Exploring the Potential and Feasibility of Water-Use Conservation for Houston Water, Houston, Texas

Report: 2021-05
June 2021

The Meadows Center
for Water and the Environment
Texas State University

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Acknowledgments

The Texas State University Team wishes to thank the Harris-Galveston Subsidence District (HGSD) for funding support under their 2019 Water Conservation Grant program. This grant program was under the supervision of Dr. Tina Petersen, P.E., Deputy General Manager, and Ms. Ashley Greuter, P.G., Project Chief. We also wish to thank the HGSD member and local collaborator, Houston Water, Ms. Paula Paciorek, Water Conservation Division Manager, for a matching grant. Ms. Paciorek provided invaluable guidance, data, and information to the Texas State Team throughout the project. Without Houston Water's participation, this project would not have been possible. We are grateful to other Houston Water staff who responded to several requests for information that were channeled through Ms. Paciorek. We also wish to acknowledge our appreciation for Mr. H.W. "Bill" Hoffman, P.E., of H.W. "Bill" Hoffman & Associates, LLC for sharing his wealth of expertise in commercial, institutional, and industrial water use/conservation. Last, but not least, we appreciate the administrative support provided to us by Ms. Sharla Gutierrez, Business Manager, The Meadows Center for Water and the Environment, Texas State University. The Project Manager and Research Associates at Texas State University take full responsibility for the various analyses, their interpretation, recommendations, and any errors contained in this report.

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A View Buffalo Bayou and Downtown Houston, Texas © Srini Sundarrajan

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INTRODUCTION

This is the fourth quarterly report submitted by the Texas State Team and it will additionally serve as the final report for the water conservation potential study that began in May 2020. This report will include new information about the analyses since the last quarterly report was submitted, using Version 3 of the Alliance for Water Efficiency's (AWE) Conservation Tracking Tool. Additionally, this report will feature the final water conservation program scenario that has been evolving during the past year.

This project was initiated with three primary goals: 1) Estimate residential water use conservation potential, 2) Estimate commercial/institutional water use by sector/subsector and water use conservation potential, and 3) Develop new data and estimate outdoor water use conservation potential for residential accounts; and explore feasibility of doing the same for commercial/institutional accounts. The report begins with a summary of new work that was undertaken during the last three months.

COMMERCIAL/INSTITUTIONAL OUTDOOR SCENARIO

(new output during fourth quarter)

The Tool's Activity Library has four built-in large landscape outdoor measures that apply to irrigated areas that are greater than two or three acres. Three of these four large landscape measures were selected for the Outdoor CI scenario: (1) Large Landscape Surveys, (2) Large Landscape Water Budgets, and (3) Large Landscape Irrigation Controller. One built-in measure, Large Landscape Turf Replacement, was excluded because it resulted in an unfeasible benefit-cost (B/C) ratio of zero.

Since the large landscape measures apply to the irrigated area of landscapes that are greater than two or three acres, the average landscape area per site in the Common Assumptions worksheet was set to 2.5 acres (108,900 square feet). All the Large Landscape measures use this input to help calculate their water savings potential.

The water use sector or "class" that was assigned to these measures is "Commercial", but the activity level and funding for each outdoor landscape measure can be divided between the commercial and institutional sectors as Houston Water deems most appropriate. There may be little functional difference between the two sectors, especially if the rate charged for water is the same. As a reminder, there is no distinction made between these two sectors in the North American Industrial Classification System.

As was mentioned in the previous quarterly reports, for the other scenarios the Team adjusted the utility and participant costs of most measures back to the original 2008-dollar values that had been set in the User Guide. In this Outdoor C/I scenario, however, the Team allowed the Tool to automatically adjust the default costs to 2016-dollar values since most of the costs associated with the large landscape measures are attributable to labor rather than physical products.

After study of the feasibility of several measures, four measures were selected for this C/I Outdoor scenario (Table 5). Each of the three Large Landscape (outdoor) measures' activity levels were set to 100/year. Since many of these measures include parts of the other related measures, the same activity level across all large landscape measures allows Houston Water to adjust the implementation levels to what is thought to be most appropriate. Additional explanation follows.

The Large Landscape survey is required and included, therefore, by each of the other large landscape measures. The survey-only measure can also exist on its own, however, since it provides value through a site visit, training, and device adjustments for the customer. Next, the Large Landscape Irrigation Controller Rebate includes the survey and the irrigation controller rebate. The Large Landscape Water Budget is the most comprehensive as it includes the survey, irrigation controller rebate, and a site budget. Houston Water should keep in mind that adjusting the activity level of one activity does not affect the activity levels of the other related measures. In other words, if the intension is to increase only the number of irrigation controllers, the independent surveys do not also need to increase since a survey is included in the controller measure, as previously mentioned.

Unrelated to the AWE large landscape measures discussed above, the fourth outdoor C/I measure is the C/I Rainwater Harvesting Rebate. This measure came from the Texas Water Development Board's Municipal Water Conservation

Planning Tool's (TWDB Tool) activity library. This measure involves the utility rebating $2,000 of the estimated $7,500 cost for a commercial/institutional facility's 10,000-gallon rainwater cistern purchase, supplies, and installation. These supplies include tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line. An activity level of just 12 measures each year results in a B/C ratio of 1.8 and an NPV of $283,743.

RESIDENTIAL OUTDOOR SCENARIO CHANGES

(enhancements made during fourth quarter)

The Team modified the Outdoor Residential scenario by exploring the feasibility of rainwater harvesting measures. The Rainwater Harvesting Rebate and Rain Barrel Rebate were added to this scenario. The default input values and water savings for each measure came directly from the TWDB Tool.

Numerous variations of the rainwater harvesting rebate were tested to determine which rebate cost would yield a positive B/C ratio. The City of Austin currently rebates its customers $0.50/gallon for Rainwater Harvesting Systems, so the Team used this as a guideline for 500- and 1,000-gallon rainwater cisterns. Even when a lower rebate of $0.40/gallon was tested, none of these Rainwater Harvesting Rebates provided B/C ratios above 1, as can be seen in Table 1. Also note that all the Single-Family Rainwater Harvesting measures result in negative Net Present Values (NPV). Values in red mean that the result is not feasible for Houston. These NPV's are a result of only one activity level per year from 2021-2040 for the purpose of comparison.

Similarly, the TWDB Tool's Rain Barrel Rebate with its default utility costs and water savings yields an unfeasible B/C ratio of 0.5. Using the TWDB Tool's default costs, this measure entails a $50 rebate from the utility towards a 75-gallon rain barrel. Processing and marketing cost estimates raise the utility cost to $65. The Team assumed an average rain barrel cost of $175, which leaves the participant with the remaining $125 of the total cost.

Table 1. TWDB Tool's residential rainwater measures variations and results.

Measure	Class	Rebate	Cistern Size	B/C Ratio	NPV
Rainwater Harvesting Rebate	Single-Family	$0.50/gal	1,000 gallons	0.6	($3,414)
Rainwater Harvesting Rebate	Single-Family	$0.50/gal	500 gallons	0.5	($2,073)
Rainwater Harvesting Rebate	Single-Family	$0.40/gal	1,000 gallons	0.7	($1,951)
Rainwater Harvesting Rebate	Single-Family	$0.40/gal	500 gallons	0.7	($1,186)
Rain Barrel Rebate	Single-Family	-	-	0.5	($450)
Rainwater Harvesting Rebate (10,000 gal)*	Multi-Family	-	-	1.8	$23,645

**Unlike like the other rainwater harvesting measures, this one has a pre-determined size of 10,000 gallons.*

One TWDB Tool Outdoor measure that proved feasible for Houston was the Multi-Family 10,000-gallon Rainwater Harvesting Rebate. This is the same TWDB Tool measure that yielded a positive B/C ratio for the outdoor commercial scenario. When the utility provides a $2,000 rebate for a 10,000-gallon tank, supplies, and installation (an estimated $7,500 total), the resulting B/C ratio from just one activity level programmed per year is 1.8 B/C ratio and the NPV is $23,645 (Table 1). This 10,000-gallon Rainwater Harvesting Rebate is feasible because it rebates $0.20 per gallon while the other unfeasible Residential Rainwater Harvesting Rebates were set to $0.50 and $0.40 per gallon (Table 1). If these unfeasible Rainwater Harvesting Rebates were set to $0.20 per gallon instead, their results would show that they are now feasible. A 1,000-gallon tank rebate would change to a 1.3 B/C ratio and $973 NPV, while a 500-gallon tank rebate would update to a 1.1 B/C ratio and a $121 NPV.

FINAL RESULTS

The All Sectors scenario in the Tool has every effective measure that was selected by the Team for all water-use sectors combined. For all the selected water conservation measures, the Tool calculates the Net Present Value (conservation program savings and resultant avoided water costs minus the costs of program implementation) to be $145,897,904. After full execution of the program, the overall Benefit/Cost ratio is estimated to be 3.2 (Table 2).

