101)	34	40	0	40	(106)
2036	0	(102)	(102)	35	42	0	42	(109)
2037	0	(102)	(102)	35	44	0	44	(112)
2038	0	(103)	(103)	35	46	0	46	(114)
2039	0	(104)	(104)	35	48	0	48	(117)
2040	0	(105)	(105)	35	50	0	50	(120)

3. Water Rate Increase
    a. For every 10% increase, estimated savings could be 2% of utility total demand.
    b. Approximately 44 MG of savings per year with current demand
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	5	(84)	(79)	44	5	0	5	(40)
2017	4	(85)	(81)	44	5	0	5	(41)
2018	3	(86)	(82)	45	6	0	6	(44)
2019	2	(86)	(84)	45	7	0	7	(46)
2020	1	(87)	(86)	45	9	0	9	(49)
2021	0	(88)	(88)	46	11	0	11	(53)
2022	0	(89)	(89)	46	13	0	13	(56)
2023	0	(90)	(90)	47	15	0	15	(58)
2024	0	(91)	(91)	47	17	0	17	(61)
2025	0	(92)	(92)	47	19	0	19	(63)
2026	0	(93)	(93)	48	21	0	21	(66)
2027	0	(94)	(94)	48	23	0	23	(68)
2028	0	(95)	(95)	49	25	0	25	(71)
2029	0	(96)	(96)	49	27	0	27	(74)
2030	0	(96)	(96)	49	29	0	29	(76)
2031	0	(97)	(97)	50	31	0	31	(79)
2032	0	(98)	(98)	50	34	0	34	(82)
2033	0	(99)	(99)	50	36	0	36	(84)
2034	0	(100)	(100)	51	38	0	38	(87)
2035	0	(101)	(101)	51	40	0	40	(89)
2036	0	(102)	(102)	52	42	0	42	(92)
2037	0	(102)	(102)	52	44	0	44	(94)
2038	0	(103)	(103)	52	46	0	46	(97)
2039	0	(104)	(104)	53	48	0	48	(100)
2040	0	(105)	(105)	53	50	0	50	(102)

4. Rain Barrels
    a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
    b. Estimated 10-year useful life for most barrels

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Statewide Water Conservation Quantification Project
City of Galveston Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached,

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus,

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Galveston's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Galveston's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Galveston's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Galveston with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	247	0	247	5	31	36	211
2016	248	0	248	7	39	45	203
2017	248	0	248	7	46	53	195
2018	248	0	248	8	54	62	186
2019	248	0	248	9	62	71	177
2020	248	0	248	12	69	81	166
2021	248	0	248	14	76	91	157
2022	249	0	249	17	83	100	149
2023	250	0	250	19	90	109	141
2024	251	0	251	22	97	119	132
2025	252	0	252	24	104	128	124
2026	254	0	254	26	111	137	116
2027	255	0	255	29	118	147	108
2028	256	0	256	31	125	156	100
2029	257	0	257	33	132	165	92
2030	258	0	258	36	139	175	84
2031	260	0	260	38	145	184	76
2032	261	0	261	41	152	193	68
2033	262	0	262	43	158	202	60
2034	263	0	263	46	165	211	53
2035	265	0	265	49	171	220	45
2036	266	0	266	51	178	229	37
2037	267	0	267	54	184	238	29
2038	269	0	269	56	191	247	21
2039	270	0	270	59	197	256	14
2040	271	0	271	61	204	265	6
2041	273	0	273	64	205	269	4
2042	274	0	274	66	206	272	2
2043	275	0	275	69	207	276	(0)
2044	277	0	277	71	208	279	(3)
2045	278	0	278	73	209	283	(5)
2046	280	0	280	76	210	286	(7)
2047	281	0	281	78	212	290	(9)
2048	283	0	283	81	213	293	(11)
2049	284	0	284	83	214	297	(13)
2050	285	0	285	86	215	300	(15)
2051	287	0	287	88	216	304	(17)
2052	288	0	288	91	217	307	(19)
2053	289	0	289	93	218	311	(21)
2054	291	0	291	96	219	314	(24)
2055	292	0	292	98	220	318	(26)
2056	294	0	294	101	221	321	(28)
2057	295	0	295	103	222	325	(30)
2058	296	0	296	106	223	328	(32)
2059	298	0	298	108	224	332	(34)
2060	299	0	299	110	225	335	(36)
2061	300	0	300	113	226	339	(39)
2062	302	0	302	116	227	343	(41)
2063	303	0	303	118	228	347	(43)
2064	305	0	305	121	229	350	(45)
2065	306	0	306	124	230	354	(48)
2066	308	0	308	126	232	358	(50)
2067	309	0	309	129	233	362	(52)
2068	311	0	311	132	234	365	(55)
2069	312	0	312	134	235	369	(57)
2070	314	0	314	137	236	373	(59)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Galveston's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	267	0	0	0
1	2015	48,950	266	11	247	237
2	2016	49,412	266	22	248	227
3	2017	49,874	265	33	248	216
4	2018	50,336	265	44	248	204
5-year Goal	2019	50,798	264	56	248	192
6	2,020	51,260	263	75	248	173
7	2,021	51,598	262	94	248	154
8	2,022	51,937	261	114	249	135
9	2,023	52,275	260	134	250	116
10-year Goal	2,024	52,613	259	154	251	98

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Galveston's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	26.00	0	0	0
1	2015	48,950	26.00	0	0	0
2	2016	49,412	26.00	0	0	0
3	2017	49,874	26.00	0	0	0
4	2018	50,336	26.00	0	0	0
5-year Goal	2019	50,798	26.00	0	0	0
6	2,020	51,260	26	4	0	(4)
7	2,021	51,598	26	8	0	(8)
8	2,022	51,937	25	11	0	(11)
9	2,023	52,275	25	15	0	(15)
10-year Goal	2,024	52,613	25	19	0	(19)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 0 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 22.78% increase in 2015
    b. Estimated customer demand reduction of 4.55%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	WaterWise Take-home Kits	TOTAL SAVINGS
2009		1.4	1.4
2010		2.6	2.6
2011		3.9	3.9
2012		5.1	5.1
2013		6.5	6.5
2014		6.6	6.6
2015	241	6.7	247.3
2016	242	6.7	248.5
2017	243	5.5	248.4
2018	244	4.1	248.2
2019	245	2.6	248.0
2020	246	1.3	247.8
2021	248		247.7
2022	249		248.9
2023	250		250.0
2024	251		251.2
2025	252		252.4
2026	254		253.6
2027	255		254.8
2028	256		256.0
2029	257		257.2
2030	258		258.3
2031	260		259.6
2032	261		260.9
2033	262		262.2
2034	263		263.5
2035	265		264.7
2036	266		266.0
2037	267		267.3
2038	269		268.6
2039	270		269.9
2040	271		271.1
2041	273		272.6
2042	274		274.0
2043	275		275.4
2044	277		276.8
2045	278		278.2
2046	280		279.7
2047	281		281.1
2048	283		282.5
2049	284		283.9
2050	285		285.4
2051	287		286.7
2052	288		288.1
2053	289		289.5
2054	291		290.8
2055	292		292.2
2056	294		293.6
2057	295		294.9
2058	296		296.3
2059	298		297.6
2060	299		299.0
2061	300		300.5
2062	302		301.9
2063	303		303.4
2064	305		304.9
2065	306		306.3
2066	308		307.8
2067	309		309.3
2068	311		310.7
2069	312		312.2
2070	314		313.7

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	26.00	0
2015	48,277	26.00	0
2016	48,501	26.00	0
2017	48,726	26.00	0
2018	48,950	26.00	0
2019	49,412	26.00	0
2020	49,874	26.00	0
2021	50,336	26.00	0
2022	50,798	26.00	0
2023	51,260	26.00	0
2024	51,598	26.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 213 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	248	0	248	213	7	39	45	416
2017	248	0	248	214	7	46	53	409
2018	248	0	248	215	8	54	62	401
2019	248	0	248	216	9	62	71	393
2020	248	0	248	217	12	69	81	383
2021	248	0	248	218	14	76	91	375
2022	249	0	249	219	17	83	100	368
2023	250	0	250	220	19	90	109	360
2024	251	0	251	221	22	97	119	353
2025	252	0	252	222	24	104	128	346
2026	254	0	254	223	26	111	137	339
2027	255	0	255	224	29	118	147	332
2028	256	0	256	225	31	125	156	325
2029	257	0	257	226	33	132	165	318
2030	258	0	258	227	36	139	175	311
2031	260	0	260	228	38	145	184	304
2032	261	0	261	229	41	152	193	297
2033	262	0	262	230	43	158	202	291
2034	263	0	263	232	46	165	211	284
2035	265	0	265	233	49	171	220	277
2036	266	0	266	234	51	178	229	271
2037	267	0	267	235	54	184	238	264
2038	269	0	269	236	56	191	247	258
2039	270	0	270	237	59	197	256	251
2040	271	0	271	238	61	204	265	244

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	248	0	248	71	7	39	45	274
2017	248	0	248	72	7	46	53	267
2018	248	0	248	72	8	54	62	258
2019	248	0	248	72	9	62	71	249
2020	248	0	248	73	12	69	81	239
2021	248	0	248	73	14	76	91	230
2022	249	0	249	73	17	83	100	222
2023	250	0	250	74	19	90	109	214
2024	251	0	251	76	22	97	119	206
2025	252	0	252	74	24	104	128	199
2026	254	0	254	75	26	111	137	191
2027	255	0	255	75	29	118	147	183
2028	256	0	256	75	31	125	156	175
2029	257	0	257	76	33	132	165	168
2030	258	0	258	76	36	139	175	160
2031	260	0	260	76	38	145	184	152
2032	261	0	261	77	41	152	193	145
2033	262	0	262	77	43	158	202	138
2034	263	0	263	78	46	165	211	130
2035	265	0	265	78	49	171	220	123
2036	266	0	266	78	51	178	229	115
2037	267	0	267	79	54	184	238	108
2038	269	0	269	79	56	191	247	101
2039	270	0	270	79	59	197	256	93
2040	271	0	271	80	61	204	265	86

3. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Houston Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Houston's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Houston's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Houston's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Houston with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	2,058	3,937	5,995	525	950	1,475	4,520
2016	2,070	3,987	6,057	656	1,187	1,843	4,213
2017	3,025	4,037	7,062	656	1,425	2,081	4,981
2018	2,988	4,087	7,075	787	1,662	2,449	4,625
2019	2,946	4,090	7,037	918	1,900	2,818	4,219
2020	2,911	4,094	7,005	1,181	2,137	3,318	3,687
2021	2,876	4,097	6,973	1,418	2,354	3,772	3,201
2022	2,892	4,100	6,992	1,656	2,570	4,226	2,766
2023	2,908	4,103	7,011	1,893	2,787	4,680	2,331
2024	2,924	4,136	7,060	2,131	3,003	5,135	1,925
2025	2,939	4,169	7,108	2,369	3,220	5,589	1,519
2026	2,954	4,202	7,157	2,606	3,437	6,043	1,114
2027	2,970	4,235	7,205	2,844	3,653	6,497	708
2028	2,986	4,268	7,254	3,081	3,870	6,951	303
2029	3,002	4,301	7,303	3,319	4,086	7,405	(102)
2030	3,019	4,334	7,352	3,557	4,303	7,859	(507)
2031	3,035	4,367	7,402	3,798	4,522	8,320	(918)
2032	3,052	4,399	7,452	4,039	4,742	8,780	(1,329)
2033	3,069	4,432	7,502	4,280	4,961	9,241	(1,739)
2034	3,086	4,465	7,551	4,521	5,180	9,701	(2,150)
2035	3,103	4,497	7,600	4,762	5,400	10,162	(2,562)
2036	3,120	4,529	7,649	5,003	5,619	10,622	(2,973)
2037	3,137	4,562	7,698	5,244	5,838	11,083	(3,384)
2038	3,153	4,594	7,748	5,485	6,058	11,543	(3,795)
2039	3,170	4,627	7,797	5,726	6,277	12,004	(4,207)
2040	3,187	4,659	7,846	5,968	6,496	12,464	(4,618)
2041	3,206	4,691	7,897	6,214	6,722	12,936	(5,038)
2042	3,225	4,724	7,949	6,460	6,948	13,408	(5,459)
2043	3,244	4,756	8,000	6,706	7,173	13,879	(5,880)
2044	3,262	4,788	8,051	6,952	7,399	14,351	(6,300)
2045	3,281	4,821	8,102	7,198	7,624	14,823	(6,721)
2046	3,300	4,853	8,153	7,444	7,850	15,294	(7,141)
2047	3,319	4,886	8,205	7,691	8,076	15,766	(7,562)
2048	3,338	4,918	8,256	7,937	8,301	16,238	(7,982)
2049	3,356	4,951	8,307	8,183	8,527	16,710	(8,403)
2050	3,375	4,983	8,358	8,429	8,752	17,181	(8,823)
2051	3,397	5,015	8,412	8,680	8,822	17,502	(9,090)
2052	3,418	5,048	8,466	8,932	8,891	17,823	(9,358)
2053	3,439	5,080	8,519	9,183	8,961	18,144	(9,625)
2054	3,460	5,113	8,574	9,435	9,030	18,465	(9,891)
2055	3,482	5,147	8,628	9,686	9,100	18,786	(10,158)
2056	3,503	5,180	8,683	9,937	9,169	19,107	(10,424)
2057	3,524	5,213	8,737	10,189	9,239	19,428	(10,690)
2058	3,546	5,246	8,792	10,440	9,308	19,748	(10,957)
2059	3,567	5,279	8,846	10,692	9,378	20,069	(11,223)
2060	3,588	5,313	8,901	10,943	9,447	20,390	(11,489)
2061	3,611	5,346	8,957	11,200	9,507	20,707	(11,751)
2062	3,633	5,379	9,012	11,458	9,567	21,025	(12,012)
2063	3,656	5,412	9,068	11,715	9,627	21,342	(12,273)
2064	3,679	5,447	9,125	11,972	9,687	21,659	(12,533)
2065	3,701	5,481	9,182	12,229	9,747	21,976	(12,793)
2066	3,724	5,516	9,240	12,487	9,806	22,293	(13,053)
2067	3,746	5,550	9,297	12,744	9,866	22,610	(13,313)
2068	3,769	5,585	9,354	13,001	9,926	22,927	(13,573)
2069	3,792	5,619	9,411	13,258	9,986	23,244	(13,833)
2070	3,814	5,654	9,468	13,516	10,046	23,562	(14,093)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Houston's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	152	0	0	0
1	2015	2,239,558	152	327	5,995	5,668
2	2016	2,241,329	151	654	6,057	5,402
3	2017	2,243,100	151	982	7,062	6,079
4	2018	2,244,872	150	1,311	7,075	5,764
5-year Goal	2019	2,246,643	150	1,640	7,037	5,397
6	2020	2,248,414	150	2,035	7,005	4,970
7	2021	2,266,441	149	2,449	6,973	4,524
8	2022	2,284,467	149	2,868	6,992	4,124
9	2023	2,302,494	148	3,294	7,011	3,717
10-year Goal	2024	2,320,520	148	3,727	7,060	3,333

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Houston's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	31.00	0	0	0
1	2015	2,239,558	30.88	98	3,937	3,838
2	2016	2,241,329	30.76	196	3,987	3,790
3	2017	2,243,100	30.64	295	4,037	3,742
4	2018	2,244,872	30.52	393	4,087	3,694
5-year Goal	2019	2,246,643	30.40	492	4,090	3,598
6	2020	2,248,414	30.28	591	4,094	3,503
7	2021	2,266,441	30.16	695	4,097	3,402
8	2022	2,284,467	30.04	800	4,100	3,300
9	2023	2,302,494	29.92	908	4,103	3,196
10-year Goal	2024	2,320,520	29.80	1,016	4,136	3,120

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (Texas Water Development Board, 2013; U.S. E.P.A., 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 3,937 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 3.4% increase in 2016
    b. Estimated customer demand reduction of .68%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years

5. **Advanced Metering Infrastructure (AMI) with Customer Engagement Portal**
    a. Houston uses a proprietary portal in its Consumption Awareness Program (CAP).
    b. Implemented in 2014
    c. Estimated savings of 1,784 MG in 2016
        i. Specific utility results may vary based on portal features and notifications
    d. Savings estimate assumes 20% of residential customers are using[19] and saving water due to the portal (Westin Engineering, 2015)

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

e. Assumes customers save 10% of total annual use due to the portal
    i. Savings estimate is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
f. Residential customers' use makes up approximately 61% of all retail customers' use based on utility profile information submitted to the TWDB
g. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.23% of total demand
h. Savings are assumed to increase along with demand as connections increase each year[20]

6. Rain Barrels

a. In Region H, estimated savings of 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
b. 1,819 50-gallon barrels sold since 2014
c. Estimated 10-year useful life for most barrels

7. WaterWise Take-home Kits

a. Estimated 46,471 kits distributed annually in Houston service area
    i. Pro-rata share of all kits distributed in Harris County by program implemented by Harris-Galveston Subsidence District and Resource Action Programs
b. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
c. Conservative 5-year useful life for all items in kit
d. 15% adoption rate assumed

8. Save Water Co. Commercial, Multi-family and Hotel Programs[21]

a. Project initiated in service area in 2014
b. Save Water completed work on 927 multi-family units by 2015
c. Average monthly savings of 305,190 gallons
d. Total annualized savings of 21.97 MG for the life of the retrofitted fixtures
e. This study estimates a lifespan of 25 years for high-efficiency toilet replacements, five years for kitchen aerators and similar devices.
f. Save Water Co. performs monthly meter readings before and after installation to quantify savings.
    i. The company's work consists of identifying and repairing all leaks and drips, rebuilding existing toilets and replacing sink aerators.

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[19] Attempts to garner more precise participation figures for the Consumption Awareness Program (CAP) from staff were unsuccessful.