If all the chosen conservation measures that are featured in the final scenario are implemented by Houston Water, the annual water savings achieved by 2040 will supplant nearly six (5.7) percent of the forecast-baseline demand. These savings have the potential to decrease the forecast-baseline total demand from 120,116 MG/368,623 acre-feet to 113,280 MG/347,644 acre-feet, a reduction of 6,836 MG by year 2040. Such available water savings offer the potential to also lower Houston's GPCD from 129 to 121 by 2040.

The conservation measures with the highest overall B/C ratios out of all the sectors are the Residential HE Toilet Rebates (multi-family), Residential Showerhead Distributions (single-family, then multi-family), and single-family Home Water Reports, respectively. The NPVs and B/C ratios shown in Table 2 can be found on the "Utility Costs and Benefits" worksheet of the Tool.

Table 2. The NPV and B/C ratio results of each selected measure in every scenario. The measures are listed in the order of each quarterly report.

Utility Conservation Program NPV and B/C Ratio (2020 Dollars)			
Class	**Activity Name**	**NPV ($)**	**B/C Ratio**
Single Family	Residential HE Toilets, SF	$38,262,468	2.6
Multi Family	Residential HE Toilets, MF	$77,697,934	5.5
Single Family	Residential LF Showerhead, SF	$322,798	5.3
Multi Family	Residential LF Showerhead, MF	$232,599	4.9
Single Family	Home Water Reports	$13,163,814	5.0
Commercial	CII 1/2 Gallon Urinal	$567,170	1.5
Commercial	CII Valve-Type HE Toilet	$4,023,760	1.9
Commercial	CII Laundromat	$586,211	1.5
Commercial	CII Dishwasher	$328,537	1.7
Commercial	CII Spray Rinse Valve	$947,087	2.9
Commercial	CII Food Steamer	$1,311,892	2.6
Commercial	CII Cooling Tower	$668,390	2.6
Commercial	CII Tank-Type HE Toilet	$278,589	2.6
Institutional	CII 1/2 Gallon Urinal	$63,390	1.5
Institutional	CII Valve-Type HE Toilet	$445,876	1.9
Institutional	CII Laundromat	$65,135	1.5
Institutional	CII Dishwasher	$32,854	1.7
Institutional	CII Spray Rinse Valve	$107,062	2.9
Institutional	CII Food Steamer	$148,301	2.6
Institutional	CII Cooling Tower	$74,266	2.6

Table 2 cont. The NPV and B/C ratio results of each selected measure in every scenario. The measures are listed in the order of each quarterly report.

Utility Conservation Program NPV and B/C Ratio (2020 Dollars)			
Class	**Activity Name**	**NPV ($)**	**B/C Ratio**
Institutional	CII Tank-Type HE Toilet	$28,331	2.6
Single Family	Residential Irrigation Controller, SF	$62,293	1.5
Multi Family	Rainwater Harvesting Rebate, MF	$283,743	1.8
Commercial	Rainwater Harvesting Rebate, C	$283,743	1.8
Commercial	Large Landscape Surveys	$1,013,946	2.1
Commercial	Larqe Landscape Water Budgets	$3,538,800	1.7
Commercial	Large Land. Irrigation Controller	$1,358,916	1.4
Subtotal Conservation Activities		**$145,897,904**	**3.2**
Total With Program Overhead		**$145,897,904**	**3.2**

Important to note are the measures that were not selected to be in any of the scenarios, displayed in Table 3. Values in red mean that the result is not feasible for Houston, usually because its B/C ratio is under 1, yet some were excluded because they were outdated or not desirable for Houston Water (see Appendix C. - Data Sources). Houston Water still has the option to implement any of these excluded measures by adjusting implementation cost estimates to achieve more desirable B/C ratios.

Alternatively, a desirable NPV may overrule a low B/C ratio for a measure that was not initially included in a scenario. These unused measures do not have NPVs in the Table 3 because the Team did not set activity levels for any measure that had a B/C ratio under 1 or deemed the measure unfeasible for other reasons. If Houston Water chooses to set an approximate annual activity level, the Tool will calculate an NPV in the "Utility Costs and Benefits" worksheet. The Utility can then decide if the NPV is desirable enough for implementation.

Table 3. Unused Measures and their resulting B/C Ratios.

Scenario	Measure	B/C Ratio
Houston MG	Residential Surveys, SF	0.6
	Residential Surveys, MF	0.4
	Residential HE Toilet Direct Install, MF	-
	Residential ULF Toilet, SF	-
	Residential ULF Toilet, MF	-
	Residential 4.0 WF Washer, SF	0.4
Houston CI	CII Valve-Type ULFT Rebate	-
	CII Tank-Type ULFT Rebate	-
Outdoor Residential	Residential Efficient Irrigation Nozzles, SF	0.2
	Residential Turf Replacement	0
	RainWater Harvesting Rebate	0.5 to 0.7
	Rain Barrel Rebate	0.5
	WaterWise Landscape Rebate	0.6
	Residential Irrigation Controller Financing, SF	7.7
	Residential Meter Installation, SF	0.9
Outdoor CI	Large Landscape Turf Replacement	0

IMPORTANCE OF THE INFLATION RATE PARAMETER

The reported NPV and B/C ratio results are dependent on the annual inflation rate that is set in the Common Assumptions worksheet of the Tool. Several inflation rates were considered before settling on a 2 percent. U.S. Labor Department publishes a 12-month average inflation rate every month. From October 2019 to October 2020, inflation was 1.2 percent. For another perspective, ten years of inflation rate data were averaged from 2010-2019, resulting in a 1.77 percent inflation. The average inflation rate for the years 2001-2020 inclusive was 2.07 percent. Since this one input value dictates the inflation rate used by the Tool for the scenario's entire 20-year period, an even 2 percent was assigned based on the longer-term average from the previous twenty years. Houston Water has the option to change this input as they deem most appropriate. Table 4 shows how various annual inflation rates affect the scenario's results.

Table 4. Multiple annual inflation rate examples and their associated results.

Inflation Rate	B/C Ratio	NPV
1.20%	3.5	$149,940,821
1.77%	3.3	$147,168,410
2.00%	3.2	$145,897,904
2.50%	3.1	$142,827,111

WATER RATES AND RELATIONSHIP TO WATER CONSERVATION

Using water rates data from the last four years, the average annual increase in Houston Water rates has been three percent. Since this is a nominal rate of increase, the real rate of increase has been approximately one percent. This relatively low real rate of increase may be insufficient for covering the cost of implementing a water conservation program. While regular rate increases that are designed to cover the cost of a conservation program without borrowing money will need to be justified to ratepayers, the increase in rates in the near-term could well turn out to be much less than what would be required in the longer-term without conservation. This scenario has been proven in other places (e.g., Westminster, Colorado) and forecast elsewhere (e.g., Elgin, Illinois). Forestalling the expansion of new infrastructure and/or reducing the scale of future expansion by lowering the water demand curve over time can prove to be a wise investment that is made possible by managing a robust water conservation program.

WATER SAVINGS

The water savings from each measure are listed in Table 5. The "lifetime" of a measure's savings is based on the water savings from both active and passive savings, which typically extend beyond the implementation of the program. The active savings come directly from the measure and the passive savings are attributable to plumbing and appliance standards.

Table 5. Water savings and lifetime of saving for each measure.

Scenario:	Conservation Measure:	Lifetime Water Savings (MG)			"Lifetime" end year	Avg. Annual Water Savings (MG)		
		Gross Savings	Utility Savings	Attributable to National Standards		Gross Savings	Utility Savings	Attributable to National Standards
Indoor Residential	HE Toilets, SF	**104,741**	56,733	48,008	2079	**1,775**	962	814
	HE Toilets, MF	**160,216**	86,781	73,435	2079	**2,716**	1,471	1,245
	LF Showerhead, SF	**2,103**	353	1,750	2079	**36**	6	30
	LF Showerhead, MF	**1,546**	260	1,287	2079	**26**	4	22
	Home Water Reports	**19,877**	19,877	-	2040	**994**	994	-
Indoor Commercial	1/2 Gallon Urinal	**1,583**	1,583	-	2064	**36**	36	-
	Valve-Type HE Toilet	**14,307**	7,749	6,558	2079	**343**	131	111
	Laundromat	**2,160**	1,640	520	2047	**80**	61	19
	Dishwasher	**693**	693	-	2059	**18**	18	-
	Spary Rinse Valve	**6,440**	1,293	5,148	2079	**109**	22	87
	Food Steamer	**1,875**	1,875	-	2049	**65**	65	-
	Cooling Tower	**944**	944	-	2044	**39**	39	-
	Tank-Type HE Toilet	**760**	412	349	2079	**13**	7	6
Indoor Institutional	1/2 Gallon Urinal	**1,583**	1,583	-	2064	**36**	36	-
	Valve-Type HE Toilet	**14,307**	7,749	6,558	2079	**242**	131	111
	Laundromat	**2,160**	1,640	520	2047	**80**	61	19
	Dishwasher	**693**	693	-	2059	**18**	18	-
	Spary Rinse Valve	**6,440**	1,293	5,148	2079	**109**	22	87
	Food Steamer	**1,875**	1,875	-	2049	**65**	65	-
	Cooling Tower	**944**	944	-	2044	**39**	39	-
	Tank-Type HE Toilet	**760**	412	349	2079	**13**	7	6
Outdoor Residential	Irrigation Controller, SF	**213**	213	-	2049	**7**	7	-
	Rainwater Harvesting Rebate, MF	**775**	775	-	2054	**23**	23	-
Outdoor Commercial	Rainwater Harvesting Rebate, C	**775**	775	-	2054	**23**	23	-
	Large Landscape Surveys	**2,344**	2,344	-	2044	**98**	98	-
	Large Landscape Water Budgets	**10,045**	10,045	-	2049	**346**	346	-
	Large Landscape Irrigation Controller	**5,692**	5,692	-	2049	**196**	196	-

Residential Indoor Results (summary from first quarterly report)

The residential indoor scenario, Houston MG, contains only indoor measures for the single- and multi-family residential sectors of Houston. With the estimated annual activity levels of each measure and their costs, the total NPV of the entire scenario is featured in Table 6. The breakdown of each measures' costs is found in Appendix A. - Per Measure Utility and Participant Costs for Program Scenario and the logic for setting annual activity levels can be found in Appendix C.

If all the measures are implemented, the indoor residential scenario will save 6,531 MG by year 2040 at its peak in gross annual water savings. This accounts for 4.6 percent of the baseline demands. Of all the indoor residential measures, Multi-Family Residential High-Efficiency ("HE") Toilet rebates have the highest average annual water savings potential at 2,716 MG in its lifetime (Table 5). This measure also has the highest B/C ratio in the scenario at 5.5 and an NPV of $77,697,934 (Table 2).

Table 6. Residential Indoor Scenario's NPV.

Scenario	Net Present Value*
Residential Indoor	$129,679,613

**All Net Present Value calculations include benefits generated out to 2079 if applicable.*

Commercial/Institutional ("C/I") Indoor Results (summary from second quarterly report)

The Commercial and Institutional indoor scenario, Houston CI, has indoor-only measures applicable to the commercial and institutional sectors. If all its measures' costs and activity levels are implemented, the water savings will reach an annual gross 868 MG at its peak in 2040 and the total NPV is shown in Table 7.

The C/I measure with the most annual water savings potential is the HE Valve-Type Toilet Rebate at 343 MG average annual water savings (Table 5). The C/I Spray Rinse Valve distribution, however, has the highest B/C ratio of 2.9 and NPV of $947,087 (Table 2).

Table 7. C/I Indoor Scenario's NPV.

Scenario	Net Present Value*
C/I Indoor	$9,676,851

Residential Outdoor Results (summary from third quarterly report)

The Outdoor Residential scenario consists of outdoor water-saving measures for the single- and multi-family residential sectors. Since only two measures are included in this scenario, the NPV is relatively low (Table 8) but can be improved with higher annual activity levels. With implementation of both measures in this scenario, the gross annual water savings will reach 48 MG by 2040.

The Multi-Family Rainwater Harvesting Rebate for a 10,000-gallon system and installation saves the most average annual water of the two outdoor measures at 23 MG and has a B/C ratio of 1.8 and NPV of $283,743 (Table 2).

Table 8. Residential Outdoor Scenario's NPV.

Scenario	Net Present Value*
Residential Outdoor	$346,036

Commercial/Institutional Outdoor Results (summary from this Final Report)

The Outdoor CI scenario has outdoor conservation measures all categorized in the table as the Commercial sector but can be split with the Institutional sector as Houston Water chooses. If all four of the large landscape and rainwater harvesting measures are implemented, this scenario would reach 943 MG of annual gross water savings by year 2040 and the total NPV of this scenario would total over $6 million as shown in Table 9.

The Large Landscape Water Budgets yield the highest NPV of $3,538,800 but it is the Large Landscape Surveys that have the highest B/C ratio of 2.1 (Table 2). The Net Present Value (NPV) and B/C ratios are simply two different ways to rank the measures for purposes of prioritization.

Table 9. C/I Outdoor Scenario's NPV.

Scenario	Net Present Value*
C/I Outdoor	$6,195,405

IMPLEMENTATION GUIDANCE

Of all the selected feasible measures, it is recommended by the Team to prioritize measures that have the highest NPVs. Table 10 shows each measure in order of highest to lowest NPV. According to this table, the top three measures that should be prioritized by Houston Water are the Multi-Family Residential HE Toilets, Single-Family Residential HE Toilets, and the Single-Family Home Water Reports, respectively. The NPV for each measure reflects the level of activity (i.e., number of measures planned for implementation each year) selected by Team (currently) or as modified by Houston Water in the future.

Table 10. All selected measures in order of highest to lowest NPV.

Class	Activity Name	NPV ($)	B/C Ratio
Multi Family	Residential HE Toilets, MF	$77,697,934	5.5
Single Family	Residential HE Toilets, SF	$38,262,468	2.6
Single Family	Home Water Reports	$13,163,814	5
Commercial	CII Valve-Type HE Toilet	$4,023,760	1.9
Commercial	Large Landscape Water Budgets	$3,538,800	1.7
Commercial	Large Land. Irrigation Controller	$1,358,916	1.4
Commercial	CII Food Steamer	$1,311,892	2.6
Commercial	Large Landscape Surveys	$1,013,946	2.1
Commercial	CII Spray Rinse Valve	$947,087	2.9
Commercial	CII Cooling Tower	$668,390	2.6
Commercial	CII Laundromat	$586,211	1.5
Commercial	CII 1/2 Gallon Urinal	$567,170	1.5
Institutional	CII Valve-Type HE Toilet	$445,876	1.9
Commercial	CII Dishwasher	$328,537	1.7
Single Family	Residential LF Showerhead, SF	$322,798	5.3
Multi Family	Rainwater Harvesting Rebate, MF	$283,743	1.8
Commercial	Rainwater Harvesting Rebate, C	$283,743	1.8
Commercial	CII Tank-Type HE Toilet	$278,589	2.6
Multi Family	Residential LF Showerhead, MF	$232,599	4.9
Institutional	CII Food Steamer	$148,301	2.6
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Institutional	CII Cooling Tower	$74,266	2.6
Institutional	CII Laundromat	$65,135	1.5
Institutional	CII 1/2 Gallon Urinal	$63,390	1.5
Single Family	Residential Irrigation Controller, SF	$62,293	1.5
Institutional	CII Dishwasher	$32,854	1.7
Institutional	CII Tank-Type HE Toilet	$28,331	2.6
Subtotal Conservation Activities		**$145,897,904**	**3.2**

Alternatively, Table 11 shows the selected measures in order of descending B/C ratios. Houston Water has another option of prioritizing measures that provide high benefit-cost ratios. These figures can prove valuable since they do not vary or rely on the level of activity that is set in the Tool. The NPVs, as noted above, will fluctuate as activity level is adjusted.

Table 11. All selected measures in order of highest to lowest B/C Ratios.

Class	Activity Name	NPV ($)	B/C Ratio
Multi Family	Residential HE Toilets, MF	$77,697,934	5.5
Single Family	Residential LF Showerhead, SF	$322,798	5.3
Single Family	Home Water Reports	$13,163,814	5
Multi Family	Residential LF Showerhead, MF	$232,599	4.9
Commercial	CII Spray Rinse Valve	$947,087	2.9
Institutional	CII Spray Rinse Valve	$107,062	2.9
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Commercial	Large Land. Irrigation Controller	$1,358,916	1.4
Subtotal Conservation Activities		**$145,897,904**	**3.2**

Residential High-Efficiency Toilets in multi-family housing and single-family Home Water Reports occur within the top three measures of rankings by both NPV and B/C ratio (Table 10 and Table 11). An effort to prioritize these two measures within the residential water-use sector is an arguably appropriate way to move forward.

Given Houston Water's particular interest in conservation potential within the commercial/institutional water-use sector, extra scrutiny on the levels of activity assigned to each CI measure by the Texas State Team will be beneficial prior to determining where to focus initial implementation efforts. That said, it might be appropriate to lead with those measures with the greatest B/C ratio, observe levels of uptake by the C/I sector, and adjust accordingly. How best to implement a conservation program for this water-use sector and others will also depend on staff resources available and how active versus passive (e.g., website promotion only) Houston Water chooses to be with executing a program.

In any event, the scenario presented in Tables 10 and 11 represents 27 measures with some duplication mostly between commercial and institutional measures. Of the 27 measures, four include high-efficiency fixture distribution – showerheads (2) and spray rinse valves (2), 20 measures feature a rebate, three involve site visits – the Large Landscape measures (one of which also includes a rebate), and one requires a new software application – Home Water Reports. Put another way, the scenario presented above is rebate heavy to minimize staff time or at least limit most of the staff resources to administering a diverse rebate program.