[20] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

[21] Savings figures and units serviced based on personal email communication with Kurt Goedrich, December 1, 2016.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	AMI with Customer Portal	Rain Barrels	WaterWise Take-home Kits	Save Water Co. Program	TOTAL SAVINGS
2009				53.4		53
2010				99.5		99
2011				150.3		150
2012				198.0		198
2013				251.5		252
2014		1,763	0.6	255.5	11	2,031
2015		1,774	1.7	260.9	22	2,058
2016		1,784	2.0	261.5	22	2,070
2017	992	1,795	2.4	213.8	22	3,025
2018	998	1,805	2.4	160.3	22	2,988
2019	1,004	1,815	2.4	102.9	22	2,946
2020	1,009	1,826	2.4	51.5	22	2,911
2021	1,015	1,836	2.4		22	2,876
2022	1,021	1,847	2.4		22	2,892
2023	1,027	1,857	2.4		22	2,908
2024	1,032	1,867	1.9		22	2,924
2025	1,038	1,878	0.7		22	2,939
2026	1,044	1,888	0.4		22	2,954
2027	1,050	1,899			22	2,970
2028	1,055	1,909			22	2,986
2029	1,061	1,919			22	3,002
2030	1,067	1,930			22	3,019
2031	1,073	1,941			22	3,035
2032	1,079	1,951			22	3,052
2033	1,085	1,962			22	3,069
2034	1,091	1,973			22	3,086
2035	1,097	1,984			22	3,103
2036	1,103	1,995			22	3,120
2037	1,109	2,006			22	3,137
2038	1,115	2,017			22	3,153
2039	1,121	2,027			22	3,170
2040	1,127	2,038			22	3,187
2041	1,134	2,050			22	3,206
2042	1,140	2,063			22	3,225
2043	1,147	2,075			22	3,244
2044	1,154	2,087			22	3,262
2045	1,160	2,099			22	3,281
2046	1,167	2,111			22	3,300
2047	1,174	2,123			22	3,319
2048	1,180	2,135			22	3,338
2049	1,187	2,147			22	3,356
2050	1,194	2,159			22	3,375
2051	1,201	2,173			22	3,397
2052	1,209	2,187			22	3,418
2053	1,217	2,201			22	3,439
2054	1,224	2,214			22	3,460
2055	1,232	2,228			22	3,482
2056	1,239	2,242			22	3,503
2057	1,247	2,255			22	3,524
2058	1,254	2,269			22	3,546
2059	1,262	2,283			22	3,567
2060	1,270	2,297			22	3,588
2061	1,278	2,311			22	3,611
2062	1,286	2,326			22	3,633
2063	1,294	2,340			22	3,656
2064	1,302	2,355			22	3,679
2065	1,310	2,369			22	3,701
2066	1,318	2,384			22	3,724
2067	1,326	2,398			22	3,746
2068	1,334	2,413			22	3,769
2069	1,342	2,428			22	3,792
2070	1,350	2,442			22	3,814

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	31.00	0
2015	2,157,023	26.00	3,937
2016	2,184,535	26.00	3,987
2017	2,212,046	26.00	4,037
2018	2,239,558	26.00	4,087
2019	2,241,329	26.00	4,090
2020	2,243,100	26.00	4,094
2021	2,244,872	26.00	4,097
2022	2,246,643	26.00	4,100
2023	2,248,414	26.00	4,103
2024	2,266,441	26.00	4,136

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 3.79% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 5,498 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	2,870	3,987	6,857	5,498	656	1,187	1,843	9,711
2017	3,025	4,037	7,062	5,530	656	1,425	2,081	10,511
2018	2,988	4,087	7,075	5,562	787	1,662	2,449	10,187
2019	2,946	4,090	7,037	5,594	918	1,906	2,818	9,813
2020	2,911	4,094	7,005	5,626	1,181	2,137	3,318	9,313
2021	2,876	4,097	6,973	5,658	1,418	2,354	3,772	8,858
2022	2,892	4,100	6,992	5,690	1,656	2,570	4,226	8,456
2023	2,908	4,103	7,011	5,722	1,893	2,787	4,680	8,053
2024	2,924	4,136	7,060	5,754	2,131	3,003	5,135	7,679
2025	2,939	4,169	7,108	5,786	2,369	3,220	5,589	7,305
2026	2,954	4,202	7,157	5,818	2,606	3,437	6,043	6,932
2027	2,970	4,235	7,205	5,850	2,844	3,653	6,497	6,558
2028	2,986	4,268	7,254	5,882	3,081	3,870	6,951	6,185
2029	3,002	4,301	7,303	5,914	3,319	4,086	7,405	5,812
2030	3,019	4,334	7,352	5,946	3,557	4,503	7,899	5,489
2031	3,035	4,367	7,402	5,980	3,798	4,522	8,320	5,062
2032	3,052	4,399	7,452	6,013	4,039	4,742	8,780	4,685
2033	3,069	4,432	7,502	6,047	4,280	4,961	9,241	4,307
2034	3,086	4,465	7,551	6,080	4,521	5,180	9,701	3,930
2035	3,103	4,497	7,600	6,113	4,762	5,400	10,162	3,552
2036	3,120	4,529	7,649	6,147	5,003	5,619	10,622	3,174
2037	3,137	4,562	7,698	6,180	5,244	5,838	11,083	2,796
2038	3,153	4,594	7,748	6,214	5,485	6,058	11,543	2,418
2039	3,170	4,627	7,797	6,247	5,726	6,277	12,004	2,041
2040	3,187	4,659	7,846	6,281	5,968	6,496	12,464	1,663

Statewide Water Conservation Quantification Project
City of Humble Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Humble's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Humble's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Humble's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Humble with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	2.0	28	30	3	8	11	19
2016	2.0	29	31	4	10	14	17
2017	1.6	29	31	4	12	16	15
2018	1.2	30	31	5	14	19	12
2019	0.8	30	31	6	16	22	9
2020	0.4	30	31	7	18	25	6
2021	0	31	31	9	20	29	2
2022	0	31	31	10	22	33	(2)
2023	0	31	31	12	25	37	(5)
2024	0	32	32	14	27	41	(8)
2025	0	33	33	15	29	44	(12)
2026	0	33	33	17	31	48	(15)
2027	0	34	34	19	34	52	(18)
2028	0	35	35	20	36	56	(21)
2029	0	36	36	22	38	60	(24)
2030	0	36	36	23	40	64	(28)
2031	0	37	37	25	43	68	(31)
2032	0	38	38	27	45	72	(35)
2033	0	38	38	29	47	76	(38)
2034	0	39	39	31	50	80	(42)
2035	0	39	39	32	52	84	(45)
2036	0	40	40	34	54	89	(49)
2037	0	40	40	36	57	93	(52)
2038	0	41	41	38	59	97	(56)
2039	0	41	41	40	61	101	(60)
2040	0	42	42	41	64	105	(63)
2041	0	42	42	43	66	109	(67)
2042	0	43	43	45	68	113	(71)
2043	0	43	43	47	71	117	(74)
2044	0	43	43	49	73	121	(78)
2045	0	44	44	50	75	126	(82)
2046	0	44	44	52	78	130	(86)
2047	0	45	45	54	80	134	(89)
2048	0	45	45	56	82	138	(93)
2049	0	45	45	58	85	142	(97)
2050	0	46	46	59	87	146	(101)
2051	0	46	46	61	89	150	(104)
2052	0	46	46	63	92	154	(108)
2053	0	47	47	64	94	158	(112)
2054	0	47	47	66	96	162	(115)
2055	0	47	47	68	98	166	(119)
2056	0	48	48	70	101	170	(123)
2057	0	48	48	71	103	174	(126)
2058	0	48	48	73	105	178	(130)
2059	0	48	48	75	107	182	(134)
2060	0	49	49	77	110	186	(137)
2061	0	49	49	78	112	190	(141)
2062	0	49	49	80	114	194	(144)
2063	0	49	49	81	116	197	(148)
2064	0	50	50	83	118	201	(151)
2065	0	50	50	85	120	205	(155)
2066	0	50	50	86	122	208	(158)
2067	0	50	50	88	124	212	(162)
2068	0	50	50	89	126	216	(165)
2069	0	51	51	91	129	220	(169)
2070	0	51	51	93	131	223	(172)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Humble's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	193	0	0	0
1	2015	16,195	191	12	30	19
2	2016	16,405	189	24	31	7
3	2017	16,614	187	36	31	(6)
4	2018	16,824	185	49	31	(18)
5-year Goal	2019	17,033	183	62	31	(31)
6	2020	17,243	182	69	31	(39)
7	2021	17,612	181	77	31	(46)
8	2022	17,980	180	85	31	(54)
9	2023	18,349	179	94	31	(62)
10-year Goal	2024	18,717	178	102	32	(70)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Humble's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	19.00	0	0	0
1	2015	16,195	19.00	0	28	28
2	2016	16,405	19.00	0	29	29
3	2017	16,614	19.00	0	29	29
4	2018	16,824	19.00	0	30	30
5-year Goal	2019	17,033	19.00	0	30	30
6	2020	17,243	18.80	1	30	29
7	2021	17,612	18.60	3	31	28
8	2022	17,980	18.40	4	31	27
9	2023	18,349	18.20	5	31	26
10-year Goal	2024	18,717	18.00	7	32	25

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 28 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	0.4	0.4
2010	0.8	0.8
2011	1.2	1.2
2012	1.5	1.5
2013	1.9	1.9
2014	2.0	2.0
2015	2.0	2.0
2016	2.0	2.0
2017	1.6	1.6
2018	1.2	1.2
2019	0.8	0.8
2020	0.4	0.4
2021		0
2022		0
2023		0
2024		0
2025		0
2026		0
2027		0
2028		0
2029		0
2030		0
2031		0
2032		0
2033		0
2034		0
2035		0
2036		0
2037		0
2038		0
2039		0
2040		0
2041		0
2042		0
2043		0
2044		0
2045		0
2046		0
2047		0
2048		0
2049		0
2050		0
2051		0
2052		0
2053		0
2054		0
2055		0
2056		0
2057		0
2058		0
2059		0
2060		0
2061		0
2062		0
2063		0
2064		0
2065		0
2066		0
2067		0
2068		0
2069		0
2070		0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	19.00	0
2015	15,570	14.00	28
2016	15,779	14.00	29
2017	15,987	14.00	29
2018	16,195	14.00	30
2019	16,405	14.00	30
2020	16,614	14.00	30
2021	16,824	14.00	31
2022	17,033	14.00	31
2023	17,243	14.00	31
2024	17,612	14.00	32

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 5.47% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 45 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	2	29	31	45	4	10	14	61
2017	2	29	31	45	4	12	16	60
2018	1	30	31	46	5	14	19	58
2019	1	30	31	47	6	16	22	56
2020	0	30	31	48	7	18	25	54
2021	0	31	31	49	9	20	29	50
2022	0	31	31	50	10	22	33	48
2023	0	31	31	50	12	25	37	45
2024	0	32	32	51	14	27	41	43
2025	0	33	33	52	15	29	44	40
2026	0	33	33	53	17	31	48	38
2027	0	34	34	54	18	34	52	36
2028	0	35	35	55	20	36	56	33
2029	0	36	36	55	22	38	60	31
2030	0	36	36	56	23	40	64	29
2031	0	37	37	57	25	43	68	26
2032	0	38	38	57	27	45	72	23
2033	0	38	38	58	29	47	76	20
2034	0	39	39	59	31	50	80	17
2035	0	39	39	59	32	52	84	14
2036	0	40	40	60	34	54	88	11
2037	0	40	40	60	36	57	93	8
2038	0	41	41	61	38	59	97	5
2039	0	41	41	62	40	61	101	2
2040	0	42	42	62	41	64	105	(1)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	2	29	31	11	4	10	14	28
2017	2	29	31	11	4	12	16	26
2018	1	30	31	11	5	14	19	23
2019	1	30	31	12	6	16	22	21
2020	0	30	31	12	7	18	25	17
2021	0	31	31	12	9	20	29	14
2022	0	31	31	12	10	22	33	10
2023	0	31	31	12	12	25	37	7
2024	0	32	32	13	14	27	41	4
2025	0	33	33	13	15	29	44	1
2026	0	33	33	13	17	31	48	(2)
2027	0	34	34	13	19	34	52	(5)
2028	0	35	35	13	20	36	56	(8)
2029	0	36	36	14	22	38	60	(11)
2030	0	36	36	14	23	40	64	(14)
2031	0	37	37	14	25	43	68	(17)
2032	0	38	38	14	27	45	72	(20)
2033	0	38	38	14	29	47	76	(24)
2034	0	39	39	14	31	50	80	(27)
2035	0	39	39	15	32	52	84	(31)
2036	0	40	40	15	34	54	89	(34)
2037	0	40	40	15	36	57	93	(38)
2038	0	41	41	15	38	59	97	(41)
2039	0	41	41	15	40	61	101	(45)
2040	0	42	42	15	41	64	105	(48)

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 16 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	2	29	31	16	4	10	14	33
2017	2	29	31	17	6	12	18	31
2018	1	30	31	17	5	14	19	29
2019	1	30	31	17	6	16	22	26
2020	0	30	31	18	7	18	25	23
2021	0	31	31	18	9	20	29	20
2022	0	31	31	18	10	22	33	16
2023	0	31	31	18	12	25	37	13
2024	0	32	32	19	14	27	41	10
2025	0	33	33	19	15	29	44	7
2026	0	33	33	19	17	31	48	4
2027	0	34	34	20	18	34	52	2
2028	0	35	35	20	20	36	56	(1)
2029	0	36	36	20	22	38	60	(4)
2030	0	36	36	21	23	40	64	(7)
2031	0	37	37	21	25	43	68	(10)
2032	0	38	38	21	27	45	72	(14)
2033	0	38	38	21	29	47	76	(17)
2034	0	39	39	21	31	50	80	(20)
2035	0	39	39	22	32	52	84	(24)
2036	0	40	40	22	34	54	89	(27)
2037	0	40	40	22	36	57	93	(30)
2038	0	41	41	22	38	59	97	(34)
2039	0	41	41	23	40	61	101	(37)
2040	0	42	42	23	41	64	105	(41)

4. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Huntsville Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Huntsville's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Huntsville's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Huntsville's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Huntsville with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	22.2	0	22	0	0	0	22
2016	24.8	0	25	0	0	0	25
2017	25.2	0	25	0	0	0	25
2018	25.7	0	26	0	0	0	26
2019	26.2	0	26	0	0	0	26
2020	26.6	0	27	0	0	0	27
2021	27.1	0	27	0	0	0	27
2022	27.6	0	28	0	0	0	28
2023	28.0	0	28	0	0	0	28
2024	28.5	0	28	0	0	0	28
2025	28.9	0	29	0	0	0	29
2026	29.4	0	29	0	0	0	29
2027	29.9	0	30	0	0	0	30
2028	30.3	0	30	0	0	0	30
2029	30.8	0	31	0	0	0	31
2030	31.3	0	31	0	0	0	31
2031	31.6	0	32	0	0	0	32
2032	31.9	0	32	0	0	0	32
2033	32.3	0	32	0	0	0	32
2034	32.6	0	33	0	0	0	33
2035	32.9	0	33	0	0	0	33
2036	33.3	0	33	0	0	0	33
2037	33.6	0	34	0	0	0	34
2038	33.9	0	34	0	0	0	34
2039	34.3	0	34	0	0	0	34
2040	34.6	0	35	0	0	0	35
2041	34.9	0	35	0	0	0	35
2042	35.1	0	35	0	0	0	35
2043	35.4	0	35	0	0	0	35
2044	35.6	0	36	0	0	0	36
2045	35.9	0	36	0	0	0	36
2046	36.2	0	36	0	0	0	36
2047	36.4	0	36	0	0	0	36
2048	36.7	0	37	0	0	0	37
2049	36.9	0	37	0	0	0	37
2050	37.2	0	37	0	0	0	37
2051	37.4	0	37	0	0	0	37
2052	37.6	0	38	0	0	0	38
2053	37.8	0	38	0	0	0	38
2054	38.0	0	38	0	0	0	38
2055	38.2	0	38	0	0	0	38
2056	38.4	0	38	0	0	0	38
2057	38.6	0	39	0	0	0	39
2058	38.8	0	39	0	0	0	39
2059	39.0	0	39	0	0	0	39
2060	39.3	0	39	0	0	0	39
2061	39.4	0	39	0	0	0	39
2062	39.6	0	40	0	0	0	40
2063	39.7	0	40	0	0	0	40
2064	39.9	0	40	0	0	0	40
2065	40.0	0	40	0	0	0	40
2066	40.2	0	40	0	0	0	40
2067	40.4	0	40	0	0	0	40
2068	40.5	0	41	0	0	0	41
2069	40.7	0	41	0	0	0	41
2070	40.8	0	41	0	0	0	41

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Huntsville's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	302	0	0	0
1	2015	39,765	282	296	22	(274)
2	2016	39,970	261	595	25	(570)
3	2017	40,174	241	897	25	(872)
4	2018	40,379	220	1,203	26	(1,177)
5-year Goal	2019	40,583	200	1,511	26	(1,485)
6	2020	40,788	199	1,533	27	(1,507)
7	2021	40,984	198	1,556	27	(1,529)
8	2022	41,180	197	1,578	28	(1,551)
9	2023	41,375	196	1,601	28	(1,573)
10-year Goal	2024	41,571	195	1,624	28	(1,595)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Huntsville's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	20.00	0	0	0
1	2015	39,765	20.00	0	0	0
2	2016	39,970	20.00	0	0	0
3	2017	40,174	20.00	0	0	0
4	2018	40,379	20.00	0	0	0
5-year Goal	2019	40,583	20.00	0	0	0
6	2020	40,788	20.00	0	0	0
7	2021	40,984	20.00	0	0	0
8	2022	41,180	20.00	0	0	0
9	2023	41,375	20.00	0	0	0
10-year Goal	2024	41,571	20.00	0	0	0

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 0 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 1.39% increase in 2015
        ii. 1.39% increase in 2016
    b. Estimated customer demand reduction of .54%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Conservation Pricing**
    a. Tiered rate structure in place saves approximately 2.5% of total demand
        i. Savings is cumulative and based on more than one source[19] (U.S. EPA, 1998; TWDB, 2013)