Another useful aspect to guide the Utility's focus is the level of opportunity that a measure may present.

Cooling Towers

As a large city located in a hot and humid climate, it is fair to assume that the City of Houston has a significant opportunity to reduce CII water use with a cooling tower water efficiency program. To better understand the potential, the project team utilized the Alliance for Water Efficiency's Cooling Tower Estimating Model that was released in February 2021. Prior to developing or expanding a cooling tower water efficiency program, it is important to gain an understanding of cooling tower prevalence and the associated water consumption in a given area. Estimating the number of cooling towers, water usage, and conservation potential can help better understand and prioritize cooling tower water use efficiency as a strategy. A cursory evaluation suggests that there is indeed a large opportunity for water savings via cooling tower water use efficiency measures in the City of Houston, Texas.

The following are estimated for the City of Houston, Texas:

- Number of Cooling Towers: 3,600
- Cooling Capacity: 1,200,000 tons
- Consumptive Water Use: 3,620 to 3,970 Million Gallons per year
- Non-Consumptive Water Use: 1,380 to 1,510 Million Gallons per year
- Total Water Use: 5,250 Million Gallons per year
- Estimated Savings Potential from Changing from an average of 5 to 6 Cycles of Concentration: 270 Million Gallons per Year

The numbers provided are useful for gaining insight into potential and suggest there is a great opportunity for water savings via a cooling tower water efficiency program. Actual savings resulting from implementation will vary by facility depending on current water use, cooling load, duty cycle (operating time), and operating parameters like cycles of concentration. Consumptive water use refers to water lost through evaporation and non-consumptive use refers to blow-down water. Blow-down water use can be reduced through the optimization of cooling tower operation via strategies such as the use of conductivity controllers.

The City of Houston can get started on a program by developing an inventory of cooling towers and identifying high-priority targets for water savings.

The most efficient way to implement cooling tower measures may be for Houston Water to work closely with the local companies that currently service cooling towers. A list of potential cooling tower maintenance companies in Houston is provided in Appendix B. - Cooling Tower Maintenance Companies List.

Both the City of San Antonio and City of Austin have cooling tower programs in place that Houston can draw from. Both cities' utilities programs contain these three features:

1. Ordinances that set efficiency standards
2. Rebate programs
3. Monitoring and Audit Programs

San Antonio

The San Antonio Water System manages cooling tower efficiency standards via regulatory ordinances. San Antonio has de jure regulations with Conservation Ordinance Chapter 34 Section 273 subsection 3 requiring all cooling towers that were built after January 1, 2006 which do not use recycled water to maintain operating standards of at least 4 cycles of concentration. They additionally use rebate and monitoring programs to ensure efficient water use.

The San Antonio Water System (SAWS) also maintains a registry of all cooling towers within its jurisdiction as part of an evaporative loss credit monitoring program that is free to clients. Part of this monitoring program requires all new cooling towers to have conductivity controllers, as well as make-up and blow down meters that provide monthly reports to the utility.

Finally, SAWS offers a free cooling tower audit program to evaluate the cooling tower and system and to recommend improvements. From the free cooling tower audit, the business may also qualify for the Commercial Custom Rebate which can allow the client to recoup up to 100 percent of the cost of implementing the recommended changes to their existing cooling tower(s).

Austin

Austin Water implements a Cooling Tower Efficiency Program. Like San Antonio, they maintain a registry of every cooling tower within their jurisdiction. Every new cooling tower goes through an application process to ensure that it meets efficiency standards before being constructed, and existing cooling towers must pass an annual inspection.

Austin's water utility has two rebate programs as a part of their Bucks for Business program for CII customers to increase cooling tower efficiency or use reclaimed water for cooling towers. These rebates can apply to projects such as automated conductivity controllers, overflow alarms, and increasing cycles of concentration above five.

Austin also has a Wastewater Billing Adjustment for Evaporative Cooling Tower program that requires customers to provide and maintain smart meters that submit monthly data for use. They can then receive an adjustment on their monthly wastewater bill for the amount of evaporated water not returned to the City's wastewater system.

SYSTEM WATER LOSS

Water loss control throughout a water service provider's distribution network has traditionally been considered an important component of a water conservation program. While an analysis of Houston Water's system water loss was not a component of this study, the topic warrants some mention, nonetheless.

All large cities are challenged to manage their real and apparent water losses and Houston is no exception. Here, we will simply suggest a range of value associated with water losses. Using data from 2019, Houston Water experienced a reported volume of 23,441,484,560 gallons or 71,939 acre-feet of total water losses (i.e., real plus apparent losses). Since not all water losses are economically feasible to recover, we will estimate the economic level of loss of be 50 percent of total annual losses or 11,720,742k gallons.

The value of this estimated economic level of loss ranges from the marginal cost of water on the low end ($0.83/1k gallons) to the retail value on the high end. For Houston Water, the range of value is US $9,728,216 - $70,324,452. A scarcity situation justifies use of a retail value to determine the value of water losses, per the American Water Works Association, and the $6.00/1k gallons value used here comes from an average monthly bill based on 8,000 gallons of residential single-family household usage. Annual investment in water-loss control and the associated capture of water losses expected can be compared to the estimated value of economically recoverable water to determine if sufficient investment is being made. Water rates that reflect the cost of service that includes an aggressive water loss control program must be in place to cover the cost of this investment in recapturing potable water.[2]

2 The water loss figure we used in the Tool did not come from the total water loss input on the 2019 Annual Report. Instead, we averaged the 3 available years (2017-2019) from the TWDB's "Historical Water Loss Audit and Conservation Annual Report Data." A resultant average of 25 GPCD was multiplied by the 2019 population and 365 days to get annual water loss of 65,622.65 AF or 21,383.21 MG.

Alternatively, the number used here in this section of the report does come from the 2019 Annual Report's "total water loss" which is the total of real + apparent losses and = 23,441,484,560 gallons. (https://www.twdb.texas.gov/conservation/municipal/waterloss/historical-annual-report.asp) A Single-Family Residential water bill (5/8" or ¾" meter size) for 8,000 gallons/month = $47.99. This total includes all fees, fixed, and other charges. One-eighth of this bill is $6.00/1k gallons. It can be argued that this figure represents the upper end of the value of economically recoverable water including an estimate of scarcity costs. (https://drive.google.com/file/d/1pJCXYbwUrRaIOpKUmbJQaHHdD5pOgJaP/view)

APPENDIX A. PER MEASURE UTILITY AND PARTICIPANT COSTS FOR PROGRAM SCENARIO

Measure	Fixture cost estimate	Utility rebate towards total fixture cost	Utility processing cost	Utility total cost	Participant's remaining cost towards fixture	Participant installation costs	Participant total costs
Res HE Toilets, SF	$150	$100	$50	**$150**	$50	$50	**$100**
Res HE Toilets, MF	$150	$100	$50	**$150**	$50	$50	**$100**
Res LF Showerhead, SF	?	$5	included	**$5**	$0	$0	**$0**
Res LF Showerhead, MF	?	$5	included	**$5**	$0	$0	**$0**
Home Water Reports	$100,000[2]	-	-	**$1**	-	-	**$0**
C/I 1/2 Gallon Urinal	$270	$140	$20	**$160**	$130	$75	**$205**
C/I Valve-Type HE Toilets	$275	$225	$50	**$275**	$50	$75	**$125**
C/I Laundromat	$740[3]	$175	$20	**$195**	$565	included	**$565**
C/I Dishwasher	$2,000[4]	$1,000	$20	**$1,020**	$1,000	included	**$1,000**
C/I Spray Rinse Valve	$75	$75	$75	**$150**	$0	$0	**$0**
C/I Food Steamer	$1,125[5]	$485	?	**$485**	$640	-	**$640**
C/I Cooling Tower	$2,850	$625	included	**$625**	$2,225	included	**$2,225**
C/I Tank-Type HE Toilet	$200	$150	$50	**$200**	$50	$50	**$100**
Res Irrigation Controller, SF	$150	$100	$50	**$150**	$50	included or 0	**$0**
Rainwater Harvesting Rebate, MF	$7,500	$2,000	$50	**$2,050**	$5,500	included	**$5,500**
Rainwater Harvesting Rebate, C	$7,500	$2,000	$50	**$2,050**	$5,500	included	**$5,500**
Large Landscape Surveys	$2,071	$633.81	?	**$633.81**	$1,665	included	**$1,665**
Large Landscape Water Budgets	$5,952	$3,276.72	N/A?	**$3,276.72**	$3,330	included	**$3,330**

"-" = not included in the rebate cost

"?" = unknown data because the User Guide did not specify

2 The estimated $100,000 cost for the Home Water Reports is the only measure that is a fixed initial cost paid by the utility that encompasses the cost for all of the Home Water Reports regardless of the number of measures implemented.

3 $740 is the HE clothes washer price "premium" (the extra cost for HE compared to less efficient washers) that the rebate would be paying for rather than the total cost of the fixture.

4 $2,000 price premium for a high-efficiency dishwasher compared to a standard dishwasher.

5 $1,125 is the midpoint of the price premium for a self-contained steamer compared to a standard steamer.

APPENDIX B. COOLING TOWER MAINTENANCE COMPANIES LIST

This list does not represent an endorsement by the Texas State Team.

1. **Total Air Service:**
   http://totalairservice.com/cooling-tower-services/
   11250 Thompson Rd.
   Willis, TX 77301 (with a service area in Houston)
   info@totalairservice.com
2. **Texas Specialty Products (TSP):**
   http://www.txsp.com/services/cooling-tower-services/
   16335 Central Green Blvd., Suite #200
   Houston, TX 77032
   713-644-9296
   Marketing@txsp.com
3. **Star Cooling Towers:**
   https://www.starcoolingtowers.com/about/
   9007 Farm-to-Market 2759
   Richmond, Tx 77469
   (832) 702-3526
   sales@starcoolingtowers.com
4. **Cooling Towers LLC:**
   http://coolingtowersllc.com/
   8010 Leesa Lane
   Pasadena, TX 77507
   281-484-2665
   Sales: sales@ctoftx.com
   Marketing: marketing@ctoftx.com
5. **International Cooling Tower Inc (ICT):**
   https://www.ictower.com/
   4460 HWY 225 Suite 180
   Deer Park TX 77536
   832-780-6900
   office@ictower.com

   Construction Services:
   407 Independence Parkway S
   LaPorte TX 77571
   281-479-3255
6. **Stone Cold Cooling Towers:**
   https://www.stonecoldcoolingtowers.com/
   220 Deerwood Glen Court
   Deer Park, TX 77536
   713-600-3390
   sales@stonecoldcoolingtowers.com

APPENDIX C. DATA SOURCES

CONTENTS

LIST OF TABLES

Scenario Name	Scenario Content
Houston MG	Indoor measures for Residential sector
Houston CI	Indoor measures for Commercial & Institutional sectors
Outdoor Residential	Outdoor measures for Residential sectors
Outdoor CI	Outdoor measures for Commercial & Institutional Sectors

UNIVERSAL INPUT VALUES

Worksheet: Common Assumptions

Population, Housing, and Account Forecasts

Population: This was found in the 2021 Regional Water Plan - Population Projections by Water User Group (Houston) for 2020-2070. This source's data was developed in April 2018. https://www.twdb.texas.gov/waterplanning/data/projections/2022/demandproj.asp

Dwelling Units: The Census Bureau (CB) lists "total housing units" data (from 2019 1-yr estimates). Since the total housing units were divided into number-of-units per structure in the CB data, the Alliance for Water Efficiency Water Conservation Tracking Tool's (Tracking Tool) single-family (SF) units were derived by adding up both the attached and unattached 1-unit structures from the CB data. Multi-family (MF) units were derived from the sum of all CB data units that were more than 1. Both the 2019 SF and MF CB calculations were used as the year 2020's dwelling units. To forecast the growth of dwelling units across years 2020-2055, the same ratios of the 2020 SF and MF units to the 2020 population were applied all the way across each year to 2055. https://data.census.gov/cedsci/table?q=housing&t=Housing&g=1600000US4835000&tid=ACSDP1Y2018.DP04&moe=false&hidePreview=true

Number of Accounts: The number of accounts for year 2020 was taken directly from Houston's 2019 Water Conservation Plan Annual Report on page 2 in the "number of connections" column of Table 2. For the forecasted years of 2025-2055, the ratio of each sector's 2020 accounts to the 2020 population was applied.

Financial Assumptions

Dollar Base Year: Since this study was conducted in year 2020, which is also the beginning year of forecasted activities, the same year was chosen for the dollar base year.

Annual Inflation Rate: The 2019 inflation rate was 2.3% so we lowered the 2020 inflation rate to 2% to account for the effects of the Coronavirus on the economy.

Nominal Interest Rate: The AWE Tracking Tool User Guide defines this input as the approximate "current interest rate your utility pays to borrow money for long-term capital improvement projects". Houston Water's finance team reported that their debt model uses a long-term interest rate of 5.25%. Although rates are currently lower at 3.5%, the Tracking Tool output will be used to determine programs for the next decade, so the long-term 5.25% interest rate was used.

Utility Rates in 2020:

- **Average Class Rates**
  - **Water & Sewer:** In Houston's 2019 Water Use Survey, the Single-Family Residential sector's annual water use divided by the sector's number of accounts across 12 months, yielded a monthly water use of approximately 5,000 gallons. Therefore, the average water rates for single-family residential users was found on table 2 of Houston's 2020 Water Rates using the 5,000 gallon tier. The base charge was subtracted from the 5,000 gallon tier rate and then divided by 5 to get the price per thousand gallons. The multi-family, commercial, industrial sectors' water rates came from the volumetric rates and did not include a base charge. The Institutional sector's water rates were assumed to be the same rate as the Commercial sector's. https://drive.google.com/file/d/1pJCXYbwUrRaIOpKUmbJQaHHdD5pOgJaP/view
  - **Electricity:** Electricityplans.com provides all available residential electricity plans in any given zip code. For the single- and multi-family residential sectors' average electricity rates, all ninety-nine available plans were averaged in the 77008 zip code. This zip code was chosen because it contains Council District C which are targeted in this study for their high water use. The commercial, institutional, and industrial sectors' average electricity rates were acquired in a similar way. The 13 available electricity plans for Texas businesses on electricityplans.com were averaged for the downtown area of Houston (specifically in zip code 77002) since this area has many commercial buildings.

- **Gas:** CenterPoint is the only gas provider in Houston, so its Current & Historical Purchased Gas Adjustment/ Gas Supply Rate PDF form for the Houston-Conroe area was used to acquire these data. The 2020 residential gas utility rates from January through May was averaged for single- and multi-family residential sectors. The 2020 large and small general service rates from January through May were averaged to get the commercial, institutional, and industrial sectors' average gas utility rates.

- **Annual rate of increase**
  - **Water & Sewer:** The four available Water & Sewer Rates on the Houston Water billing webpage are the utility rates for years 2017 through 2020. The rate that each year's water rates increased was averaged to get the annual rate of increase for all sectors' water and sewer rates of increase.
  - **Electricity & Gas:** The 2020 inflation rate was used for electricity and gas rates of increase because the rate of increase data was not available. The Texas State Team (hereafter "Team") estimates that the 2% inflation rate may fluctuate with the growth of natural gas and renewable electricity sources, but over the Tracking Tool scenario's twenty-year planning horizon, will maintain a 2% annual rate of inflation. This inflation rate can be changed at any time in the Common Assumptions worksheet which will affect the results accordingly.

Information Needed to Calculate Water/Energy Savings from Plumbing/Appliance Standards

Persons per household: This input value came from the CB's 2019 American Community Survey "Selected Social Characteristics in the United States" table, the product of 2019 -year estimates Data Profiles. Persons per household was found under the label, "average household size" with Houston as the geography selection. https://data.census.gov/cedsci/table?q=persons%20per%20household&t=Household%20and%20Family&g=1600000US4835000&tid=ACSDP1Y2019.DP02&moe=false&hidePreview=true

Full Baths/Dwelling Unit & Half Baths/Dwelling Unit: This was found by searching for the city of Houston on the Bathroom Lookup Table Tool.

Dwelling Units in 1992: Dwelling units were determined by using the CB's American Community Survey in the Selected Housing Characteristics table with Houston selected as the geography of focus. From this table, under the "Year structure built" section, the total housing units from 1939 to 1989 were summed up and 20 percent of the 1990 and 1991 units were taken to calculate the number of dwelling units in 1992. To divide this total between single-and multi-family dwelling units, the same ratio of 2020 single-family to total 2020 dwelling units was applied. https://data.census.gov/cedsci/table?g=1600000US4835000&d=ACS%205-Year%20Estimates%20Data%20Profiles&tid=ACSDP5Y2018.DP04&hidePreview=true

Population in 1990: This was acquired from the CB's "Population Estimates, Population Estimates for States, Counties, Places and Minor Civil Divisions: Annual Time Series, April 1, 1990 Census to July 1, 2000 Estimate" for Houston City under the Harris County subsection of the 4/1/1990 estimate. https://www2.census.gov/programs-surveys/popest/tables/1990-2000/2000-subcounties-evaluation-estimates/sc2000f_tx.txt

Information Needed to Calculate Water Savings for Landscape Measures in Library

Reference ET: The reference evapotranspiration for Houston was found on the Texas A&M AgriLife Extension website. Under the ET and Weather Data tab, the "Average ETo" selection provides monthly averages for 31 years of Historic ETo Reference data for Houston. These monthly ET averages were summed up to provide the "Reference ET" input value for the Tracking Tool. https://texaset.tamu.edu/

Avg Annual Rainfall: The same method as the Reference ET was employed for the Average Annual Rainfall in inches per year. Under the Texas A&M AgriLife Extension website's "ET and Weather Data" tab, the "Historic Rainfall Reference" option provides the monthly average rainfall from 31 years of data.