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.
[19] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Conservation Pricing	Water Rate Increases	Outdoor Landscape Evaluations (SF/MF)	TOTAL SAVINGS
2009				0
2010				0
2011				0
2012				0
2013	19			19.2
2014	20			19.6
2015	20	2		22.2
2016	20	4		24.8
2017	21	4		25.2
2018	21	5		25.7
2019	22	5		26.2
2020	22	5		26.6
2021	22	5		27.1
2022	23	5		27.6
2023	23	5		28.0
2024	23	5		28.5
2025	24	5		28.9
2026	24	5		29.4
2027	25	5		29.9
2028	25	5		30.3
2029	25	5		30.8
2030	26	6		31.3
2031	26	6		31.6
2032	26	6		31.9
2033	27	6		32.3
2034	27	6		32.6
2035	27	6		32.9
2036	27	6		33.3
2037	28	6		33.6
2038	28	6		33.9
2039	28	6		34.3
2040	28	6		34.6
2041	29	6		34.9
2042	29	6		35.1
2043	29	6		35.4
2044	29	6		35.6
2045	30	6		35.9
2046	30	6		36.2
2047	30	6		36.4
2048	30	7		36.7
2049	30	7		36.9
2050	31	7		37.2
2051	31	7		37.4
2052	31	7		37.6
2053	31	7		37.8
2054	31	7		38.0
2055	31	7		38.2
2056	32	7		38.4
2057	32	7		38.6
2058	32	7		38.8
2059	32	7		39.0
2060	32	7		39.3
2061	32	7		39.4
2062	33	7		39.6
2063	33	7		39.7
2064	33	7		39.9
2065	33	7		40.0
2066	33	7		40.2
2067	33	7		40.4
2068	33	7		40.5
2069	33	7		40.7
2070	34	7		40.8

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	20.00	0
2015	39,161	20.00	0
2016	39,362	20.00	0
2017	39,564	20.00	0
2018	39,765	20.00	0
2019	39,970	20.00	0
2020	40,174	20.00	0
2021	40,379	20.00	0
2022	40,583	20.00	0
2023	40,788	20.00	0
2024	40,984	20.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region H savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 102 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	25	0	25	102	0	0	0	127
2017	25	0	25	102	0	0	0	127
2018	26	0	26	102	0	0	0	128
2019	26	0	26	103	0	0	0	129
2020	27	0	27	103	0	0	0	130
2021	27	0	27	103	0	0	0	130
2022	28	0	28	103	0	0	0	131
2023	28	0	28	104	0	0	0	132
2024	28	0	28	104	0	0	0	132
2025	29	0	29	104	0	0	0	133
2026	29	0	29	104	0	0	0	134
2027	30	0	30	105	0	0	0	135
2028	30	0	30	105	0	0	0	135
2029	31	0	31	105	0	0	0	136
2030	31	0	31	105	0	0	0	137
2031	32	0	32	106	0	0	0	137
2032	32	0	32	106	0	0	0	138
2033	32	0	32	106	0	0	0	138
2034	33	0	33	106	0	0	0	139
2035	33	0	33	106	0	0	0	139
2036	33	0	33	106	0	0	0	140
2037	34	0	34	107	0	0	0	140
2038	34	0	34	107	0	0	0	141
2039	34	0	34	107	0	0	0	141
2040	35	0	35	107	0	0	0	142

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[20]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[20] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	25	0	25	34	0	0	0	59
2017	25	0	25	34	0	0	0	59
2018	26	0	26	34	0	0	0	60
2019	26	0	26	34	0	0	0	61
2020	27	0	27	34	0	0	0	61
2021	27	0	27	35	0	0	0	62
2022	28	0	28	35	0	0	0	62
2023	28	0	28	35	0	0	0	63
2024	28	0	28	35	0	0	0	63
2025	29	0	29	35	0	0	0	64
2026	29	0	29	35	0	0	0	64
2027	30	0	30	35	0	0	0	65
2028	30	0	30	35	0	0	0	66
2029	31	0	31	35	0	0	0	66
2030	31	0	31	35	0	0	0	67
2031	32	0	32	35	0	0	0	67
2032	32	0	32	35	0	0	0	67
2033	32	0	32	35	0	0	0	68
2034	33	0	33	36	0	0	0	68
2035	33	0	33	36	0	0	0	69
2036	33	0	33	36	0	0	0	69
2037	34	0	34	36	0	0	0	69
2038	34	0	34	36	0	0	0	70
2039	34	0	34	36	0	0	0	70
2040	35	0	35	36	0	0	0	70

3. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Jersey Village Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Jersey Village's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Jersey Village's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Jersey Village's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Jersey Village with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0.9	19.6	20.5	2	0	2	18
2016	0.9	19.6	20.5	3	0	3	18
2017	0.7	19.6	20.3	3	0	3	18
2018	0.6	19.6	20.2	3	0	3	17
2019	0.4	19.6	20.0	4	0	4	16
2020	0.2	19.7	19.8	5	0	5	15
2021	0	19.7	19.7	5	0	5	14
2022	0	19.7	19.7	6	0	6	13
2023	0	19.7	19.7	7	0	7	13
2024	0	19.7	19.7	8	0	8	12
2025	0	19.8	19.8	9	0	9	11
2026	0	19.8	19.8	10	0	10	10
2027	0	19.8	19.8	10	0	10	9
2028	0	19.8	19.8	11	0	11	8
2029	0	19.8	19.8	12	0	12	8
2030	0	19.9	19.9	13	0	13	7
2031	0	19.9	19.9	14	0	14	6
2032	0	19.9	19.9	15	0	15	5
2033	0	19.9	19.9	15	0	15	5
2034	0	19.9	19.9	16	0	16	4
2035	0	20.0	20.0	17	0	17	3
2036	0	20.0	20.0	18	0	18	2
2037	0	20.1	20.1	18	0	18	2
2038	0	20.1	20.1	19	0	19	1
2039	0	20.1	20.1	20	0	20	0
2040	0	20.2	20.2	21	0	21	(0)
2041	0	20.2	20.2	21	0	21	(1)
2042	0	20.2	20.2	22	0	22	(2)
2043	0	20.3	20.3	23	0	23	(2)
2044	0	20.3	20.3	23	0	23	(3)
2045	0	20.4	20.4	24	0	24	(4)
2046	0	20.4	20.4	25	0	25	(4)
2047	0	20.4	20.4	26	0	26	(5)
2048	0	20.5	20.5	26	0	26	(6)
2049	0	20.5	20.5	27	0	27	(6)
2050	0	20.6	20.6	28	0	28	(7)
2051	0	20.6	20.6	28	0	28	(8)
2052	0	20.6	20.6	29	0	29	(8)
2053	0	20.7	20.7	30	0	30	(9)
2054	0	20.7	20.7	31	0	31	(10)
2055	0	20.8	20.8	31	0	31	(11)
2056	0	20.8	20.8	32	0	32	(11)
2057	0	20.9	20.9	33	0	33	(12)
2058	0	20.9	20.9	33	0	33	(13)
2059	0	21.0	21.0	34	0	34	(13)
2060	0	21.0	21.0	35	0	35	(14)
2061	0	21.0	21.0	36	0	36	(14)
2062	0	21.1	21.1	36	0	36	(15)
2063	0	21.1	21.1	37	0	37	(16)
2064	0	21.2	21.2	37	0	37	(16)
2065	0	21.2	21.2	38	0	38	(17)
2066	0	21.3	21.3	39	0	39	(17)
2067	0	21.3	21.3	39	0	39	(18)
2068	0	21.4	21.4	40	0	40	(19)
2069	0	21.4	21.4	41	0	41	(19)
2070	0	21.5	21.5	41	0	41	(20)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Jersey Village's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline		184	0	0	0
1	2015	7,680	183	2	20.5	18
2	2016	7,689	182	4	20.5	16
3	2017	7,697	182	7	20.3	14
4	2018	7,706	181	9	20.2	11
5-year Goal	2019	7,714	180	11	20.0	9
6	2,020	7,723	178	16	20	3
7	2,021	7,730	176	21	20	(2)
8	2,022	7,736	175	27	20	(7)
9	2,023	7,743	173	32	20	(12)
10-year Goal	2,024	7,750	171	37	20	(17)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Jersey Village's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	18.00	0	0	0
1	2015	7,680	17.40	2	19.6	18
2	2016	7,689	16.80	3	19.6	16
3	2017	7,697	16.20	5	19.6	15
4	2018	7,706	15.60	7	19.6	13
5-year Goal	2019	7,714	15.00	8	19.6	11
6	2020	7,723	14.40	10	19.7	10
7	2021	7,730	13.80	12	19.7	8
8	2022	7,736	13.20	14	19.7	6
9	2023	7,743	12.60	15	19.7	4
10-year Goal	2024	7,750	12.00	17	19.7	3

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 20 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.

[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	0.2	0.2
2010	0.3	0.3
2011	0.5	0.5
2012	0.7	0.7
2013	0.9	0.9
2014	0.9	0.9
2015	0.9	0.9
2016	0.9	0.9
2017	0.7	0.7
2018	0.6	0.6
2019	0.4	0.4
2020	0.2	0.2
2021		0
2022		0
2023		0
2024		0
2025		0
2026		0
2027		0
2028		0
2029		0
2030		0
2031		0
2032		0
2033		0
2034		0
2035		0
2036		0
2037		0
2038		0
2039		0
2040		0
2041		0
2042		0
2043		0
2044		0
2045		0
2046		0
2047		0
2048		0
2049		0
2050		0
2051		0
2052		0
2053		0
2054		0
2055		0
2056		0
2057		0
2058		0
2059		0
2060		0
2061		0
2062		0
2063		0
2064		0
2065		0
2066		0
2067		0
2068		0
2069		0
2070		0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	18.00	0
2015	7,654	11.00	20
2016	7,663	11.00	20
2017	7,671	11.00	20
2018	7,680	11.00	20
2019	7,689	11.00	20
2020	7,697	11.00	20
2021	7,706	11.00	20
2022	7,714	11.00	20
2023	7,723	11.00	20
2024	7,730	11.00	20

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 23 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	20	20	23	3	0	3	41
2017	1	20	20	23	3	0	3	41
2018	1	20	20	23	3	0	3	40
2019	0	20	20	23	4	0	4	39
2020	0	20	20	23	5	0	5	38
2021	0	20	20	23	5	0	5	37
2022	0	20	20	23	6	0	6	36
2023	0	20	20	23	7	0	7	35
2024	0	20	20	23	8	0	8	34
2025	0	20	20	23	9	0	9	34
2026	0	20	20	23	10	0	10	33
2027	0	20	20	23	10	0	10	32
2028	0	20	20	23	11	0	11	31
2029	0	20	20	23	12	0	12	30
2030	0	20	20	23	13	0	13	29
2031	0	20	20	23	14	0	14	29
2032	0	20	20	23	15	0	15	28
2033	0	20	20	23	15	0	15	27
2034	0	20	20	23	16	0	16	27
2035	0	20	20	23	17	0	17	26
2036	0	20	20	23	18	0	18	25
2037	0	20	20	23	18	0	18	24
2038	0	20	20	23	19	0	19	24
2039	0	20	20	23	20	0	20	23
2040	0	20	20	23	21	0	21	22

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	20	20	8	3	0	3	28
2017	1	20	20	8	3	0	3	28
2018	1	20	20	8	3	0	3	25
2019	0	20	20	8	4	0	4	24
2020	0	20	20	8	5	0	5	23
2021	0	20	20	8	5	0	5	22
2022	0	20	20	8	6	0	6	21
2023	0	20	20	8	7	0	7	20
2024	0	20	20	8	8	0	8	19
2025	0	20	20	8	9	0	9	19
2026	0	20	20	8	10	0	10	18
2027	0	20	20	8	10	0	10	17
2028	0	20	20	8	11	0	11	16
2029	0	20	20	8	12	0	12	15
2030	0	20	20	8	13	0	13	14
2031	0	20	20	8	14	0	14	14
2032	0	20	20	8	15	0	15	13
2033	0	20	20	8	15	0	15	12
2034	0	20	20	8	16	0	16	11
2035	0	20	20	8	17	0	17	11
2036	0	20	20	8	18	0	18	10
2037	0	20	20	8	18	0	18	9
2038	0	20	20	8	19	0	19	9
2039	0	20	20	8	20	0	20	8
2040	0	20	20	8	21	0	21	7

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 11 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1	20	20	11	3	0	3	29
2017	1	20	20	11	3	0	3	29
2018	1	20	20	11	3	0	3	29
2019	0	20	20	11	4	0	4	28
2020	0	20	20	11	5	0	5	27
2021	0	20	20	11	5	0	5	26
2022	0	20	20	11	6	0	6	25
2023	0	20	20	11	7	0	7	24
2024	0	20	20	11	8	0	8	23
2025	0	20	20	11	9	0	9	22
2026	0	20	20	11	10	0	10	21
2027	0	20	20	11	10	0	10	21
2028	0	20	20	11	11	0	11	20
2029	0	20	20	11	12	0	12	19
2030	0	20	20	11	13	0	13	18
2031	0	20	20	11	14	0	14	17
2032	0	20	20	11	15	0	15	17
2033	0	20	20	11	15	0	15	16
2034	0	20	20	11	16	0	16	15
2035	0	20	20	11	17	0	17	15
2036	0	20	20	11	18	0	18	14
2037	0	20	20	11	18	0	18	13
2038	0	20	20	11	19	0	19	12
2039	0	20	20	11	20	0	20	12
2040	0	20	20	11	21	0	21	11

4. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Katy Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were to be completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Katy's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Katy's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Katy's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in million gallons) in Regional Water Plan

Table 3-1 shows a 2070 outlook for Katy with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	2.5	(23)	(20)	5	0	5	(25)
2016	2.5	(24)	(21)	7	0	7	(28)
2017	2.1	(25)	(23)	7	0	7	(29)
2018	1.5	(26)	(24)	8	0	8	(32)
2019	1.0	(27)	(26)	9	0	9	(35)
2020	0.5	(28)	(28)	12	0	12	(39)
2021	0	(29)	(29)	15	0	15	(44)
2022	0	(30)	(30)	18	0	18	(48)
2023	0	(32)	(32)	21	0	21	(53)
2024	0	(33)	(33)	24	0	24	(57)
2025	0	(35)	(35)	27	0	27	(62)
2026	0	(36)	(36)	30	0	30	(66)
2027	0	(38)	(38)	33	0	33	(71)
2028	0	(39)	(39)	36	0	36	(75)
2029	0	(41)	(41)	39	0	39	(80)
2030	0	(42)	(42)	42	0	42	(84)
2031	0	(44)	(44)	44	0	44	(88)
2032	0	(45)	(45)	47	0	47	(92)
2033	0	(47)	(47)	49	0	49	(96)
2034	0	(47)	(47)	52	0	52	(98)
2035	0	(47)	(47)	54	0	54	(101)
2036	0	(47)	(47)	56	0	56	(103)
2037	0	(47)	(47)	59	0	59	(106)
2038	0	(47)	(47)	61	0	61	(108)
2039	0	(47)	(47)	63	0	63	(111)
2040	0	(48)	(48)	66	0	66	(113)
2041	0	(48)	(48)	68	0	68	(116)
2042	0	(48)	(48)	70	0	70	(118)
2043	0	(48)	(48)	72	0	72	(120)
2044	0	(48)	(48)	75	0	75	(123)
2045	0	(48)	(48)	77	0	77	(125)
2046	0	(49)	(49)	79	0	79	(127)
2047	0	(49)	(49)	81	0	81	(130)
2048	0	(49)	(49)	83	0	83	(132)
2049	0	(49)	(49)	85	0	85	(134)
2050	0	(49)	(49)	88	0	88	(137)
2051	0	(49)	(49)	90	0	90	(139)
2052	0	(49)	(49)	92	0	92	(141)
2053	0	(49)	(49)	94	0	94	(143)
2054	0	(50)	(50)	96	0	96	(145)
2055	0	(50)	(50)	98	0	98	(147)
2056	0	(50)	(50)	100	0	100	(150)
2057	0	(50)	(50)	102	0	102	(152)
2058	0	(50)	(50)	104	0	104	(154)
2059	0	(50)	(50)	106	0	106	(156)
2060	0	(50)	(50)	108	0	108	(158)
2061	0	(51)	(51)	109	0	109	(160)
2062	0	(51)	(51)	111	0	111	(162)
2063	0	(51)	(51)	113	0	113	(164)
2064	0	(51)	(51)	115	0	115	(166)
2065	0	(51)	(51)	117	0	117	(168)
2066	0	(51)	(51)	118	0	118	(170)
2067	0	(51)	(51)	120	0	120	(172)
2068	0	(52)	(52)	122	0	122	(174)
2069	0	(52)	(52)	124	0	124	(176)
2070	0	(52)	(52)	126	0	126	(178)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Katy's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	184	0	0	0
1	2015	17,510	182	12	(20)	(32)
2	2016	18,351	180	24	(21)	(45)
3	2017	19,191	179	38	(23)	(60)
4	2018	20,032	177	53	(24)	(77)
5-year Goal	2019	20,872	175	69	(26)	(94)
6	2020	21,713	173	86	(28)	(113)
7	2021	22,733	171	105	(29)	(134)
8	2022	23,753	170	125	(30)	(155)
9	2023	24,773	168	146	(32)	(178)
10-year Goal	2024	25,793	166	169	(33)	(203)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Katy's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	**Baseline**	-	9.00	0	0	0
1	2015	17,510	8.80	1	(23)	(24)
2	2016	18,351	8.60	3	(24)	(26)
3	2017	19,191	8.40	4	(25)	(29)
4	2018	20,032	8.20	6	(26)	(31)
5-year Goal	2019	20,872	8.00	8	(27)	(34)
6	2020	21,713	8.00	8	(28)	(36)
7	2021	22,733	8.00	8	(29)	(38)
8	2022	23,753	8.00	9	(30)	(39)
9	2023	24,773	8.00	9	(32)	(41)
10-year Goal	2024	25,793	8.00	9	(33)	(43)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 23 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	WaterWise Take-home Kits	TOTAL SAVINGS
2009	0.5	0.5
2010	1.0	1.0
2011	1.5	1.5
2012	1.9	1.9
2013	2.4	2.4
2014	2.5	2.5
2015	2.5	2.5
2016	2.5	2.5
2017	2.1	2.1
2018	1.5	1.5
2019	1.0	1.0
2020	0.5	0.5
2021		0
2022		0
2023		0
2024		0
2025		0
2026		0
2027		0
2028		0
2029		0
2030		0
2031		0
2032		0
2033		0
2034		0
2035		0
2036		0
2037		0
2038		0
2039		0
2040		0
2041		0
2042		0
2043		0
2044		0
2045		0
2046		0
2047		0
2048		0
2049		0
2050		0
2051		0
2052		0
2053		0
2054		0
2055		0
2056		0
2057		0
2058		0
2059		0
2060		0
2061		0
2062		0
2063		0
2064		0
2065		0
2066		0
2067		0
2068		0
2069		0
2070		0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	9.00	0
2015	15,504	13.00	(23)
2016	16,173	13.00	(24)
2017	16,841	13.00	(25)
2018	17,510	13.00	(26)
2019	18,351	13.00	(27)
2020	19,191	13.00	(28)
2021	20,032	13.00	(29)
2022	20,872	13.00	(30)
2023	21,713	13.00	(32)
2024	22,733	13.00	(33)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region H savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 56 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	3	(24)	(21)	56	7	0	7	28
2017	2	(25)	(23)	59	7	0	7	30
2018	2	(26)	(24)	62	8	0	8	30
2019	1	(27)	(26)	65	9	0	9	30
2020	0	(28)	(28)	68	12	0	12	29
2021	0	(29)	(29)	71	15	0	15	27
2022	0	(30)	(30)	74	18	0	18	26
2023	0	(32)	(32)	77	21	0	21	25
2024	0	(33)	(33)	80	24	0	24	23
2025	0	(35)	(35)	83	27	0	27	22
2026	0	(36)	(36)	86	30	0	30	20
2027	0	(38)	(38)	89	33	0	33	19
2028	0	(39)	(39)	92	36	0	36	17
2029	0	(41)	(41)	95	39	0	39	16
2030	0	(42)	(42)	98	42	0	42	14
2031	0	(44)	(44)	99	44	0	44	11
2032	0	(45)	(45)	99	47	0	47	7
2033	0	(47)	(47)	99	49	0	49	3
2034	0	(47)	(47)	99	52	0	52	1
2035	0	(47)	(47)	100	54	0	54	(1)
2036	0	(47)	(47)	100	56	0	56	(3)
2037	0	(47)	(47)	100	59	0	59	(6)
2038	0	(47)	(47)	100	61	0	61	(8)
2039	0	(47)	(47)	101	63	0	63	(10)
2040	0	(48)	(48)	101	66	0	66	(12)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	3	(24)	(21)	19	7	0	7	(9)
2017	2	(25)	(23)	20	7	0	7	(9)
2018	2	(26)	(24)	21	8	0	8	(11)
2019	1	(27)	(26)	22	9	0	9	(13)
2020	0	(28)	(28)	23	12	0	12	(16)
2021	0	(29)	(29)	24	15	0	15	(20)
2022	0	(30)	(30)	25	18	0	18	(23)
2023	0	(32)	(32)	26	21	0	21	(27)
2024	0	(33)	(33)	27	24	0	24	(30)
2025	0	(35)	(35)	28	27	0	27	(34)
2026	0	(36)	(36)	29	30	0	30	(37)
2027	0	(38)	(38)	30	33	0	33	(41)
2028	0	(39)	(39)	31	36	0	36	(44)
2029	0	(41)	(41)	32	39	0	39	(48)
2030	0	(42)	(42)	33	42	0	42	(51)
2031	0	(44)	(44)	33	44	0	44	(55)
2032	0	(45)	(45)	33	47	0	47	(59)
2033	0	(47)	(47)	33	49	0	49	(63)
2034	0	(47)	(47)	33	52	0	52	(65)
2035	0	(47)	(47)	33	54	0	54	(67)
2036	0	(47)	(47)	33	56	0	56	(70)
2037	0	(47)	(47)	34	59	0	59	(72)
2038	0	(47)	(47)	34	61	0	61	(75)
2039	0	(47)	(47)	34	63	0	63	(77)
2040	0	(48)	(48)	34	66	0	66	(80)