Effective Rainfall: The User Guide says that the typical range of Effective Rainfall is 20-30% and that the EPA's landscape models use a default of 25%. The Texas A&M AgriLife Extension website only provided the Effective Rainfall for the current two-week period, so the Team contacted the listed contact for the Texas A&M AgriLife Extension website – Charles Swanson. His response stated that the AgriLife Exension uses 67% for effective rainfall across the

board. To honor this high percentage while remaining within the typical range used by the EPA landscape models, the higher 30% effective rainfall was used as the input value. https://texaset.tamu.edu/DataSummary/Daily/150

Turf Landscape Water Requirement Coefficient: The Texas AgrLlife Extension ET Network lists a warm-season turf coefficient of 0.6 (on the "ET and weather data" drop down under the Houston Landscape Calculator) so 60% was entered as the turf landscape coefficient.

Other Than Turf Landscape Water Requirement Coefficient: Older versions of the tool may have had the "other than turf" coefficient as 60%, but this was adjusted to 50% for the final tool. When the turf and "other than turf" water requirement coefficients are the same percentage, the landscape-based measures that rely on these inputs will not be able to calculate water savings (Define Activities worksheet). Therefore a 50% coefficient was selected because the same AgriLife Extension Landscape calculator lists the "occasional water plant coefficient" as 0.5.

Avg Landscape Area Per Site: The Team identified four of the most affluent neighborhoods within in the highest water-using council districts (council districts (CD) C and G). These neighborhoods are Tanglewood, River Oaks, Braeswood, and Old Braeswood. The Team then used Geographic Information System (GIS) and remote sensing to gather samples of each neighborhood and calculate the residential average landscape area per parcel for each neighborhood. The four average landscape areas for each neighborhood were then averaged to get 7,799 square feet. The exact methodology of how landscape area was calculated is recorded in the third quarterly report that was submitted on March 1, 2021.

These landscape area and turf percentages are used by the Tool to calculate water savings and costs for the outdoor landscaping measures. Since the built-in large landscape measures are based on 2- to 3-acre sites, the non-residential average landscape area was set to 2.5 acres (which is entered as 108,900 square feet).

Avg Turf Area (% of Total): Using the same remote-sensing calculations as above, the percent of turf for each of the neighborhoods was also determined. The average of those four averages for the residential average turf percent is 76 percent. Since similar non-residential landscape area data were not calculated, a similar figure of 75 percent was used as the non-residential turf percentage.

Avg Irrigation Efficiency (%): The Tool's User Guide states that the average irrigation efficiency is typically between 60 and 80 percent, so the Team used the average of that range: 70%.

Worksheet: Specify Demands

Peak Demand Season

Houston's total water use from years 2009 through 2018 was separated by months and then totaled to determine which months consistently had the highest water use throughout the ten-year period. This data was found on the 2014 and 2019 Water Conservation Plan Annual Reports (WCPAR) in the "Water Use Data for Service Area" tables (on page 4 of the 2014 WCPAR and page 7 of the 2019 WCPAR). By looking at the monthly totals and their percentages of the total water use, there were 4 months with the highest percentage of water use: July through October.

Baseline Demand Forecast

Annual Sales: Projected water demand numbers were derived from those in the Texas Water Development Board's (TWDB) "2021 Regional Water Plan - Water Demand Projections for 2020-2070 Municipal Water User Group Summary in Acre-Feet" for Houston. Since one total demand is given, the ratio of each sector's annual sales to the total sales (found on the 2019 Water Use Survey (WUS) on the "Connections & Usage" table) was applied to the TWDB's regional forecasted sales for Houston. https://www3.twdb.texas.gov/apps/reports/Projections/2022%20Reports/demand_MunWUG_Search (Once on this webpage, select Houston as the Water User Group to view data.)

Peak Season % of Annual: The same ten years of water use data from the Peak Demand Season section was used here. For each of the ten years, the percent of water that was consumed during the peak season (July through October) was calculated. Then each of the ten years' peak season percent of water use was averaged to come up with the "peak season % of annual" in the Tracking Tool. Because the total water use from the WCPAR was not separated by sector, the same percent was used for each sector.

System Loss: The TWDB provides annual water loss in units of gallons per capita per day (GPCD) for the City of Houston on its "Historical Water Loss Audit and Conservation Annual Report Data" graph (on the "Targets & Goals" tab). The three years of water loss data (2017-2019) were averaged and then converted from GPCD to Million Gallons (MG). https://www3.twdb.texas.gov/apps/wcreps/wcreports.aspx (Select Targets and Goals under Reports and then input Houston for Utility Name to obtain graph.)

Adjust Baseline Demand Forecast for Future Effects of Plumbing/Appliance Standards

Adjust demand forecast for future effects of plumbing/appliance standards?: "No" was selected. Since the TWDB's demand projections include passive conservation savings from fixture standards, we do not need the Tracking Tool to additionally adjust for these expected savings.

Worksheet: Enter Utility Avoided Costs

Tracking Tool Utility Avoided Cost Calculator

Water and Wastewater System Variable Costs:

- **Water**
  - **$/MG:** To find the water purchase cost, the TWDB's "Summary of Water Loss Audit Reports" for the Utility of Houston was used. At the time of inputting this data into the Tracking Tool, the most recent data for this source came from year 2018. By dividing the given dollar value of real loss (from the 2018 TWDB Water Loss Audit Report) by the total real losses (from the 2018 Water Loss Audit and Water Conservation Plan Annual Report), the cost per thousand gallons was calculated and then converted into cost per Million Gallons. https://www.twdb.texas.gov/conservation/municipal/waterloss/historical-annual-report.asp
  - **Nominal Increase:** This is the same as the nominal interest rate from the Common Assumptions worksheet.
- **Wastewater**
  - **$/MG:** The energy and chemicals cost for wastewater comes in part from an excel worksheet sent by Paula Paciorek named "Cost of Energy and Chemicals for WWO" (WWO excel file). The 2019 fiscal year's (FY) total energy costs for wastewater from the WWO excel file was divided by the total water use from the 2019 WCPAR and then converted into the cost per Million Gallons. The same was done for the chemical costs.
  - **Nominal Increase:** The energy cost for wastewater had a negative rate of increase from FY 2018 to FY 2019 in the WWO excel file. Because this is not an increase, it is not allowed in the Tracking Tool so the annual inflation rate from the Common Assumptions worksheet was used instead. The nominal increase in energy costs from FY 2018 to FY 2019 was positive and so was included in the correlating Nominal Increase column of the Avoided Variable Costs table of the Tracking Tool.

Water System Capacity Requirement

Existing peak season system delivery capacity: This figure is the system's design capacity in Million Gallons per Day units (MGD) which was sent in an email from Houston Public Works dated June 2020.

SCENARIO: HOUSTON MG

Worksheet: Define Activities

Activity Name:

The selected activities came from the Tracking Tool's built-in Activity Library. The built-in activities that were initially omitted were the Ultra-low-flush (ULF) toilet rebates for both single-family (SF) and multi-family (MF) sectors and the MF Toilet Direct Install rebate. ULF toilets were omitted because they do not meet current state water-fixture standards for residential toilets. Instead, the High-Efficiency (HE) toilet rebates were selected because they meet the Texas water savings standards.

Other AWE built-in measures were later dropped from the scenario because they resulted in B/C ratios that were unfeasible (less than 1). These include the Residential Surveys (both Single- and Multi-family) and the Residential 4.0 Washer, SF.

One measure - Home Water Reports - was added to the table that did not come from the Tracking Tool's list of default activities. This measure comes from the Texas Water Development Board's Municipal Water Conservation Planning Tool (TWDB Tool). It was selected to be included in the Tracking Tool's list of measures because with the right software, a monthly report to supplement the monthly water bill could result in additional savings with fairly minimal investment per measure.

Several other measures from the TWDB Tool were considered but were ultimately rejected. The TWDB Tool Bathroom Retrofit measure would pay for the direct installation of high-efficiency toilets and retrofit water-efficient showerheads and faucet aerators through a licensed plumbing contractor. This measure was not used, however, because its resulting B/C ratio (1.2 for SF; 2.6 for MF) was lower than the B/C ratios of most of the Team's programmed showerhead (5.3 for SF; 4.9 for MF) and toilet rebate (2.6 for SF; 5.5 for MF) measures. The bathroom retrofit measure also utilized contractors which was avoided by the Team to avoid added costs and complication for Houston Water.

The TWDB Showerhead and Aerator Kit measure distributes low-flow showerhead and faucet aerators to replace less efficient devices. This measure was decided against because its B/C ratio (3.0 for SF & MF) is lower than the Team's programmed showerhead distribution measure's B/C ratios (5.3 for SF; 4.9 for MF). Anther downside of this measure is that it does not allow the faucet aerator to be separate from the showerhead distribution. As the TWDB Tool's User Guide mentions, the water savings from a showerhead is higher (at 5.5 gallons per day) than a faucet aerator (at 1.5 gallons per day). Since the Team's AWE Tool scenario already consists of a showerhead distribution measure with a high B/C ratio, this additional showerhead and aerator kit measure was ruled out.