3. Water Rate Increase
   a. For every 10% increase, estimated savings could be 2% of utility total demand.
   b. Approximately 28 MG of savings per year with current demand
   c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   d. See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	3	(24)	(21)	28	7	0	7	0
2017	2	(25)	(23)	30	7	0	7	1
2018	2	(26)	(24)	31	8	0	8	(1)
2019	1	(27)	(26)	33	9	0	9	(2)
2020	0	(28)	(28)	34	12	0	12	(5)
2021	0	(29)	(29)	36	15	0	15	(8)
2022	0	(30)	(30)	37	18	0	18	(11)
2023	0	(32)	(32)	39	21	0	21	(14)
2024	0	(33)	(33)	40	24	0	24	(17)
2025	0	(35)	(35)	42	27	0	27	(20)
2026	0	(36)	(36)	43	30	0	30	(23)
2027	0	(38)	(38)	45	33	0	33	(26)
2028	0	(39)	(39)	46	36	0	36	(29)
2029	0	(41)	(41)	48	39	0	39	(32)
2030	0	(42)	(42)	49	42	0	42	(35)
2031	0	(44)	(44)	49	44	0	44	(39)
2032	0	(45)	(45)	49	47	0	47	(42)
2033	0	(47)	(47)	50	49	0	49	(46)
2034	0	(47)	(47)	50	52	0	52	(49)
2035	0	(47)	(47)	50	54	0	54	(51)
2036	0	(47)	(47)	50	56	0	56	(53)
2037	0	(47)	(47)	50	59	0	59	(56)
2038	0	(47)	(47)	50	61	0	61	(58)
2039	0	(47)	(47)	50	63	0	63	(61)
2040	0	(48)	(48)	51	66	0	66	(63)

4. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Lake Jackson Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Lake Jackson's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Lake Jackson's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Lake Jackson's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Lake Jackson with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	69	69	8	12	21	48
2016	0	69	69	10	16	26	43
2017	0	69	69	10	19	29	40
2018	0	69	69	12	22	34	35
2019	0	69	69	14	25	39	30
2020	0	69	69	18	28	46	23
2021	0	70	70	21	31	52	18
2022	0	70	70	24	33	57	12
2023	0	70	70	27	36	63	7
2024	0	70	70	31	38	69	1
2025	0	70	70	34	41	74	(4)
2026	0	70	70	37	43	80	(10)
2027	0	71	71	40	46	86	(15)
2028	0	71	71	43	48	91	(20)
2029	0	71	71	46	51	97	(26)
2030	0	71	71	49	53	102	(31)
2031	0	71	71	51	56	107	(36)
2032	0	72	72	54	58	112	(41)
2033	0	72	72	57	61	117	(45)
2034	0	72	72	59	63	122	(50)
2035	0	72	72	62	65	127	(55)
2036	0	72	72	64	68	132	(59)
2037	0	73	73	67	70	137	(64)
2038	0	73	73	69	72	142	(69)
2039	0	73	73	72	75	147	(74)
2040	0	73	73	74	77	152	(78)
2041	0	73	73	76	80	156	(82)
2042	0	74	74	79	82	160	(87)
2043	0	74	74	81	84	165	(91)
2044	0	74	74	83	86	169	(95)
2045	0	74	74	85	89	174	(99)
2046	0	75	75	87	91	178	(103)
2047	0	75	75	89	93	182	(107)
2048	0	75	75	91	95	187	(112)
2049	0	75	75	93	98	191	(116)
2050	0	76	76	95	100	196	(120)
2051	0	76	76	97	102	200	(124)
2052	0	76	76	99	105	204	(128)
2053	0	76	76	101	107	208	(132)
2054	0	77	77	103	109	212	(135)
2055	0	77	77	104	112	216	(139)
2056	0	77	77	106	114	220	(143)
2057	0	77	77	108	116	224	(147)
2058	0	78	78	110	119	228	(151)
2059	0	78	78	112	121	232	(155)
2060	0	78	78	113	123	237	(159)
2061	0	78	78	115	124	239	(161)
2062	0	79	79	116	125	241	(163)
2063	0	79	79	118	126	244	(165)
2064	0	79	79	120	126	246	(167)
2065	0	79	79	121	127	248	(169)
2066	0	80	80	123	128	250	(171)
2067	0	80	80	124	129	253	(173)
2068	0	80	80	126	129	255	(175)
2069	0	80	80	127	130	257	(177)
2070	0	81	81	129	131	260	(179)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Lake Jackson's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	152	0	0	0
1	2016	27,158	150	16	69	53
2	2017	27,195	149	32	69	37
3	2018	27,233	147	48	69	21
4	2019	27,270	146	64	69	6
5-year Goal	2,020	27,308	144	80	69	(10)
6	2,021	27,387	143	94	69	(24)
7	2,022	27,466	141	108	70	(39)
8	2,023	27,544	140	123	70	(53)
9	2,024	27,623	138	137	70	(67)
10-year Goal	2,025	27,702	137	152	70	(82)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Lake Jackson's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	30.00	0	0	0
1	2016	27,158	29.80	2	69	67
2	2017	27,195	29.60	4	69	65
3	2018	27,233	29.40	6	69	63
4	2019	27,270	29.20	8	69	61
5-year Goal	2020	27,308	29.00	10	69	59
6	2021	27,387	28.60	14	69	55
7	2022	27,466	28.20	18	70	52
8	2023	27,544	27.80	22	70	48
9	2024	27,623	27.40	26	70	44
10-year Goal	2025	27,702	27.00	30	70	40

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 69 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
        i. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	30.00	0
2014	27,061	23.00	69
2015	27,120	23.00	69
2016	27,158	23.00	69
2017	27,195	23.00	69
2018	27,233	23.00	70
2019	27,270	23.00	70
2020	27,308	23.00	70
2021	27,387	23.00	70
2022	27,466	23.00	70
2023	27,544	23.00	70

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs

- The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
  - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   - **a.** Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
     - i. Average Region H savings
     - ii. Specific percentage of outdoor usage unknown for your utility at this time
   - **b.** Savings could be 69 MG per year with current demand.
   - **c.** See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	69	69	69	10	16	26	112
2017	0	69	69	69	10	19	29	110
2018	0	69	69	69	12	22	34	105
2019	0	69	69	69	14	25	39	100
2020	0	69	69	69	18	28	46	93
2021	0	70	70	69	21	31	52	87
2022	0	70	70	69	24	33	57	82
2023	0	70	70	69	27	36	63	76
2024	0	70	70	69	31	38	69	71
2025	0	70	70	70	34	41	74	65
2026	0	70	70	70	37	43	80	60
2027	0	71	71	70	40	46	86	55
2028	0	71	71	70	43	48	91	49
2029	0	71	71	70	46	51	97	44
2030	0	71	71	70	49	53	102	39
2031	0	71	71	70	51	56	107	34
2032	0	72	72	70	54	58	112	29
2033	0	72	72	70	57	61	117	25
2034	0	72	72	70	58	63	122	20
2035	0	72	72	70	62	65	127	15
2036	0	72	72	70	64	68	132	11
2037	0	73	73	70	67	70	137	6
2038	0	73	73	70	69	72	142	1
2039	0	73	73	70	72	75	147	(3)
2040	0	73	73	70	74	77	152	(8)

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[17]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	69	69	23	10	16	26	66
2017	0	69	69	23	10	19	29	64
2018	0	69	69	23	12	22	34	59
2019	0	69	69	23	14	25	39	54
2020	0	69	69	23	18	28	46	46
2021	0	70	70	23	21	31	52	41
2022	0	70	70	23	24	33	57	35
2023	0	70	70	23	27	36	63	30
2024	0	70	70	23	31	38	69	25
2025	0	70	70	23	34	41	74	19
2026	0	70	70	23	37	43	80	14
2027	0	71	71	23	40	46	86	8
2028	0	71	71	23	43	48	91	3
2029	0	71	71	23	46	51	97	(2)
2030	0	71	71	23	49	53	102	(8)
2031	0	71	71	23	51	56	107	(13)
2032	0	72	72	23	54	58	112	(17)
2033	0	72	72	23	57	61	117	(22)
2034	0	72	72	23	59	63	122	(27)
2035	0	72	72	23	62	65	127	(33)
2036	0	72	72	23	64	68	132	(38)
2037	0	73	73	24	67	70	137	(41)
2038	0	73	73	24	69	72	142	(45)
2039	0	73	73	24	72	75	147	(50)
2040	0	73	73	24	74	77	152	(55)

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 35 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	69	69	35	10	18	26	78
2017	0	69	69	35	10	19	29	75
2018	0	69	69	35	12	22	34	70
2019	0	69	69	35	14	25	39	65
2020	0	69	69	35	18	28	46	58
2021	0	70	70	35	21	31	52	52
2022	0	70	70	35	24	33	57	47
2023	0	70	70	35	27	36	63	41
2024	0	70	70	35	31	38	69	36
2025	0	70	70	35	34	41	74	31
2026	0	70	70	35	37	43	80	25
2027	0	71	71	35	40	46	86	20
2028	0	71	71	35	43	48	91	14
2029	0	71	71	35	46	51	97	9
2030	0	71	71	35	49	53	102	4
2031	0	71	71	35	51	56	107	(1)
2032	0	72	72	35	54	58	112	(6)
2033	0	72	72	35	57	61	117	(10)
2034	0	72	72	35	59	63	122	(15)
2035	0	72	72	35	62	65	127	(20)
2036	0	72	72	35	64	68	132	(24)
2037	0	73	73	35	67	70	137	(29)
2038	0	73	73	35	69	72	142	(34)
2039	0	73	73	35	72	75	147	(38)
2040	0	73	73	35	74	77	152	(43)

4. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
League City Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares League City's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) League City's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in League City's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for League City with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	244	(97)	147	5	0	5	142
2016	247	(99)	148	6	0	6	141
2017	247	(102)	145	6	0	6	139
2018	246	(104)	142	8	0	8	135
2019	246	(107)	138	9	0	9	129
2020	245	(110)	135	11	0	11	123
2021	245	(114)	131	14	0	14	117
2022	247	(117)	130	16	0	16	114
2023	250	(120)	130	19	0	19	111
2024	252	(122)	131	21	0	21	109
2025	255	(123)	132	24	0	24	108
2026	257	(125)	133	26	0	26	106
2027	260	(126)	134	29	0	29	105
2028	262	(128)	135	31	0	31	103
2029	265	(129)	136	34	0	34	102
2030	267	(131)	137	36	0	36	100
2031	269	(132)	137	39	0	39	98
2032	271	(134)	137	41	0	41	96
2033	273	(135)	138	44	0	44	94
2034	275	(136)	139	46	0	46	92
2035	277	(138)	139	49	0	49	91
2036	279	(139)	140	51	0	51	89
2037	281	(140)	141	54	0	54	87
2038	283	(141)	142	57	0	57	85
2039	285	(142)	143	59	0	59	84
2040	287	(144)	143	62	0	62	82
2041	289	(145)	144	64	0	64	80
2042	290	(146)	144	67	0	67	78
2043	292	(147)	145	69	0	69	76
2044	294	(148)	146	72	0	72	74
2045	295	(149)	146	74	0	74	72
2046	297	(150)	147	77	0	77	70
2047	299	(151)	148	79	0	79	69
2048	300	(152)	148	82	0	82	67
2049	302	(153)	149	84	0	84	65
2050	304	(154)	150	87	0	87	63
2051	305	(155)	150	89	0	89	61
2052	306	(156)	150	91	0	91	59
2053	307	(157)	150	94	0	94	56
2054	308	(157)	150	96	0	96	54
2055	309	(158)	151	98	0	98	53
2056	310	(158)	151	101	0	101	51
2057	311	(159)	152	103	0	103	49
2058	312	(159)	152	105	0	105	47
2059	313	(160)	153	108	0	108	45
2060	314	(161)	153	110	0	110	43
2061	314	(161)	153	112	0	112	41
2062	315	(162)	154	115	0	115	39
2063	316	(162)	154	117	0	117	37
2064	317	(163)	154	119	0	119	35
2065	317	(163)	154	121	0	121	33
2066	318	(163)	155	123	0	123	31
2067	319	(164)	155	126	0	126	29
2068	320	(164)	155	128	0	128	28
2069	320	(164)	156	130	0	130	26
2070	321	(165)	156	132	0	132	24

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how League City's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	**Baseline**	-	118	0	0	0
1	2015	95,002	118	14	147	134
2	2016	97,938	117	29	148	119
3	2017	100,874	117	44	145	101
4	2018	103,811	116	61	142	82
5-year Goal	2019	106,747	116	78	138	60
6	2020	109,683	115	128	135	7
7	2021	111,072	114	178	131	(47)
8	2022	112,462	112	230	130	(99)
9	2023	113,851	111	283	130	(153)
10-year Goal	2024	115,241	110	337	131	(206)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how League City's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	10.00	0	0	0
1	2015	95,002	9.00	35	(97)	(132)
2	2016	97,938	8.00	71	(99)	(171)
3	2017	100,874	7.00	110	(102)	(212)
4	2018	103,811	6.00	152	(104)	(256)
5-year Goal	2019	106,747	5.00	195	(107)	(302)
6	2020	109,683	5.00	200	(110)	(311)
7	2021	111,072	5.00	203	(114)	(316)
8	2022	112,462	5.00	205	(117)	(322)
9	2023	113,851	5.00	208	(120)	(328)
10-year Goal	2024	115,241	5.00	210	(122)	(332)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 97 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 13.0% increase in 2015
    b. Estimated customer demand reduction of 2.6%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Conservation Pricing**
    a. Tiered rate structure in place saves approximately 2.5% of total demand
    b. Savings is cumulative and based on more than one source[19] (U.S. EPA, 1998; TWDB, 2013)

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.
[19] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

6. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
    c. 15% adoption rate assumed

7. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.
    c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
        i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Conservation Pricing	Water Rate Increases	WaterWise Take-home Kits	TOTAL SAVINGS
2009			2.9	3
2010			5.5	5
2011			8.3	8
2012			10.9	11
2013			13.8	14
2014			14.1	14
2015	113	117	14.4	244
2016	114	118	14.4	247
2017	115	120	11.8	247
2018	116	121	8.8	246
2019	118	122	5.7	246
2020	119	124	2.8	245
2021	120	125		245
2022	121	126		247
2023	122	127		250
2024	124	129		252
2025	125	130		255
2026	126	131		257
2027	127	132		260
2028	129	134		262
2029	130	135		265
2030	131	136		267
2031	132	137		269
2032	133	138		271
2033	134	139		273
2034	135	140		275
2035	136	141		277
2036	137	142		279
2037	138	143		281
2038	139	144		283
2039	140	145		285
2040	141	146		287
2041	141	147		289
2042	142	148		290
2043	143	149		292
2044	144	150		294
2045	145	151		295
2046	146	151		297
2047	146	152		299
2048	147	153		300
2049	148	154		302
2050	149	155		304
2051	149	155		305
2052	150	156		306
2053	150	156		307
2054	151	157		308
2055	151	157		309
2056	152	158		310
2057	152	158		311
2058	153	159		312
2059	153	159		313
2060	154	160		314
2061	154	160		314
2062	155	161		315
2063	155	161		316
2064	155	161		317
2065	156	162		317
2066	156	162		318
2067	156	163		319
2068	157	163		320
2069	157	163		320
2070	157	164		321