Year Denominated:

Columns J and P ask for the year denominated for utility and participant costs. These were changed from the default year of 2014 to the base year of 2020 which was set up on the Common Assumptions worksheet. The same was done for each scenario.

Initial Variable Utility Costs and Initial Participant Cost:

The AWE Tracking Tool User Guide used data sources for each measure's costs dating from 2005 that were inflated to 2008 dollars. In 2016, the Tool was updated to once again inflate those 2008 costs to 2016 dollars. This, however, caused two issues. The inflated costs and therefore rebate amounts became random dollar amounts such as $212 washer rebates rather than an even $200 rebate.

The other and more important problem with inflated rebate amounts is that utilities do not usually change their offered rebate prices to match inflation. For example, many CII measures in the AWE User Guide referenced the Metropolitan Water District of Southern California's (MWDSC) Save Water, Save a Buck program as their rebate benchmark. Those same rebate amounts that were referenced in 2008 are still the same dollar amount offered today (in November 2020). For these reasons, the Team decided to adjust most residential measures from the Tool's inflated 2016 cost to the User Guide's original 2008 costs, unless otherwise noted in Table 12 and explained further below. The costs that are bolded are the utility costs that were ultimately entered into the Tool for each measure.

Table 12. AWE Tracking Tool's Residential Measures Utility Costs.

Measure	User Guide's 2008 Utility Costs	Tool's 2016 Inflated Utility Cost	Team's Decided Utility Cost
Residential Surveys, SF	$95.00	$105.45	**$32.55**
Residential Surveys, MF	$50.00	$55.50	**$31.25**
Residential LF Showerhead, SF	**$5.00**	$5.55	--
Residential LF Showerhead, MF	**$5.00**	$5.55	--
Residential 4.0 WF Washer, SF	**$200.00**	$212.00	--
Residential HE Toilets, SF	$200.00	$222.00	**$150.00**
Residential HE Toilets, MF	$200.00	$222.00	**$150.00**

1. **Residential High-Efficiency (HE) Toilet Rebates:** Although the User Guide's default utility cost for HE Toilet rebates is $200, toilet prices have decreased over time. Therefore, the utility costs for SF and MF HE Toilet rebates were both reduced to $150. Of that utility cost, $100 is the offered rebate and $50 goes towards administration of the measure. The participant is expected to pay $100 ($50 towards the toilet and $50 for installation) which was changed from the inflated $111. This change in effort to reflect accurate toilet prices actually increases the B/C ratio.
2. **Residential Low-Flow (LF) Showerhead Distribution:** Originally, the Team assigned $18 to the variable cost because it was assumed that each showerhead fixture would cost $3. 15 minutes processing time from a $78,120 salary ($63k plus 24 percent fringe benefits) would cost $9. And additional expenses, such as time spent working with customers, disposal of replaced showerhead, and marketing, would cost $6. However, the user guide uses studies that show that an appropriate utility cost for administration and the fixture together is $5 so the updated and final Tool reflects that $5 price.
3. **Residential Surveys:** In the updated and final version of the tool, the Team decided to use the User Guide's utility cost of $95/survey for SF and $50/survey for MF. One reason for this decision is that the user guide's assigned costs are more reliable since they are based on thoroughly researched studies. The other reason is that the Team reverted many other measures to their initial costs so this would keep consistent with that methodology.
    - It was initially assumed that this measure would be contracted out, so the utility cost included the salary of two employees ($63,000 salaries with 24 percent fringe benefits) divided by the chosen activity level of 4,800 surveys each year. An additional profit for the contractor of around $30 yielded a utility initial variable cost of $65. Since this cost – the same for both SF and MF sectors – produced a B/C ratio of less than 1, this contracted-out method was reevaluated.
    - An alternative to a contracted-out implementation of residential surveys would be that Houston Water hires two full-time employees to carry out this measure. With two full-time employees ($63,000 salaries with 24 percent fringe benefits), the base rate is the same activity cost per survey as before (SF=$32.55/survey, MF=$31.25/survey) without adding the additional contractor's profit. This is the only method of implementing the residential survey measure that yields a B/C ratio above 1 for the SF sector. The MF sector, however, still has a B/C ratio that is less than 1.
4. **Home Water Reports:** Since Home Water Reports requires that a special system be in place to be able to send out the tailored reports to households that compare their current and past use with similar households. It was estimated by the Team that such a system would cost around $100,000 for its utility initial fixed cost. It is a minimal cost from there to send out the home water reports so a small $1 fee was selected for the utility variable cost per report. As with all of the measures that came from the TWDB Tool, the gallons per year (gpy) of water savings for the AWE Tool was determined using the gallons per day (gpd) of water savings from the TWDB Tool. The TWDB automatically input 12.1 gpd which was multiplied by 365 days in one year to get a water savings figure of 4,416.5 gpy.

5. **Residential 4.0 WF Washer Rebate, SF:** To match the User Guide's default values, the Washer rebate utility cost was adjusted from the inflated cost of $212 back to $200. The participant cost was similarly changed from the inflated $166.50 back to the year 2008 default of $150. Because it is difficult to determine and since there are no reliable studies on it, the User Guide did not assign free-ridership values to any measures. The Team's discussions with the AWE influenced a decision to set the Washer free-ridership rate to 25%. This 25% value was chosen because out of all the measures, washers is the most likely to have a high percentage of free riders. Free-ridership is much less likely, however, when the rebate does not cover the purchase of a new fixture. This Washer rebate assumes that the premium for an upgrade to a High-Efficiency washer is $300. The Utility will cover $150 (the other $50 of the total $200 utility cost goes towards administration costs), and the participant cost is $150 for the other half of the premium.

Worksheet: Enter Annual Activity

Enter Annual Conservation Activity

All activity levels are programmed to begin in 2021 and extend to the end of 2040 for a total of 20 years of implementation.

1. **Residential High-Efficiency Toilet Rebates:** The Tracking Tool estimates the number of non-efficient toilets in 2020 to be 217,678 for SF and 158,190 for MF according to its "Toilet_Stdrds_Resid_TX" worksheet. When divided by 20 years for the length of the program the annual number of toilets that can be replaced is 10,884 SF toilets and 7,910 MF toilets.
2. **Residential Low Flow Showerhead Distribution:** The Tracking Tool estimates the number of non-efficient showerheads for year 2020 in its "Showerhead_Stdrds_Resid" worksheet to be 20,590 showerheads for the SF residential sector. That estimate divided by the 20 years of the program length is 1,030 showerhead replacements each year. Using the same methodology as SF, the estimate inefficient MF showerheads is 16,466 which means that over the 20-year program, 823 showerhead replacements can take place each year.
3. **Home Water Reports:** Because Home Water Reports have a useful life of one year, the number of annual activity will increase each year as more homes begin receiving home water reports. The Home Water Reports measure is only applicable to the SF sector and Texas has a reputation of gaining around 40 percent registrants from its population of SF dwellings units. Therefore, Paula Paciorek suggested the number of home water reports begin at 50,000 reports in year 2021, increasing by 50,000 each year, and maxing out at 250,000 reports by year 2025 where it remains steady until year 2040.
4. **Residential Surveys:** It was estimated that 1 percent of the SF and MF residential dwelling units could receive residential surveys each year. Since the Census Bureau's 2018 data was used in the calculations for the utility initial variable costs of this measure, the 2018 dwelling units were also used for this annual activity calculation. 1 percent of the 2018 single-family dwelling units (477,657) was rounded to 4,800 SF residential surveys per year and 1 percent of the 2018 MF dwelling units (498,571) was rounded to 5,000 MF residential surveys per year.
5. **Residential 4.0 WF Washers, SF:** The Tracking Tool does not provide an estimate of inefficient clothes washers in its "ClothesWasher_Stdrds_Resid" worksheet. Therefore, an arbitrary activity level of 1,000 clothes washer rebates per year was selected for the 20-year program.

SCENARIO: HOUSTON CI

Between the Commercial/Institutional (Houston CI) and Residential (Houston MG) scenarios, the input data remain the same for the first three worksheets: Common Assumptions, Specify Demands, and Enter Utility Avoided Costs. The two worksheets that are different between the two scenarios are Define Activities and Enter Annual Activity.

Worksheet: Define Activities

Activity Name:

The selected activities came from the Tracking Tool's built-in Activity Library. The only built-in activities that were not selected for the table on this worksheet were the Ultra-low-flush (ULF) toilet rebates for both tank-type and valve-type toilets. ULF toilets were omitted because they do not meet current state water-fixture standards for residential toilets. Instead, the High-Efficiency (HE) toilet rebates were selected because they meet the Texas water savings standards.