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	10.00	0
2015	88,459	13.00	(97)
2016	90,640	13.00	(99)
2017	92,821	13.00	(102)
2018	95,002	13.00	(104)
2019	97,938	13.00	(107)
2020	100,874	13.00	(110)
2021	103,811	13.00	(114)
2022	106,747	13.00	(117)
2023	109,683	13.00	(120)
2024	111,072	13.00	(122)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 182 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	247	(99)	148	182	6	0	6	324
2017	247	(102)	145	184	6	0	6	323
2018	246	(104)	142	186	8	0	8	321
2019	246	(107)	138	188	9	0	9	318
2020	245	(130)	135	190	11	0	11	313
2021	245	(114)	131	192	14	0	14	309
2022	247	(117)	130	194	16	0	16	308
2023	250	(120)	130	196	19	0	19	307
2024	252	(121)	131	198	21	0	21	307
2025	255	(123)	132	200	24	0	24	308
2026	257	(125)	133	202	26	0	26	308
2027	260	(126)	134	204	29	0	29	309
2028	262	(128)	135	206	31	0	31	309
2029	265	(129)	136	208	34	0	34	310
2030	267	(130)	137	210	36	0	36	310
2031	269	(132)	137	211	39	0	39	309
2032	271	(134)	137	213	41	0	41	309
2033	273	(135)	138	214	44	0	44	308
2034	275	(136)	139	216	46	0	46	308
2035	277	(138)	139	217	49	0	49	308
2036	279	(139)	140	219	51	0	51	308
2037	281	(140)	141	220	54	0	54	307
2038	283	(141)	142	222	57	0	57	307
2039	285	(142)	143	223	59	0	59	307
2040	287	(144)	143	225	62	0	62	307

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[20]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[20] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	247	(99)	148	61	6	0	6	202
2017	247	(102)	145	62	6	0	6	200
2018	246	(104)	142	62	8	0	8	197
2019	246	(107)	138	63	9	0	9	192
2020	245	(110)	135	64	11	0	11	187
2021	245	(114)	131	64	14	0	14	182
2022	247	(117)	130	65	18	0	18	179
2023	250	(120)	130	66	19	0	19	177
2024	252	(122)	131	66	21	0	21	176
2025	255	(123)	132	67	24	0	24	175
2026	257	(125)	133	68	26	0	26	174
2027	260	(126)	134	68	29	0	29	173
2028	262	(126)	135	69	31	0	31	172
2029	265	(128)	136	70	34	0	34	171
2030	267	(131)	137	70	36	0	36	171
2031	269	(132)	137	71	39	0	39	169
2032	271	(134)	137	71	41	0	41	167
2033	273	(135)	138	72	44	0	44	166
2034	275	(136)	139	72	46	0	46	165
2035	277	(138)	139	73	48	0	48	163
2036	279	(139)	140	73	51	0	51	162
2037	281	(140)	141	74	54	0	54	161
2038	283	(141)	142	74	57	0	57	160
2039	285	(142)	143	75	59	0	59	158
2040	287	(144)	143	75	62	0	62	157

3. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Pasadena Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Pasadena's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Pasadena's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Pasadena's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8,9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Pasadena with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	1,375	111	1,486	27	45	71	1,415
2016	1,375	111	1,487	33	56	89	1,398
2017	1,372	112	1,484	33	67	100	1,384
2018	1,368	113	1,481	40	78	118	1,363
2019	1,364	113	1,477	46	89	136	1,341
2020	1,361	113	1,474	60	100	160	1,314
2021	1,357	113	1,470	71	109	180	1,290
2022	1,357	113	1,470	82	118	200	1,270
2023	1,357	113	1,470	93	127	220	1,250
2024	1,357	113	1,470	104	136	240	1,230
2025	1,358	113	1,472	115	146	260	1,212
2026	1,358	114	1,472	126	155	280	1,192
2027	1,358	114	1,472	137	164	300	1,172
2028	1,358	114	1,473	148	173	320	1,152
2029	1,358	115	1,473	159	182	340	1,133
2030	1,358	115	1,473	170	191	360	1,113
2031	1,358	115	1,474	180	199	379	1,095
2032	1,358	116	1,474	190	207	397	1,077
2033	1,358	116	1,474	200	215	415	1,059
2034	1,358	116	1,475	210	224	434	1,041
2035	1,359	117	1,476	220	232	452	1,024
2036	1,359	117	1,476	230	240	471	1,006
2037	1,359	117	1,477	241	248	489	988
2038	1,359	118	1,477	251	257	507	970
2039	1,359	118	1,477	261	265	526	952
2040	1,359	118	1,478	271	273	544	934
2041	1,361	118	1,480	280	277	557	923
2042	1,363	119	1,482	290	280	570	912
2043	1,365	119	1,484	299	284	583	901
2044	1,366	119	1,486	309	287	596	890
2045	1,368	120	1,488	318	291	609	879
2046	1,370	120	1,490	328	294	622	868
2047	1,372	120	1,493	337	298	635	857
2048	1,374	121	1,495	347	302	648	847
2049	1,375	121	1,496	356	305	662	835
2050	1,377	121	1,499	366	309	675	824
2051	1,381	122	1,503	375	309	685	818
2052	1,384	122	1,506	384	310	694	812
2053	1,387	122	1,510	393	311	704	805
2054	1,390	123	1,513	403	312	714	799
2055	1,394	123	1,517	412	312	724	793
2056	1,397	123	1,521	421	313	734	787
2057	1,400	124	1,524	430	314	744	780
2058	1,403	124	1,527	439	315	754	773
2059	1,407	124	1,532	448	315	764	768
2060	1,410	125	1,535	458	316	774	761
2061	1,414	125	1,539	466	317	783	756
2062	1,417	125	1,543	475	318	793	750
2063	1,421	125	1,547	484	319	803	744
2064	1,425	126	1,551	493	319	812	739
2065	1,428	126	1,555	502	320	822	733
2066	1,432	126	1,559	510	321	831	728
2067	1,436	127	1,563	519	322	841	722
2068	1,439	127	1,567	528	323	851	716
2069	1,443	127	1,571	537	323	860	711
2070	1,447	128	1,575	546	324	870	705

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Pasadena's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	122	0	0	0
1	2015	154,250	121	34	1,486	1,452
2	2016	154,288	121	68	1,487	1,419
3	2017	154,326	120	101	1,484	1,383
4	2018	154,365	120	135	1,481	1,346
5-year Goal	2019	154,403	119	169	1,477	1,308
6	2020	154,441	118	209	1,474	1,265
7	2021	154,881	118	249	1,470	1,221
8	2022	155,321	117	289	1,470	1,181
9	2023	155,761	116	330	1,470	1,140
10-year Goal	2024	156,201	116	371	1,470	1,100

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Pasadena's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	15.00	0	0	0
1	2015	154,250	14.60	23	111	88
2	2016	154,288	14.20	45	111	66
3	2017	154,326	13.80	68	112	44
4	2018	154,365	13.40	90	113	22
5-year Goal	2019	154,403	13.00	113	113	(0)
6	2020	154,441	12.40	147	113	(34)
7	2021	154,881	11.80	181	113	(68)
8	2022	155,321	11.20	215	113	(103)
9	2023	155,761	10.60	250	113	(137)
10-year Goal	2024	156,201	10.00	285	113	(172)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 111 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increase**
    a. Last rate increase:[17]
        i. 91.0% increase in 2012
    b. Estimated customer demand reduction of 18.2%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

6. WaterWise Take-home Kits

a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
b. Conservative 5-year useful life for all items in kit
c. 15% adoption rate assumed

7. Save Water Co. Commercial, Multi-family and Hotel Programs[19]

a. Project initiated in service area in 2014
b. Save Water completed work on 44 multi-family units in June 2014.
c. Average monthly savings of 286,156 gallons
d. Annualized savings of 3.43 MG for the life of the retrofitted fixtures
e. This study estimates a lifespan of 25 years for high-efficiency toilet replacements, five years for kitchen aerators and similar devices.
f. Save Water Co. performs monthly meter readings before and after installation to quantify savings.
    i. The company's work consists of identifying and repairing all leaks and drips, rebuilding existing toilets and replacing sink aerators.

[19] Savings figures and units serviced based on personal email communication with Kurt Goedrich, December 1, 2016.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increase	WaterWise Take-home Kits	Save Water Co. Program	TOTAL SAVINGS
2009		3.7		4
2010		6.8		7
2011		10.3		10
2012	1,353	13.6		1,367
2013	1,353	17.3		1,370
2014	1,354	17.5	3.4	1,375
2015	1,354	17.9	3.4	1,375
2016	1,354	18.0	3.4	1,375
2017	1,354	14.7	3.4	1,372
2018	1,354	11.0	3.4	1,368
2019	1,354	7.1	3.4	1,364
2020	1,354	3.5	3.4	1,361
2021	1,354		3.4	1,357
2022	1,354		3.4	1,357
2023	1,354		3.4	1,357
2024	1,354		3.4	1,357
2025	1,355		3.4	1,358
2026	1,355		3.4	1,358
2027	1,355		3.4	1,358
2028	1,355		3.4	1,358
2029	1,355		3.4	1,358
2030	1,355		3.4	1,358
2031	1,355		3.4	1,358
2032	1,355		3.4	1,358
2033	1,355		3.4	1,358
2034	1,355		3.4	1,358
2035	1,356		3.4	1,359
2036	1,356		3.4	1,359
2037	1,356		3.4	1,359
2038	1,356		3.4	1,359
2039	1,356		3.4	1,359
2040	1,356		3.4	1,359
2041	1,358		3.4	1,361
2042	1,360		3.4	1,363
2043	1,362		3.4	1,365
2044	1,363		3.4	1,366
2045	1,365		3.4	1,368
2046	1,367		3.4	1,370
2047	1,369		3.4	1,372
2048	1,371		3.4	1,374
2049	1,372		3.4	1,375
2050	1,374		3.4	1,377
2051	1,378		3.4	1,381
2052	1,381		3.4	1,384
2053	1,384		3.4	1,387
2054	1,387		3.4	1,390
2055	1,391		3.4	1,394
2056	1,394		3.4	1,397
2057	1,397		3.4	1,400
2058	1,400		3.4	1,403
2059	1,404		3.4	1,407
2060	1,407		3.4	1,410
2061	1,411		3.4	1,414
2062	1,414		3.4	1,417
2063	1,418		3.4	1,421
2064	1,422		3.4	1,425
2065	1,425		3.4	1,428
2066	1,429		3.4	1,432
2067	1,433		3.4	1,436
2068	1,436		3.4	1,439
2069	1,440		3.4	1,443
2070	1,444		3.4	1,447

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	15.00	0
2015	151,443	13.00	111
2016	152,378	13.00	111
2017	153,314	13.00	112
2018	154,250	13.00	113
2019	154,288	13.00	113
2020	154,326	13.00	113
2021	154,365	13.00	113
2022	154,403	13.00	113
2023	154,441	13.00	113
2024	154,881	13.00	113

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 298 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1,375	111	1,487	298	53	56	89	1,695
2017	1,372	112	1,484	298	33	67	100	1,681
2018	1,368	113	1,481	298	40	78	118	1,661
2019	1,364	113	1,477	298	46	89	136	1,639
2020	1,361	113	1,474	298	60	100	160	1,611
2021	1,357	113	1,470	298	71	109	180	1,588
2022	1,357	113	1,470	298	82	118	200	1,568
2023	1,357	113	1,470	298	93	127	220	1,548
2024	1,357	113	1,470	298	104	136	240	1,528
2025	1,358	113	1,472	298	115	146	260	1,509
2026	1,358	114	1,472	298	126	155	280	1,490
2027	1,358	114	1,472	298	137	164	300	1,470
2028	1,358	114	1,473	298	148	173	320	1,450
2029	1,358	115	1,473	298	159	182	340	1,430
2030	1,358	115	1,473	298	170	191	360	1,411
2031	1,358	115	1,474	298	180	199	379	1,393
2032	1,358	116	1,474	298	190	207	397	1,375
2033	1,358	116	1,474	298	200	215	415	1,357
2034	1,358	116	1,475	298	210	224	434	1,339
2035	1,359	117	1,476	298	220	232	452	1,322
2036	1,359	117	1,476	298	230	240	471	1,304
2037	1,359	117	1,477	298	241	248	489	1,286
2038	1,359	118	1,477	298	251	257	507	1,268
2039	1,359	118	1,477	298	261	265	526	1,250
2040	1,359	118	1,478	298	271	273	544	1,232

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

- **a.** Specific utility results will vary based on portal features and frequency of customer notifications
- **b.** Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
- **c.** Estimate assumes customers will save 10% of total annual use due to the portal
    - i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
- **d.** Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    - i. This was the most common percentage of residential use among participating utilities in this project.
    - ii. Actual customer class demand percentages will vary by utility.
- **e.** 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
- **f.** Savings are assumed to increase along with demand as connections increase each year[20]
- **g.** See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[20] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	1,375	111	1,487	100	33	56	89	1,497
2017	1,372	112	1,484	100	33	67	100	1,484
2018	1,368	113	1,481	100	40	78	118	1,463
2019	1,364	113	1,477	100	46	88	136	1,441
2020	1,361	113	1,474	100	60	100	160	1,413
2021	1,357	113	1,470	100	71	109	180	1,390
2022	1,357	113	1,470	100	82	118	200	1,370
2023	1,357	113	1,470	100	93	127	220	1,350
2024	1,357	113	1,470	100	104	136	240	1,330
2025	1,358	113	1,472	100	115	146	260	1,311
2026	1,358	114	1,472	100	126	155	280	1,292
2027	1,358	114	1,472	100	137	164	300	1,272
2028	1,358	114	1,473	100	148	173	320	1,252
2029	1,358	115	1,473	100	159	182	340	1,232
2030	1,358	115	1,473	100	170	191	360	1,213
2031	1,358	115	1,474	100	180	199	379	1,195
2032	1,358	116	1,474	100	190	207	397	1,177
2033	1,358	116	1,474	100	200	215	415	1,159
2034	1,358	116	1,475	100	210	224	434	1,141
2035	1,359	117	1,476	100	220	232	452	1,124
2036	1,359	117	1,476	100	230	240	471	1,106
2037	1,359	117	1,477	100	241	248	489	1,088
2038	1,359	118	1,477	100	251	257	507	1,070
2039	1,359	118	1,477	100	261	265	526	1,051
2040	1,359	118	1,478	100	271	273	544	1,033

3. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Pearland Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Pearland's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Pearland's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Pearland's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD[7] consumption and water loss GPCD.[8][9]

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as

[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.
[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.
[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365
[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.
[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in million gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Pearland with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	280	(175)	105	24	29	53	52
2016	724	(179)	545	30	37	67	479
2017	731	(184)	547	30	44	74	473
2018	738	(188)	550	36	51	87	462
2019	744	(192)	552	42	59	101	451
2020	751	(197)	554	54	66	120	434
2021	757	(201)	556	64	73	137	419
2022	764	(206)	558	74	80	154	404
2023	770	(210)	560	84	87	171	389
2024	777	(212)	565	94	94	188	377
2025	783	(214)	570	104	101	205	365
2026	790	(216)	574	115	107	222	352
2027	797	(218)	579	125	114	239	340
2028	803	(219)	584	135	121	256	328
2029	810	(221)	588	145	128	273	315
2030	816	(223)	593	155	135	290	303
2031	825	(225)	600	165	139	304	295
2032	833	(227)	606	175	144	319	287
2033	841	(229)	613	185	148	333	279
2034	849	(231)	619	195	152	348	271
2035	858	(233)	625	205	157	362	263
2036	866	(236)	631	215	161	376	254
2037	874	(238)	636	225	165	391	246
2038	883	(240)	642	235	170	405	237
2039	891	(242)	648	245	174	419	229
2040	899	(245)	654	256	178	434	221
2041	907	(247)	660	265	180	445	215
2042	915	(249)	666	275	181	456	210
2043	924	(252)	672	284	183	467	205
2044	932	(254)	678	294	184	478	200
2045	940	(256)	684	303	186	489	194
2046	948	(259)	689	313	187	500	189
2047	956	(261)	695	322	189	511	184
2048	964	(263)	701	332	191	522	179
2049	972	(265)	707	341	192	533	174
2050	981	(268)	713	351	194	545	168
2051	989	(270)	719	360	195	555	164
2052	997	(272)	725	369	197	566	159
2053	1,005	(275)	731	378	198	576	155
2054	1,014	(277)	737	387	200	587	150
2055	1,022	(279)	743	396	201	597	145
2056	1,030	(281)	749	405	203	608	141
2057	1,038	(284)	755	414	205	618	136
2058	1,047	(286)	761	423	206	629	132
2059	1,055	(288)	767	432	208	640	127
2060	1,063	(291)	772	441	209	650	122
2061	1,071	(293)	778	449	211	660	118
2062	1,079	(295)	783	457	212	669	114
2063	1,086	(298)	789	465	214	679	110
2064	1,094	(300)	794	473	215	689	106
2065	1,102	(302)	800	481	217	698	101
2066	1,109	(304)	805	489	218	708	97
2067	1,117	(306)	811	498	220	717	93
2068	1,125	(308)	816	506	221	727	89
2069	1,133	(311)	822	514	223	737	85
2070	1,140	(313)	827	522	225	746	81

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Pearland's quantified savings from its implemented activities compare with 5- and 10-years goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	117	0	0	0
1	2015	103,013	115	60	105	45
2	2016	105,443	114	123	545	422
3	2017	107,873	112	189	547	358
4	2018	110,304	111	258	550	292
5-year Goal	2019	112,734	109	329	552	222
6	2020	115,164	109	353	554	201
7	2021	116,171	108	373	556	183
8	2022	117,177	108	393	558	165
9	2023	118,184	107	414	560	146
10-year Goal	2024	119,191	107	435	565	130

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Pearland's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	11.00	0	0	0
1	2015	103,013	11.00	0	(175)	(175)
2	2016	105,443	11.00	0	(179)	(179)
3	2017	107,873	11.00	0	(184)	(184)
4	2018	110,304	11.00	0	(188)	(188)
5-year Goal	2019	112,734	11.00	0	(192)	(192)
6	2020	115,164	11.00	0	(197)	(197)
7	2021	116,171	11.00	0	(201)	(201)
8	2022	117,177	11.00	0	(206)	(206)
9	2023	118,184	11.00	0	(210)	(210)
10-year Goal	2024	119,191	11.00	0	(212)	(212)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 175 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 7.8% increase in 2014 (no increase on base)
        ii. 12.2% increase in 2016 (no increase on base)
    b. Estimated customer demand reduction of 2.0%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
        i. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	TOTAL SAVINGS
2009		0
2010		0
2011		0
2012		0
2013		0
2014	277	277
2015	280	280
2016	724	724
2017	731	731
2018	738	738
2019	744	744
2020	751	751
2021	757	757
2022	764	764
2023	770	770
2024	777	777
2025	783	783
2026	790	790
2027	797	797
2028	803	803
2029	810	810
2030	816	816
2031	825	825
2032	833	833
2033	841	841
2034	849	849
2035	858	858
2036	866	866
2037	874	874
2038	883	883
2039	891	891
2040	899	899
2041	907	907
2042	915	915
2043	924	924
2044	932	932
2045	940	940
2046	948	948
2047	956	956
2048	964	964
2049	972	972
2050	981	981
2051	989	989
2052	997	997
2053	1,005	1,005
2054	1,014	1,014
2055	1,022	1,022
2056	1,030	1,030
2057	1,038	1,038
2058	1,047	1,047
2059	1,055	1,055
2060	1,063	1,063
2061	1,071	1,071
2062	1,079	1,079
2063	1,086	1,086
2064	1,094	1,094
2065	1,102	1,102
2066	1,109	1,109
2067	1,117	1,117
2068	1,125	1,125
2069	1,133	1,133
2070	1,140	1,140

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	11.00	0
2015	95,722	16.00	(175)
2016	98,153	16.00	(179)
2017	100,583	16.00	(184)
2018	103,013	16.00	(188)
2019	105,443	16.00	(192)
2020	107,873	16.00	(197)
2021	110,304	16.00	(201)
2022	112,734	16.00	(206)
2023	115,164	16.00	(210)
2024	116,171	16.00	(212)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 1,449 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	724	(179)	545	1,449	30	37	67	1,927
2017	731	(184)	547	1,462	30	44	74	1,935
2018	738	(188)	550	1,475	36	51	87	1,937
2019	744	(192)	552	1,488	42	59	101	1,939
2020	751	(197)	554	1,501	54	66	120	1,935
2020	757	(201)	556	1,514	64	73	137	1,933
2020	764	(206)	558	1,528	74	80	154	1,932
2020	770	(210)	560	1,541	84	87	171	1,930
2020	777	(212)	565	1,554	94	94	188	1,931
2020	783	(214)	570	1,567	104	101	205	1,932
2020	790	(216)	574	1,580	115	107	222	1,932
2020	797	(218)	579	1,593	125	114	239	1,933
2020	803	(219)	584	1,606	135	121	256	1,934
2020	810	(221)	588	1,619	145	128	273	1,935
2020	816	(223)	593	1,633	155	135	290	1,936
2020	825	(225)	600	1,649	165	139	304	1,944
2020	833	(227)	606	1,686	175	144	319	1,953
2020	841	(229)	613	1,682	185	148	333	1,962
2020	849	(231)	619	1,699	195	152	348	1,970
2020	858	(233)	625	1,715	205	157	362	1,978
2020	868	(236)	631	1,732	215	161	376	1,986
2020	874	(238)	636	1,749	225	168	391	1,994
2020	883	(240)	642	1,765	235	170	405	2,003
2020	891	(242)	648	1,782	245	174	419	2,011
2020	899	(245)	654	1,798	256	178	434	2,019

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	724	(179)	545	485	30	37	67	964
2017	731	(184)	547	490	30	44	74	963
2018	738	(188)	550	494	36	51	87	956
2019	744	(192)	552	499	42	59	101	950
2020	751	(197)	554	503	54	66	120	937
2021	757	(201)	556	507	64	73	137	926
2022	764	(206)	558	512	74	80	154	916
2023	770	(210)	560	516	84	87	171	905
2024	777	(212)	565	521	94	94	188	897
2025	783	(214)	570	525	104	101	205	890
2026	790	(216)	574	529	115	107	222	882
2027	797	(218)	579	534	125	114	239	874
2028	803	(219)	584	538	135	121	256	866
2029	810	(221)	588	542	145	128	273	858
2030	816	(223)	593	547	155	135	290	850
2031	825	(225)	600	552	165	139	304	848
2032	833	(227)	606	558	175	144	319	845
2033	841	(228)	613	564	185	148	333	843
2034	849	(231)	619	569	195	152	348	840
2035	858	(233)	625	575	205	157	362	837
2036	866	(236)	631	580	215	161	376	834
2037	874	(238)	636	586	225	166	391	832
2038	883	(240)	642	591	235	170	405	828
2039	891	(242)	648	597	245	174	419	826
2040	899	(245)	654	602	256	178	434	823

3. Rain Barrels
   - **a.** In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   - **b.** Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Southern Montgomery County MUD Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Southern Montgomery County MUD's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Southern Montgomery County MUD's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Southern Montgomery County MUD's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8 9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Southern Montgomery County MUD with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB.[12] The summary of these savings can be referenced in Table 5-1.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	0	40	40	1	0	1	39
2016	0	40	40	1	0	1	39
2017	0	41	41	1	0	1	40
2018	0	41	41	2	0	2	40
2019	0	42	42	2	0	2	40
2020	0	42	42	2	0	2	40
2021	0	42	42	3	0	3	40
2022	0	43	43	3	0	3	40
2023	0	43	43	3	0	3	40
2024	0	43	43	4	0	4	40
2025	0	44	44	4	0	4	40
2026	0	44	44	4	0	4	40
2027	0	45	45	5	0	5	40
2028	0	45	45	5	0	5	40
2029	0	46	46	6	0	6	40
2030	0	46	46	6	0	6	40
2031	0	46	46	6	0	6	40
2032	0	47	47	6	0	6	41
2033	0	47	47	6	0	6	41
2034	0	47	47	7	0	7	41
2035	0	47	47	7	0	7	40
2036	0	47	47	7	0	7	40
2037	0	47	47	7	0	7	40
2038	0	47	47	7	0	7	40
2039	0	47	47	8	0	8	40
2040	0	48	48	8	0	8	40
2041	0	48	48	8	0	8	39
2042	0	48	48	9	0	9	39
2043	0	48	48	9	0	9	39
2044	0	48	48	9	0	9	38
2045	0	48	48	10	0	10	38
2046	0	48	48	10	0	10	38
2047	0	48	48	11	0	11	37
2048	0	48	48	11	0	11	37
2049	0	48	48	11	0	11	37
2050	0	48	48	12	0	12	36
2051	0	48	48	12	0	12	36
2052	0	48	48	12	0	12	37
2053	0	48	48	12	0	12	37
2054	0	48	48	12	0	12	37
2055	0	49	49	12	0	12	37
2056	0	49	49	12	0	12	37
2057	0	49	49	12	0	12	37
2058	0	49	49	12	0	12	37
2059	0	49	49	12	0	12	37
2060	0	49	49	12	0	12	38
2061	0	49	49	12	0	12	38
2062	0	50	50	12	0	12	38
2063	0	50	50	12	0	12	38
2064	0	50	50	12	0	12	38
2065	0	50	50	12	0	12	38
2066	0	50	50	12	0	12	38
2067	0	50	50	12	0	12	38
2068	0	50	50	12	0	12	38
2069	0	50	50	12	0	12	39
2070	0	50	50	12	0	12	39

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Southern Montgomery County MUD's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	115	0	0	0
1	2015	11,310	112	12	40	28
2	2016	11,402	109	25	40	15
3	2017	11,493	106	38	41	3
4	2018	11,585	103	51	41	(9)
5-year Goal	2019	11,676	100	64	42	(22)
6	2020	11,768	98	73	42	(31)
7	2021	11,885	96	82	42	(40)
8	2022	12,002	94	92	43	(49)
9	2023	12,120	92	102	43	(59)
10-year Goal	2024	12,237	90	112	43	(68)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Southern Montgomery County MUD's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-1 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	20.00	0	0	0
1	2015	11,310	19.00	4	40	36
2	2016	11,402	18.00	8	40	32
3	2017	11,493	17.00	13	41	28
4	2018	11,585	16.00	17	41	24
5-year Goal	2019	11,676	15.00	21	42	20
6	2020	11,768	14.20	25	42	17
7	2021	11,885	13.40	29	42	14
8	2022	12,002	12.60	32	43	10
9	2023	12,120	11.80	36	43	7
10-year Goal	2024	12,237	11.00	40	43	3

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 40 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
        i. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	20.00	0
2015	10,963	10.00	40
2016	11,078	10.00	40
2017	11,194	10.00	41
2018	11,310	10.00	41
2019	11,402	10.00	42
2020	11,493	10.00	42
2021	11,585	10.00	42
2022	11,676	10.00	43
2023	11,768	10.00	43
2024	11,885	10.00	43

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.

- Avoided system expansion costs
    - Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
    a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
        i. Average Region H savings
        ii. Specific percentage of outdoor usage unknown for your utility at this time
    b. Savings could be 11 MG per year with current demand.
    c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	40	40	11	1	0	1	50
2017	0	41	41	11	1	0	1	51
2018	0	41	41	11	2	0	2	51
2019	0	42	42	11	2	0	2	51
2020	0	42	42	11	2	0	2	51
2021	0	42	42	11	3	0	3	51
2022	0	43	43	11	3	0	3	51
2023	0	43	43	11	3	0	3	51
2024	0	43	43	11	4	0	4	51
2025	0	44	44	11	4	0	4	51
2026	0	44	44	11	4	0	4	51
2027	0	45	45	11	5	0	5	51
2028	0	45	45	11	5	0	5	51
2029	0	46	46	11	6	0	6	51
2030	0	46	46	11	6	0	6	51
2031	0	46	46	11	6	0	6	52
2032	0	47	47	11	6	0	6	52
2033	0	47	47	11	6	0	6	52
2034	0	47	47	11	7	0	7	52
2035	0	47	47	11	7	0	7	52
2036	0	47	47	11	7	0	7	52
2037	0	47	47	11	7	0	7	51
2038	0	47	47	11	7	0	7	51
2039	0	47	47	11	8	0	8	51
2040	0	48	48	11	8	0	8	51

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	40	40	4	1	0	1	43
2017	0	41	41	4	1	0	1	43
2018	0	41	41	4	2	0	2	44
2019	0	42	42	4	2	0	2	44
2020	0	42	42	4	2	0	2	43
2021	0	42	42	4	3	0	3	43
2022	0	43	43	4	3	0	3	43
2023	0	43	43	4	3	0	3	43
2024	0	43	43	4	4	0	4	43
2025	0	44	44	4	4	0	4	44
2026	0	44	44	4	4	0	4	44
2027	0	45	45	4	5	0	5	44
2028	0	45	45	4	5	0	5	44
2029	0	46	46	4	6	0	6	44
2030	0	46	46	4	6	0	6	44
2031	0	46	46	4	6	0	6	44
2032	0	47	47	4	6	0	6	44
2033	0	47	47	4	6	0	6	45
2034	0	47	47	4	7	0	7	44
2035	0	47	47	4	7	0	7	44
2036	0	47	47	4	7	0	7	44
2037	0	47	47	4	7	0	7	44
2038	0	47	47	4	7	0	7	44
2039	0	47	47	4	8	0	8	44
2040	0	48	48	4	8	0	8	43

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 6 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	0	40	40	6	1	0	1	45
2017	0	41	41	6	1	0	1	45
2018	0	41	41	6	2	0	2	45
2019	0	42	42	6	2	0	2	45
2020	0	42	42	6	2	0	2	45
2021	0	42	42	6	3	0	3	45
2022	0	43	43	6	3	0	3	45
2023	0	43	43	6	3	0	3	45
2024	0	43	43	6	4	0	4	45
2025	0	44	44	6	4	0	4	45
2026	0	44	44	6	4	0	4	45
2027	0	45	45	6	5	0	5	46
2028	0	45	45	6	5	0	5	46
2029	0	46	46	6	6	0	6	46
2030	0	46	46	6	6	0	6	46
2031	0	46	46	6	6	0	6	46
2032	0	47	47	6	6	0	6	46
2033	0	47	47	6	6	0	6	46
2034	0	47	47	6	7	0	7	46
2035	0	47	47	6	7	0	7	46
2036	0	47	47	6	7	0	7	46
2037	0	47	47	6	7	0	7	46
2038	0	47	47	6	7	0	7	46
2039	0	47	47	6	8	0	8	45
2040	0	48	48	6	8	0	8	45

4. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
Fort Bend County WCID #2 Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Fort Bend County WCID #2's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Fort Bend County WCID #2's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Fort Bend County WCID #2's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8] [9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Fort Bend County WCID #2 with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

Actual Current Conservation Activity Savings – All quantified activities currently being performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	54	0	54	4	0	4	51
2016	56	0	56	5	0	5	51
2017	54	0	54	5	0	5	49
2018	53	0	53	5	0	5	47
2019	51	0	51	6	0	6	45
2020	49	0	49	8	0	8	41
2021	48	0	48	9	0	9	39
2022	48	0	48	10	0	10	38
2023	48	0	48	12	0	12	36
2024	48	0	48	13	0	13	35
2025	48	0	48	14	0	14	34
2026	48	0	48	15	0	15	33
2027	48	0	48	16	0	16	32
2028	48	0	48	17	0	17	31
2029	48	0	48	18	0	18	30
2030	48	0	48	20	0	20	28
2031	49	0	49	20	0	20	29
2032	49	0	49	21	0	21	28
2033	49	0	49	22	0	22	27
2034	49	0	49	23	0	23	26
2035	49	0	49	24	0	24	25
2036	49	0	49	25	0	25	24
2037	49	0	49	26	0	26	23
2038	49	0	49	27	0	27	22
2039	49	0	49	28	0	28	21
2040	49	0	49	29	0	29	20
2041	50	0	50	30	0	30	20
2042	50	0	50	31	0	31	19
2043	50	0	50	32	0	32	18
2044	50	0	50	33	0	33	17
2045	50	0	50	33	0	33	17
2046	50	0	50	34	0	34	16
2047	50	0	50	35	0	35	15
2048	51	0	51	36	0	36	15
2049	51	0	51	37	0	37	14
2050	51	0	51	38	0	38	13
2051	51	0	51	39	0	39	12
2052	51	0	51	39	0	39	12
2053	51	0	51	40	0	40	11
2054	52	0	52	41	0	41	11
2055	52	0	52	42	0	42	10
2056	52	0	52	42	0	42	10
2057	52	0	52	43	0	43	9
2058	52	0	52	44	0	44	8
2059	53	0	53	45	0	45	8
2060	53	0	53	46	0	46	7
2061	53	0	53	46	0	46	7
2062	53	0	53	47	0	47	6
2063	53	0	53	48	0	48	5
2064	54	0	54	49	0	49	5
2065	54	0	54	50	0	50	4
2066	54	0	54	50	0	50	4
2067	54	0	54	51	0	51	3
2068	55	0	55	52	0	52	3
2069	55	0	55	53	0	53	2
2070	55	0	55	53	0	53	2

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Fort Bend County WCID #2's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	140	0	0	0
1	2015	17,880	140	0	54	54
2	2016	17,918	140	0	56	56
3	2017	17,956	140	0	54	54
4	2018	17,995	140	0	53	53
5-year Goal	2019	18,033	140	0	51	51
6	2020	18,071	144	(26)	49	76
7	2021	18,121	148	(53)	48	101
8	2022	18,172	152	(80)	48	128
9	2023	18,222	156	(106)	48	154
10-year Goal	2024	18,272	160	(133)	48	181

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Fort Bend County WCID #2's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match five- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	17.00	0	0	0
1	2015	17,880	17.00	0	0	0
2	2016	17,918	17.00	0	0	0
3	2017	17,956	17.00	0	0	0
4	2018	17,995	17.00	0	0	0
5-year Goal	2019	18,033	17.00	0	0	0
6	2,020	18,071	17	(3)	0	3
7	2,021	18,121	18	(5)	0	5
8	2,022	18,172	18	(8)	0	8
9	2,023	18,222	19	(11)	0	11
10-year Goal	2,024	18,272	19	(13)	0	13

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (Texas Water Development Board, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Savings of 0 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Water Rate Increases**
    a. Last rate increases:[17]
        i. 7.0% increase in 2013
        ii. 10.0% increase in 2015
    b. Estimated customer demand reduction of 3.4%
    c. Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
    d. Savings from rate increases are shown to persist over time, however, note that savings from these pricing signals will likely decrease if rates remain the same in future years.

5. **Automatic Meter Reading (AMR)/Advanced Metering Infrastructure**
    a. These metering systems can save water in a number of ways, including from water loss reduction through improved leak detection.
    b. All water loss reduction savings associated with this activity are detailed in Section 5, which assessed utility baseline water loss GPCD and most recently reported water loss GPCD to determine water savings.

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[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.
[17] Correspondence with utility staff.
[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

c. For estimated water savings that could be increased by implementing meter data management (MDM) and customer engagement portal applications, refer to Section 6 of this report.
    i. With these additional applications, water savings can be achieved through changed customer behavior and other real-time actions that go beyond water loss reduction.

6. WaterWise Take-home Kits

a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
b. Conservative 5-year useful life for all items in kit
    i. 15% adoption rate assumed

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	Water Rate Increases	WaterWise Take-home Kits	TOTAL SAVINGS
2009		1.5	1
2010		2.7	3
2011		4.0	4
2012		5.6	6
2013	19	7.1	26
2014	20	7.2	27
2015	47	7.4	54
2016	48	7.5	56
2017	48	6.0	54
2018	48	4.5	53
2019	48	2.9	51
2020	48	1.4	49
2021	48		48
2022	48		48
2023	48		48
2024	48		48
2025	48		48
2026	48		48
2027	48		48
2028	48		48
2029	48		48
2030	48		48
2031	49		49
2032	49		49
2033	49		49
2034	49		49
2035	49		49
2036	49		49
2037	49		49
2038	49		49
2039	49		49
2040	49		49
2041	50		50
2042	50		50
2043	50		50
2044	50		50
2045	50		50
2046	50		50
2047	50		50
2048	51		51
2049	51		51
2050	51		51
2051	51		51
2052	51		51
2053	51		51
2054	52		52
2055	52		52
2056	52		52
2057	52		52
2058	52		52
2059	53		53
2060	53		53
2061	53		53
2062	53		53
2063	53		53
2064	54		54
2065	54		54
2066	54		54
2067	54		54
2068	55		55
2069	55		55
2070	55		55

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	17.00	0
2015	17,809	17.00	0
2016	17,833	17.00	0
2017	17,856	17.00	0
2018	17,880	17.00	0
2019	17,918	17.00	0
2020	17,956	17.00	0
2021	17,995	17.00	0
2022	18,033	17.00	0
2023	18,071	17.00	0
2024	18,121	17.00	0

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
  - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 4% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
      i. Average Region H savings
      ii. Specific percentage of outdoor usage unknown for your utility at this time
   b. Savings could be 56 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	56	0	56	56	5	0	5	107
2017	54	0	54	56	5	0	5	105
2018	53	0	53	56	5	0	5	103
2019	51	0	51	56	6	0	6	101
2020	49	0	49	56	8	0	8	98
2021	48	0	48	56	9	0	9	95
2022	48	0	48	56	10	0	10	94
2023	48	0	48	56	12	0	12	93
2024	48	0	48	57	13	0	13	92
2025	48	0	48	57	14	0	14	91
2026	48	0	48	57	15	0	15	90
2027	48	0	48	57	16	0	16	89
2028	48	0	48	57	17	0	17	88
2029	48	0	48	57	18	0	18	86
2030	48	0	48	57	20	0	20	85
2031	49	0	49	57	20	0	20	86
2032	49	0	49	57	21	0	21	85
2033	49	0	49	57	22	0	22	84
2034	49	0	49	57	23	0	23	83
2035	49	0	49	58	24	0	24	82
2036	49	0	49	58	25	0	25	81
2037	49	0	49	58	26	0	26	81
2038	49	0	49	58	27	0	27	80
2039	49	0	49	58	28	0	28	79
2040	49	0	49	58	29	0	29	78

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[19]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

[19] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	56	0	56	19	5	0	5	70
2017	54	0	54	19	5	0	5	68
2018	53	0	53	19	5	0	5	66
2019	51	0	51	19	6	0	6	63
2020	49	0	49	19	8	0	8	60
2021	48	0	48	19	9	0	9	58
2022	48	0	48	19	10	0	10	56
2023	48	0	48	19	12	0	12	55
2024	48	0	48	19	13	0	13	54
2025	48	0	48	19	14	0	14	53
2026	48	0	48	19	15	0	15	52
2027	48	0	48	19	16	0	16	51
2028	48	0	48	19	17	0	17	50
2029	48	0	48	19	18	0	18	49
2030	48	0	48	19	20	0	20	48
2031	49	0	49	19	20	0	20	48
2032	49	0	49	19	21	0	21	47
2033	49	0	49	19	22	0	22	46
2034	49	0	49	19	23	0	23	45
2035	49	0	49	19	24	0	24	44
2036	49	0	49	19	25	0	25	43
2037	49	0	49	19	26	0	26	42
2038	49	0	49	19	27	0	27	41
2039	49	0	49	19	28	0	28	40
2040	49	0	49	19	29	0	29	39

3. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels

Statewide Water Conservation Quantification Project
City of Sugar Land Report • 2017

1 Introduction

In Texas' 2017 State Water Plan, municipal water conservation is projected to meet 9.6 percent[1] of the state's future water needs by 2070. According to the 16 regional water plans that comprise the state water plan, this is expected to be achieved through a variety of measures such as installation of water efficient plumbing fixtures, water conservation pricing structures, water system audits, landscape irrigation ordinances, as well as other water conservation activities. The 9.6 percent is "in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards, which are embedded in municipal water demand projections" (Texas Water Development Board, 2017).

In 2015, the Texas Legislature appropriated funds to the Texas Water Development Board (TWDB) to fund a research project principally charged with quantitatively determining the savings of municipal water conservation activities being implemented in relation to the recommended conservation goals (supply volumes) in the State Water Plan. As part of the project, individual reports were completed for all participating utilities.

With this report, utilities will benefit by receiving a clear and concise picture of its water conservation goals alongside estimated savings from quantifiable activities. In the event that current activity savings may not be able to reach long-term goals, this report offers suggestions on how utilities can reach water conservation goals with activities that are effective, easily adopted, have widespread appeal, and are quantifiable.

2 Municipal Conservation Terminology and Review of Methodology Used by Regional Planners

To make use of the results of this study, it is important to understand several key terms used in the water planning process.

What is a water user group?

In this report, a water user group (WUG) refers to a retail water provider in the form a city, municipal utility district, water control and improvement district, special utility district, water supply corporation, fresh water supply district, or other type of water utility. The TWDB further defines WUGs as one of the following (Region C Water Planning Group, 2016):

- Cities and towns with a population of 500 or more
- Non-city utilities providing more than 280 acre-feet per year per year of water for municipal use
- Collective reporting units (CRUs) consisting of grouped utilities having a common association

[1] Equal to 811,224 acre-feet per year in conservation savings.

- County-Wide WUGs:
  - County-Other (Rural/unincorporated areas of municipal water use)
  - Manufacturing
  - Steam electric power generation

What is a recommended water management strategy?

A recommended water management strategy (WMS) is a measure that will help ensure WUGs have adequate water supplies for their end users well into the future. WMS examples include river diversions, groundwater use, reservoir and aquifer development, and irrigation conservation. When WMS is referred to in this report, it refers only to municipal conservation, which may include water loss reduction as a part of the same strategy.

What is a WMS supply volume?

A WMS supply volume is the amount of water that a given strategy is expected to yield each decade in the planning period if carried out by the WUG. In this report, a WMS supply volume is the amount of water recommended to come from municipal water conservation.

Some regional water plans separate this strategy's supply volume into a volume for municipal water conservation and a volume for water loss reduction for each decade. The total strategy supply volume is the sum of both. A regional water plan may also refer to "advanced conservation" as part of this strategy. Advanced conservation usually indicates that the volume could be achieved through a more robust mix of conservation activities described in the plan.

2.1 Regional Planning Group Approach to Determining Supply Volumes

Each regional water planning group (RWPG) is responsible for producing its own individual plan that, if executed, will provide sufficient water to its WUGs throughout a 50-year planning period. These plans are completed in five-year cycles, with the most recent edition being completed in 2016. The 2016 regional plans make up the 2017 State Water Plan, which sets out WMS supply volumes for the years 2020 through 2070.

The decadal WMS supply volumes for municipal conservation were established by each of the RWPGs in much the same manner. The RWPGs generally followed the guidelines of the Texas Legislature's Water Conservation Implementation Task Force on the pace utilities should target to reduce gallons per capita per day (GPCD)[2] consumption levels.

The targeted reductions used by most regions follow this formula:

- For municipal WUGs with water use of 140 GPCD and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 GPCD is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year

[2] Regional water planning GPCD is defined as the annual volume of water pumped, diverted, or purchased minus the volume exported (sold) to other water systems or large industrial facilities divided by the permanent resident population of the Municipal Water User Group in the regional water planning process divided by 365. Saline and reused/recycled water are not included in this volume (TWDB, 2012).

for the remainder of the planning period (South Central Texas Regional Water Planning Group, 2016).

The yearly reductions in GPCD for a given WUG are then converted into recommended supply volumes in acre-feet per year for each decade as the reductions in consumption continue. Some regions reduce GPCD by slightly different percentages before and after the 140 GPCD threshold, some do not apply further reductions in GPCD for WUGs once they reach 140 GPCD, while others recommend only "advanced conservation" activities once WUGs meet 140 GPCD.

2.2 Methodology

In order to complete a uniform quantification process, the first engagement was with utilities that agreed to participate and collected as much relevant data as possible. These data included, among many others, historical GPCD consumption figures, advanced metering infrastructure (AMI) specifications, and detailed feedback on each conservation activity being implemented. Personal interviews focused on determining when and to what extent these activities were being employed, as well as assessing plans to continue such conservation. Examples of frequently implemented activities include tiered water rate conservation pricing, strategic water rate increases, outdoor irrigation audits and ordinances, and rain barrel distribution.

Subsequently, each utility's conservation activities were quantified through several different means, including evidence-based studies, utility field results and savings determinations, manufacturer guarantees, water loss audits, TWDB studies, and other information that assigned a savings value to the activity's implementation.

Every conservation activity studied and quantified has a gallons-per-year estimate, useful life, and decay rate (if applicable) associated with it. Some activities' savings are projected to grow as demand grows over time, while some savings are constant each year and subside once useful life has run its course. For expanded methodology and details on studies and formulas used to determine activity savings, refer to Section 6 of the State Report included as part of this document.

Once analyzed, the resulting savings estimates from each utility were compared with the recommended WMS supply volumes in its respective regional plan to determine if the savings met, exceeded, or fell short of those volumes. Individual utility savings were aggregated to compare with regional volumes, and regional savings were aggregated to compare with state volumes.

It is important to note that this report quantified activity savings—not including water loss reduction—for the WMS supply volume comparison dating back to 2012. The reason for this is, with a few exceptions, the regional planners used 2011 as the base year for establishing potential WMS supply volumes.[3] In addition, any conservation savings achieved through 2011 are assumed to be accounted for in the regional water planning GPCD for that year.[4] Thus, quantifying from 2012 and forward is the most accurate way to determine if utilities are meeting

[3] Confirmed via personal communication with Region C, H, K, and L Plan consultants.
[4] It was established with TWDB planning staff that 2011 GPCD levels were chosen because they represented the most current water use and conservation patterns at the time.

the recommended conservation volumes in the regional plans. This assumption is by no means 100 percent accurate, however. Some previously implemented activities' savings persist into future years beyond this starting point, while some activities' savings have ceased. One year's GPCD will not necessarily include all savings yielded by conservation activities that came before it, but the quantification assessment must have a starting point.

2.3 Quantifiable Savings

The key to the project being useful and reliable is that the results from year to year are measurable. Quantifying conservation activities that can be accurately measured provides greater certainty and better planning for all stakeholders.

While many utilities are engaged in a variety of conservation activities, not all can currently be properly measured. Some examples of these activities include education initiatives, website and social media engagement, and enforcement for water waste. That does not mean these measures are not essential. Education of consumers, for example, is a fundamental activity that makes all others effective, but little hard data exists to quantify the results of education alone.

In addition, the work of conservation coordinators can have a particularly significant effect on the savings of all other activities, but the specific savings attributed to that staff role is difficult to quantify.

3 Results

This report compares Sugar Land's current water conservation activities and their quantified savings to two metrics: 1) Region H Water Plan's (Region H Water Planning Group, 2016) recommended WMS supply volumes for municipal conservation, and 2) Sugar Land's own 5- and 10-year goals as established in its most recent water conservation plan submitted to the TWDB.

The WMS supply volumes for municipal water conservation are laid out by decade (2020 – 2070) in the regional water plans to serve as benchmarks for what each utility could achieve via that strategy during a 50-year planning period.[5]

The 5- and 10-year goals in Sugar Land's most recent water conservation plan are established by the utility as realistic targets for reducing consumption over that timeframe. These reductions[6] are expressed in decreasing total GPCD [7] consumption and water loss GPCD.[8 9]

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[5] Some regional water plans separate this strategy volume into a volume for water conservation and a volume for water loss reduction for each decade. The total strategy volume is the sum of both.

[6] Occasionally, some utilities expect consumption to increase due to various reasons, such as an incoming industrial presence expected to raise consumption figures for the entire service area.

[7] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Gallons in System ÷ Permanent Population) ÷ 365

[8] These plans also have targets for residential GPCD and water loss as a percentage (rather than GPCD), but this report does not address those goals.

[9] As defined in TWDB water conservation plan annual report (TWDB, 2016): (Total Water Loss ÷ Permanent Population) ÷ 365

The estimated savings in Tables 3-1 through 3-3 indicate the best information available as provided by utility staff. Some ongoing activities may not be known and are within a utility's service area are implemented on a micro-scale that may not be quantified. Individual households and businesses may be implementing conservation measures that are unknown and therefore cannot be included in the report.

Explanation of approach to assessing water loss reduction savings

Water loss reduction savings are defined as the volume of water participating utilities are realizing from their water loss mitigation efforts. For this report, this value is the difference between each individual utility's baseline[10] for water loss GPCD and its most recent water loss GPCD reported in 2015 water loss audits on file with TWDB. Savings from all water loss reduction efforts—including pipe replacements and leak repair—are assumed to be included in this comparison to a utility's baseline.

Note that because a single year (2015) value was used for comparison, it is possible that the 2015 value could be anomalous due to a number of events that may have occurred that year, such as a water main break, a particularly wet year, or a robust effort by the utility to curtail water loss. This will distort future savings figures that were carried forward in the study because water loss will inevitably increase or decrease in later years.

Ideally, using a rolling five-year average in the calculation would correct such anomalies. However, there was insufficient data to do that for every utility. The approach was to use the most complete water loss data possible, which was represented by the 2015 water loss audit. This problem will be further minimized, as continued data collection will allow five-year averages to be calculated for a majority of utilities.

In this way, water loss savings estimates are different from all other activity savings estimates in the project. Whether savings were positive or negative depended on where individual utilities established their own baselines or where their five-year average started, and what water loss GPCD value was reported in 2015.

3.1 Current Savings Compared to Conservation WMS Supply Volume (in Million Gallons) in Regional Water Plan

Table 3-1 shows the 2070 outlook for Sugar Land with the utility's yearly recommended WMS supply volume in million gallons (MG) alongside its water savings from implemented activities, including from water loss reduction. These activities and their associated savings are covered in greater detail in Sections 4 and 5.

Starting in 2015, this table compares all quantified conservation activity and the recommended conservation WMS supply volume for the planning period. The following definitions pair with the column headers in Table 3-1.

Actual Current Conservation Activity Savings – All quantified activities currently being

[10] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

performed by the utility, *excluding* savings from water loss reduction. The regional planners used 2011 GPCD as the baseline for determining future conservation WMS supply volumes, therefore the study quantifies utility savings starting in 2012 for this comparison. The summary of these savings can be referenced in Table 5-1.

Actual Water Loss Reduction Savings (as of 2015) – The difference between the baseline[11] for water loss GPCD and most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. [12] The summary of these savings can be referenced in Table 5-2.

Total Savings from All Conservation Activity – Actual Current Conservation Activity Savings plus Actual Water Loss Reduction Savings (as of 2015).

Conservation WMS Volume – The recommended municipal water conservation supply volume in the regional plan for the decades ranging from 2020 to 2070. These volumes are converted to MG from the values listed in the plan in acre-feet and then calculated in annual increments.

Water Loss Reduction WMS Volume – Some regional water plans have a separate WMS volume for water conservation and for water loss reduction for each decade. If a WUG's regional plan has a WMS volume for water loss reduction, this column will have values other than zero.

Total Yearly WMS Volume – The sum of the Conservation WMS Volume and Water Loss Reduction WMS Volume.

Over (Short) – The amount that the utility's Total Savings from All Conservation Activity (since 2012), is over or below the Total Yearly WMS Volume in the regional water plan. If the amount falls below the WMS volume, it will appear in parentheses.

[11] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.
[12] If water loss GPCD has increased from the utility's baseline or historic five-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.

Table 3-1. Current Savings Compared to Conservation WMS Supply Volume (MG) in Regional Water Plan.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2015	47	(30)	16	23	8	31	(15)
2016	47	(31)	16	28	10	39	(23)
2017	37	(32)	5	28	12	41	(36)
2018	27	(32)	(5)	34	14	49	(53)
2019	17	(33)	(16)	40	17	56	(72)
2020	9	(35)	(26)	51	19	70	(96)
2021	0	(36)	(36)	59	19	78	(114)
2022	0	(37)	(37)	68	19	87	(124)
2023	0	(39)	(39)	76	19	95	(133)
2024	0	(39)	(39)	84	19	103	(142)
2025	0	(39)	(39)	93	19	112	(151)
2026	0	(40)	(40)	101	19	120	(160)
2027	0	(40)	(40)	109	19	129	(168)
2028	0	(40)	(40)	117	20	137	(177)
2029	0	(41)	(41)	126	20	145	(186)
2030	0	(41)	(41)	134	20	154	(195)
2031	0	(41)	(41)	141	20	161	(202)
2032	0	(42)	(42)	148	20	168	(210)
2033	0	(42)	(42)	155	20	176	(218)
2034	0	(42)	(42)	163	20	183	(225)
2035	0	(42)	(42)	170	20	190	(233)
2036	0	(43)	(43)	177	20	197	(240)
2037	0	(43)	(43)	184	21	205	(248)
2038	0	(43)	(43)	191	21	212	(255)
2039	0	(44)	(44)	198	21	219	(263)
2040	0	(44)	(44)	206	21	227	(270)
2041	0	(44)	(44)	212	21	233	(277)
2042	0	(44)	(44)	219	21	240	(284)
2043	0	(45)	(45)	226	21	247	(291)
2044	0	(45)	(45)	232	21	254	(298)
2045	0	(45)	(45)	239	22	260	(306)
2046	0	(45)	(45)	246	22	267	(313)
2047	0	(46)	(46)	252	22	274	(320)
2048	0	(46)	(46)	259	22	281	(327)
2049	0	(46)	(46)	265	22	288	(334)
2050	0	(46)	(46)	272	22	294	(341)
2051	0	(47)	(47)	278	22	300	(347)
2052	0	(47)	(47)	284	22	307	(354)
2053	0	(47)	(47)	290	22	313	(360)
2054	0	(47)	(47)	297	23	319	(366)
2055	0	(48)	(48)	303	23	325	(373)
2056	0	(48)	(48)	309	23	331	(379)
2057	0	(48)	(48)	315	23	338	(386)
2058	0	(48)	(48)	321	23	344	(392)
2059	0	(48)	(48)	327	23	350	(399)
2060	0	(49)	(49)	333	23	356	(405)
2061	0	(49)	(49)	338	23	361	(410)
2062	0	(49)	(49)	343	23	367	(416)
2063	0	(49)	(49)	349	23	372	(421)
2064	0	(50)	(50)	354	23	377	(427)
2065	0	(50)	(50)	359	23	383	(432)
2066	0	(50)	(50)	364	24	388	(438)
2067	0	(50)	(50)	370	24	393	(443)
2068	0	(50)	(50)	375	24	398	(449)
2069	0	(50)	(50)	380	24	404	(454)
2070	0	(50)	(50)	385	24	409	(459)

3.2 Utility Water Conservation Plan Goals – Total GPCD

Table 3-2 shows how Sugar Land's quantified savings from its implemented activities compare with 5- and 10-year goals established in its individual water conservation plan submitted to the TWDB. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Total GPCD Goals – Total GPCD goals start with the utility's baseline[13] for total GPCD and progress in subsequent years to match 5- and 10-year goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Annual Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline total GPCD – target total GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings for All Current Quantified Activities (MG) – Total quantified savings for all current conservation activities and savings from water loss reduction. Refer to Tables 5-1 and 5-2 for details on these savings.

Over (Short) – The amount that the utility's total quantified savings for all current conservation activities (since 2012), including water loss reduction, is over or below the volume represented by reductions in GPCD each year. If the quantified savings are less than these target volumes, the value will appear in parentheses.

Table 3-2. Utility Water Conservation Plan Goals — Total GPCD.

Year #	Year	Utility Population	Total GPCD Goals	Annual Savings Goal with Reduction in GPCD (MG)	Total Savings for All Current Quantified Activities (MG)	Over (Short) (MG)
0	Baseline	-	187	0	0	0
1	2015	88,156	187	13	16	3
2	2016	91,627	186	27	16	(11)
3	2017	95,098	186	42	5	(36)
4	2018	98,568	185	58	(5)	(62)
5-year Goal	2019	102,039	185	74	(16)	(91)
6	2020	105,510	185	92	(26)	(119)
7	2021	106,450	184	109	(36)	(145)
8	2022	107,390	184	125	(37)	(163)
9	2023	108,329	183	142	(39)	(181)
10-year Goal	2024	109,269	183	160	(39)	(198)

[13] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for total GPCD from the utility's most recently submitted five-year water conservation plan was used.

3.3 Utility Water Conservation Plan Goals – Water Loss GPCD

Table 3-3 shows how Sugar Land's most recent water loss audit compares with 5- and 10-year water loss goals in its water conservation plan. The following definitions pair with the column headers in Table 3-2.

Utility Population – Estimated utility service area population for the years indicated.

Water Loss GPCD Goals – Water loss GPCD goals start with the utility's baseline[14] for water loss GPCD and progress in subsequent years to match 5- and 10-year water loss goals indicated in a utility's five-year water conservation plan on file with the TWDB. The first five annual GPCD goals were developed by spreading the difference between the baseline and five-year goal evenly over five years. The second five annual GPCD goals spread the difference between the five-year goal and 10-year goal evenly over the next five years.

Yearly Savings Goal with Reduction in GPCD (MG) – This column shows what reductions from the baseline water loss GPCD would yield in terms of volume each year as more water is saved. The volumes indicated here are what target water loss GPCD goals look like expressed in million gallons. Annual volumes were derived using the formula: (baseline water loss GPCD – target water loss GPCD for that year) x 365 days ÷ 1,000,000 gallons.

Total Savings from Water Loss Reduction (MG) – The difference between a utility's established baseline for water loss GPCD and the most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB. If water loss GPCD has increased from the utility's baseline to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount. Reference Table 5-2 for savings from water loss reduction.

Over (Short) – The amount that the utility's total savings from water loss reduction is over or below the volume represented by reductions in GPCD each year. If water loss reduction savings are less than these target volumes, the value will appear in parentheses.

Table 3-3. Utility Water Conservation Plan Goals — Water Loss GPCD.

Year #	Year	Utility Population	Water Loss GPCD Goals	Yearly Savings Goal with Reduction in GPCD (MG)	Total Savings from Water Loss Reduction (MG)	Over (Short) (MG)
0	Baseline	-	18.00	0	0	0
1	2015	88,156	17.80	6	(30)	(37)
2	2016	91,627	17.60	13	(31)	(44)
3	2017	95,098	17.40	21	(32)	(52)
4	2018	98,568	17.20	29	(32)	(61)
5-year Goal	2019	102,039	17.00	37	(33)	(71)
6	2020	105,510	16.80	46	(35)	(81)
7	2021	106,450	16.60	54	(36)	(90)
8	2022	107,390	16.40	63	(37)	(100)
9	2023	108,329	16.20	71	(39)	(110)
10-year Goal	2024	109,269	16.00	80	(39)	(119)

[14] In the absence of having a baseline figure provided by the TWDB or utility staff, the historic five-year average for water loss GPCD from the utility's most recently submitted five-year water conservation plan was used.

4 Implemented Activities

Below is a list of completed activities with estimated water savings. Note that drought response and other measures are not included in the utility's water savings because they are temporary, awareness-based or not able to be accurately quantified on an annual basis.

These are not savings projections of potential future activities. Estimated savings are based on measures that have actually been implemented. If savings are shown to persist in future years, it is because the measure is permanent, such as an ordinance, or the savings are assumed to continue for the reason listed under the itemized activity. Estimated savings from water rate increases are the one exception to these conditions.

Water Rate Increases

Savings from water rate increases were included because entities such as the U.S. Environmental Protection Agency and others indicate specific savings for utilities that raise rates (TWDB, 2013; U.S. EPA, 1998; Whitcomb, 1999). This project includes surveys of several utilities that have minimal education efforts, perform no other substantive conservation activities, and yet experienced significant demand reduction that coincided with rate increases. In those cases, savings estimates matched up closely with decreases in total GPCD. For many smaller utilities, especially those with customers lacking disposable income, this measure is the only tool used to conserve other than water loss reduction.

The following assumptions were made for water rate increases:

- The model assumes that savings persist into future years because it is expected that the utility will continue to make periodic rate increases in line with the percentage increases from previous years.
- Only the last two rate increases for a utility were quantified.
- Savings grow with demand because as new customers enter the service area, they are assumed to adhere to the same price elasticity model estimates.
- A weighted average for savings was used when rate increases differed between residential and industrial-commercial-institutional (ICI) customers based on the individual utility's customer class breakdown.
- When a utility raised rates using tiered rate conservation pricing, a 50/50 savings split was used when increases differed between base and volumetric rates.
    - The reasoning is that all customers must react to the base increase, yet the pricing signal is stronger when volumetric rate increases affect the higher usage customers.
    - The 50/50 split is reasonable because many customers will not reach the higher volumetric tiers.
    - Studies show that most customers do not actually know they have reached the higher volumetric tiers; just that their bill has increased (TWDB, 2013).

4.1 Itemized Activities

1. **Utility Website**
    a. Easy-to-use website with conservation tips and water rates
    b. Features contact information for Public Works staff and customer service

2. **Continuing Public Education**
    a. The utility engages the public in many ways including:
        i. Brochures, bill messages, displays, and exhibits

3. **Water Loss Reduction Savings**[15]
    a. Loss of 30 MG annually in 2015
    b. Water loss reduction savings = the difference between a utility's baseline[16] water loss GPCD submitted in its most recent 5-year water conservation plan and its most recent water loss GPCD reported in the 2015 water loss audit on file with TWDB
    c. If water loss GPCD has increased from the utility's baseline or historic 5-year average to its reported 2015 water loss audit level, then this value will appear negative because more water is being lost than the baseline amount.
    d. All savings estimates grow each year at the same rate population figures for the utility grow in the regional water plan.

4. **Outdoor landscape evaluations for single family (SF) customers**
    a. 700 outdoor evaluations performed since 2011
    b. Estimated 8,000 gallons per year for each system evaluation (A&N Technical Services, 2005)
        i. Assumed 65% savings from typical indoor and outdoor survey when only outdoor watering is evaluated (Whitcomb, 2000)
    c. Approximately 22 gallons per day
    d. Greater savings during peak periods
    e. Lesser savings during off-peak periods
    f. 20% decay rate per year attributed to customer behavior (A&N Technical Services, 2005)

5. **WaterWise Take-home Kits**
    a. Estimated savings of 7,384 gallons per year per kit (Frontier Associates, 2015)
    b. Conservative 5-year useful life for all items in kit
        i. 15% adoption rate assumed

[15] If current water loss levels exceed a utility's baseline, this value is treated as a deduction from total quantified savings.
[16] In the absence of having a baseline figure provided in the utility's most recently submitted 5-year water conservation plan, the historic 5-year average for water loss GPCD in the plan was used.

5 Summary of Savings

Table 5-1. Savings by Water Conservation Activity (MG).

Year	W.I.S.E. Guys Outdoor Landscape Evaluations (SF)	WaterWise Take-home Kits	TOTAL SAVINGS
2009		8.7	8.7
2010		15.8	15.8
2011	0.53	23.6	24.2
2012	0.81	32.7	33.5
2013	2.90	41.3	44.2
2014	3.35	42.0	45.3
2015	3.21	43.3	46.5
2016	2.59	44.0	46.5
2017	1.85	34.9	36.7
2018	0.92	26.3	27.2
2019	0.43	16.9	17.3
2020	0.17	8.4	8.6
2021	0.05		0
2022			0
2023			0
2024			0
2025			0
2026			0
2027			0
2028			0
2029			0
2030			0
2031			0
2032			0
2033			0
2034			0
2035			0
2036			0
2037			0
2038			0
2039			0
2040			0
2041			0
2042			0
2043			0
2044			0
2045			0
2046			0
2047			0
2048			0
2049			0
2050			0
2051			0
2052			0
2053			0
2054			0
2055			0
2056			0
2057			0
2058			0
2059			0
2060			0
2061			0
2062			0
2063			0
2064			0
2065			0
2066			0
2067			0
2068			0
2069			0
2070			0

Table 5-2. Savings from Water Loss Reduction (MG).

Year	Utility Population	Water Loss GPCD	Total Savings from Water Loss Reduction
Baseline	-	18.00	0
2015	82,728	19.00	(30)
2016	84,537	19.00	(31)
2017	86,347	19.00	(32)
2018	88,156	19.00	(32)
2019	91,627	19.00	(33)
2020	95,098	19.00	(35)
2021	98,568	19.00	(36)
2022	102,039	19.00	(37)
2023	105,510	19.00	(39)
2024	106,450	19.00	(39)

6 Suggested Activities

Up to four activities were chosen as potential suggested activities for individual reports. These activities are: AMI system with customer portal, twice-per-week (or less) outdoor watering ordinances, strategic water rate increases, and rain barrels.

Activities were chosen because they are:

- Achievable
- Prevalence of vendors that can actually implement them
- Acceptability to city councils, MUD boards, et al.
- Easily adopted
- Cost effective
- Yield high savings relative to cost

AMI systems with customer engagement portals were also chosen because they represent a profusion of future applications that will undoubtedly continue to advance conservation efforts. AMI and meter data management (MDM) companies are developing new and innovative ways to benefit water providers, customers, and ultimately states that are pushing conservation and usage analytics further.

Each utility should be cognizant of the potential impact that these suggested activities may have on its own unique rate and revenue situation.

Benefits to consider:

- Avoided water supply and wastewater costs
    - The higher water purchase, transmission, and distribution costs are, the greater the potential benefit realized when large amounts of water are conserved with these activities.
- Avoided system expansion costs

- Conserving water may allow a utility to postpone building new system capacity by decreasing demand even as population grows.

Costs to consider:

- Staff time and resources
- Unit cost per unit saved
- Implementation costs
- Stakeholder agreement and support
- Other overhead and budget considerations

6.1 Suggested Activities with Savings Estimates

1. Twice-a-week Outdoor Watering Restriction Ordinance
   a. Potentially 6.95% savings of total demand (Hermitte and Mace, 2012; Sierra Club-Lone Star Chapter and National Wildlife Federation, 2015)
   b. Savings could be 618 MG per year with current demand.
   c. See Table 6-1 for potential savings from this measure compared with the city's WMS supply volumes targets.

Table 6-1. Current Savings + Potential Savings from 2x per Week Watering Ordinance (MG).

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Ordinance	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	47	(31)	16	618	28	10	39	595
2017	37	(32)	5	623	28	12	41	588
2018	27	(32)	(5)	628	34	14	49	575
2019	17	(33)	(16)	633	40	17	56	561
2020	9	(35)	(26)	638	51	19	70	542
2021	0	(36)	(36)	643	59	19	78	529
2022	0	(37)	(37)	648	68	19	87	524
2023	0	(39)	(39)	653	76	19	95	519
2024	0	(39)	(39)	658	84	19	103	516
2025	0	(39)	(39)	663	93	19	112	512
2026	0	(40)	(40)	668	101	19	120	508
2027	0	(40)	(40)	673	109	19	129	504
2028	0	(40)	(40)	678	117	20	137	500
2029	0	(41)	(41)	682	126	20	145	496
2030	0	(41)	(41)	687	134	20	154	493
2031	0	(41)	(41)	691	141	20	161	489
2032	0	(42)	(42)	695	148	20	168	485
2033	0	(42)	(42)	699	155	20	176	481
2034	0	(42)	(42)	703	163	20	183	478
2035	0	(42)	(42)	707	170	20	190	474
2036	0	(43)	(43)	710	177	20	197	470
2037	0	(43)	(43)	714	184	21	205	467
2038	0	(43)	(43)	718	191	21	212	463
2039	0	(44)	(44)	722	198	21	219	459
2040	0	(44)	(44)	726	206	21	227	456

2. Advanced Metering Infrastructure with Customer Engagement Portal

These portals, along with mobile applications and billing statements, can provide customers with much more access to their water use data in simple and compelling formats. This access and comparison with other customers' usage can reduce water use through changed behavior, as well as provide an opportunity for other conservation programs to be offered to the customer for increased adoption and additional savings. AMI systems support leak notification and web portals with real-time data. Any water loss reduction savings that these systems also yield were included in the water loss assessment of individual reports for this project.

a. Specific utility results will vary based on portal features and frequency of customer notifications
b. Potential savings estimate assumes 20% of residential customers will use and save water due to the portal (Westin Engineering, 2015)
c. Estimate assumes customers will save 10% of total annual use due to the portal
    i. Savings estimate of 10% is an average of results from multiple studies (Chesnutt and Mitchell, 2013; East Bay Municipal Utility District, 2014; IBM, 2011; Texas A&M and Texas Water Resources Institute, 2016; Westin Engineering, 2015)
d. Residential customers' use assumed to make up approximately 67% of all retail customers' use based on utility profile information submitted to the TWDB
    i. This was the most common percentage of residential use among participating utilities in this project.
    ii. Actual customer class demand percentages will vary by utility.
e. 20% of residential customers saving 10% with this customer class breakdown amounts to 1.34% of total demand
f. Savings are assumed to increase along with demand as connections increase each year[17]
g. See Table 6-2 for potential savings from this measure compared with the utility's WMS supply volumes targets.

Table 6-2. Current Savings + Potential Savings from AMI with Customer Portal (MG).

[17] The 10% consumption reduction figure for 20% of residential customers is conservative, but savings could be greater when monitored yearly as customer engagement increases.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from AMI with Customer Portal	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	47	(11)	16	119	28	10	39	96
2017	37	(32)	5	120	28	12	41	85
2018	27	(32)	(5)	121	34	14	49	68
2019	17	(33)	(16)	122	40	17	56	50
2020	9	(35)	(26)	123	51	19	70	27
2021	0	(36)	(36)	124	59	19	78	10
2022	0	(37)	(37)	125	68	19	87	1
2023	0	(39)	(39)	126	76	19	95	(8)
2024	0	(39)	(39)	127	84	19	103	(15)
2025	0	(39)	(39)	128	93	19	112	(23)
2026	0	(40)	(40)	129	101	19	120	(31)
2027	0	(40)	(40)	130	109	19	129	(39)
2028	0	(40)	(40)	131	117	20	137	(47)
2029	0	(41)	(41)	132	126	20	146	(54)
2030	0	(41)	(41)	133	134	20	154	(62)
2031	0	(41)	(41)	133	141	20	161	(69)
2032	0	(42)	(42)	134	148	20	168	(76)
2033	0	(42)	(42)	135	155	20	176	(83)
2034	0	(42)	(42)	135	163	20	183	(90)
2035	0	(42)	(42)	136	170	20	190	(95)
2036	0	(43)	(43)	137	177	20	197	(103)
2037	0	(43)	(43)	138	184	21	205	(110)
2038	0	(43)	(43)	138	191	21	212	(117)
2039	0	(44)	(44)	139	198	21	219	(124)
2040	0	(44)	(44)	140	206	21	227	(130)

3. Water Rate Increase
   - **a.** For every 10% increase, estimated savings could be 2% of utility total demand.
   - **b.** Approximately 178 MG of savings per year with current demand
   - **c.** Savings is cumulative and based on more than one source[18] (U.S. EPA, 1998; Whitcomb, 1999)
   - **d.** See Table 6-3 for potential savings from this measure compared with the utility's conservation goals.

Table 6-3. Current Savings + Potential Savings from 10% Water Rate Increase (MG).

[18] The study estimates a 2% demand reduction with 10% increase in price on a targeted customer class. By applying a ratio, it is possible to determine the savings for lower or higher percentage increases.

Year	Actual Current Conservation Activity Savings	Actual Water Loss Reduction Savings (as of 2015)	Total Savings from All Conservation Activity	Potential Savings from Water Rate Increase	Conservation WMS Volume	Water Loss Reduction WMS Volume	Total Yearly WMS Volume	Over (Short)
2016	47	(31)	16	178	28	10	38	155
2017	47	(32)	5	179	28	12	41	144
2018	27	(32)	(5)	181	34	14	49	127
2019	17	(33)	(15)	182	40	17	56	110
2020	9	(35)	(26)	184	51	19	70	88
2021	0	(36)	(36)	185	59	19	78	71
2022	0	(37)	(37)	188	68	19	87	63
2023	0	(39)	(39)	188	76	19	95	54
2024	0	(39)	(39)	189	84	19	103	47
2025	0	(39)	(39)	191	93	19	112	40
2026	0	(40)	(40)	192	101	19	120	32
2027	0	(40)	(40)	194	109	19	129	25
2028	0	(40)	(40)	195	117	20	137	18
2029	0	(41)	(41)	196	126	20	145	10
2030	0	(42)	(42)	198	134	20	154	3
2031	0	(41)	(41)	199	141	20	161	(3)
2032	0	(42)	(42)	200	148	20	168	(10)
2033	0	(42)	(42)	201	155	20	176	(16)
2034	0	(42)	(42)	202	163	20	183	(23)
2035	0	(42)	(42)	203	170	20	190	(29)
2036	0	(43)	(43)	204	177	20	197	(36)
2037	0	(43)	(43)	206	184	21	205	(42)
2038	0	(43)	(43)	207	191	21	212	(49)
2039	0	(44)	(44)	208	198	21	219	(55)
2040	0	(44)	(44)	209	206	21	227	(62)

4. Rain Barrels
   a. In Region H, utilities could save approximately 26.8 gallons per year per gallon of capacity rebated, sold, or distributed (GDS Associates, 2002).
   b. Estimated 10-year useful life for most barrels