Savings, Participant Free Riders (% of Participants):

None of the free rider percentages were changed from the default 0 percent. It was discussed with the AWE that it is not common for the Commercial or Institutional sectors to have free riders.

Initial Variable Utility Costs and Initial Participant Cost:

For the same reasons discussed above in the same section for the previous scenario the Team decided to use the Tracking Tool's initial 2008 utility costs. Table 2 below notes which measures the Team did not use the Tracking Tool's 2008 utility cost and discusses why in further detail below. The costs that are bolded are the utility costs that were ultimately entered into the tool for each measure.

Table 13. AWE Tracking Tool's Residential Measures Utility Costs.

Measure	User Guide's 2008 Utility Costs	Tool's 2016 Inflated Utility Cost	Team's Decided Utility Cost
CII 1/2 Gallon Urinal	$450.00	$499.50	$160.00
CII Valve-Type HE Toilet	**$275.00**	$305.25	--
CII Laundromat	$370.00	$410.70	$195.00
CII Dishwasher	$1,000.00	$1,110.00	$1,020.00
CII Spray Rinse Valve	$150.00	$166.50	---
CII Food Steamer	$485.00	$538.35	---
CII Cooling Tower	$625.00	$693.75	---
CII Tank-Type HE Toilet	$200.00	$222.00	---

1. **CII ½ GPF Urinal Direct Installation:** The user guide's initial utility cost of $450 for the rebate and installation of a CII ½ gpf (gallons per flush) urinal yielded a B/C ratio that was less than By decreasing the utility's variable cost from $450 to $160 and increasing the participant's variable cost from $0 to $205, the Team was able to increase the B/C ratio to 1.5. The Team estimated that a ½ gallon commercial urinal would cost around $270. Of the $160 utility cost, a $140 rebate goes towards the toilet purchase and installation and $20 contributes to the utility's processing costs. Of the $205 estimated participant cost, $130 pays for the remaining urinal price and $75 pays for its installation. By requiring the participant to pay for a larger portion of the fixture, this change lowers the risk of free riders.

2. **CII Valve-Type HE Toilet Rebates:** The user guide estimates that the variable cost for the utility will be $275. $225 of that will go towards the CII valve-type toilet as a rebate and it will cost $50 for utility processing. The Team kept the user guide's utility variable cost as well as its participant variable cost of $125.
3. **CII Laundromat Washer Rebates:** The user guide initially assigned the cost of $370 for utility costs of HE washing machine laundromat rebates. Of that cost, the rebate is $320 and processing costs $50. This $370 utility cost and $420 participant cost, however, yielded a B/C ratio of less than 1. In order to increase the B/C ratio to 1.5, the utility cost was decreased to $195, which consists of a $175 rebate and $20 for processing costs. In order to maintain the estimated HE washing machine premium of $740, the participant's remaining cost for the machine must increase from the $420 to $565.
4. **CII Dishwasher Rebates:** This rebate is meant to cover only half of the cost difference between conventional and HE dishwashers, the other half being paid by the participant. The premium is estimated to be $2,000, so the utility will pay $1,000 with an added $20 processing cost (for a total $1,020 utility variable cost) and the participant will pay the remaining $1,000 towards the HE dishwasher premium.
5. **CII Spray Pre-Rinse Spray Valve Replacements:** The user guide estimates that utility variable costs for a kitchen pre-rinse spray valve replacement will cost $150 per fixture. $75 is the assumed cost for the spray rinse valve and $75 for processing and administration. The participant is not expected to contribute to this measure, so the participant cost remains unchanged at $0.
6. **CII Kitchen Food Steamer Rebate:** This rebate is meant to cover half of the $1,125 premium of self-contained steamers from the average cost of standard steamers. Of this amount, the user guide says that the utility cost is $485 and the participant cost will be $640. The utility cost covers the rebate, administration, contractors, marketing and the utility's option of including installation.
7. **CII Cooling Tower Conductivity Controller Rebate:** Assuming the cost of a cooling tower to be around $2,850, the utility rebate covers $625 of this and the participant is responsible for the remaining cost of $2,225. Utility processing and administration cost is not mentioned in the User Guide for this measure so is left out of the costs listed in the Tracking Tool for Cooling Towers.
8. **CII Tank-Type HE Toilet Rebates:** The User Guide assumes tank-type toilets will cost around $200. The utility will pay a $150 rebate and $50 in processing costs for a total utility cost of $200. The participant will need to pay the remaining $50 towards the toilet and $50 for its installation for a total of $100.

Worksheet: Enter Annual Activity

All activity levels are programmed to begin in 2021 and extend to the end of 2040 for a total of 20 years of implementation.

Every CI measure was duplicated so that one could be assigned to the Commercial sector and the other to the Institutional sector for proper was savings functioning of the Tracking Tool. This meant that each measure's activity level was also split between the Commercial and Institutional sectors. To do this, the ratio of water demand for each sector was referenced from the Annual Sales table of the Tracking Tool's Specify Demands worksheet to calculate a ratio for their activity levels.

The ratio calculation revealed that from 2020-2055 the Commercial sector is expected to use 90 percent and the Institutional 10 percent of their shared water demand. Therefore, the determined activity levels for each of the following measures were divided into Commercial and Institutional using that 90:10 ratio. Those separated activity levels are listed at the end of each of the following measure descriptions below.

1. **CII ½ GPF Urinal Direct Installation:** Unlike CII toilets, the Tracking Tool did not have estimates for the number of non-efficient CII urinals in the city. While the TWDB Tool does estimate non-efficient urinals in Houston, its estimate for non-efficient toilets was much higher than the Tracking Tool's toilet estimate. Because of this large discrepancy, the Team did not directly use the TWDB Tool's urinal estimates. Instead, the same ratio of Tracking Tool toilet estimates to the TWDB Tool toilet estimates was applied to the TWDB Tool urinal estimates to yield the estimated non-efficient urinals in Houston. Of the calculated 22,680 non-efficient urinals, the Team decided to set the measure's activity to capture half of those over the lifetime of the 20-year program, equaling 567 urinal rebates each year. Commercial = 510; Institutional = 57.
2. **CII Valve-Type HE Toilet Rebates:** In the "Toilets_Stdrds_Nonresid" worksheet, the Tracking Tool estimates the number of non-efficient Commercial and Institutional toilets in Houston for year 2020. These numbers were combined to represent both sectors together (42,791+ 9,133= 51,924 toilets). Like the CII Urinal measure, the Team decided that half of the non-efficient CII urinals could be reached and replaced (51,924 CI toilets/2=25,962). This was divided over the 20-year program time frame (25,962/20=1,298 toilet rebates/year). Since the non-efficient toilets estimate includes both valve-type and tank-type toilets, 5 percent of this annual activity level was distributed to the tank-type toilets measure (1,298*.05=65 tank-type toilet rebates per year), leaving the rest to valve-type toilet rebates (1,298-65=1,233 valve-type toilet rebates per year). Commercial = 1,110 valve-type toilets/year; Institutional = 123.
3. **CII Laundromat Washer Rebates:** Using data from the North American Industry Classification System (NAICS), the Team determined that there are 127 coin-operated laundromats in Houston. It was assumed that there are about 20 machines in each laundromat (so 127*20=2,540) and that about 20 percent of those would need upgrades at any given time (so 2,540*0.2=508). When rounded, that amounts to 500 HE Laundromat Washer Rebates each year. Commercial = 450; Institutional = 50.
4. **CII Dishwasher Rebates:** The NAICS code 722 revealed that there are 6,642 food service establishments in Houston. Upon consultation with Bill Hoffman, he suggested a targeted range of 5 to 10 percent of the food service establishments for the dishwasher rebate. His reasoning stands that "food service establishments" include fast food restaurants, which do not use dishwashers. The Team considered, however, that there are other establishments that are not included in the NAICS food service establishment category that do use dishwashers. Such establishments may include senior living facilities, corporate campuses, prisons, hospitals, schools, & community centers. The Team chose the higher end of Bill's suggested range at 10 percent of the food service establishments in Houston. By targeting 10 percent of food service establishments (6,642*.10=664 establishments) over the 20-year program (664/20=33), the activity level became 33 CII dishwasher rebates each year. Commercial = 30; Institutional = 3.
5. **CII Spray Pre-Rinse Spray Valve Replacements:** Using the NAICS codes 722511, 722513, and 722514 for "full-service restaurants", "limited-service restaurants", and "cafeterias, grills, buffets", Houston is estimated to have 5,100 restaurants. To give each of those establishments one CII pre-rinse spray valve over the span of the 20-year program, the activity level would be (5100/20=255) 255 spray valve replacements per year. Commercial = 230; Institutional = 26.
6. The second quarterly report incorrectly used the activity level of 425 pre-rinse spray valves (Commercial = 383;

Institutional = 42) because of a math error. In the final version of the Tool this was corrected to the intended total activity level of 255 which comes from the 5,100 food establishments divided by the 20-year program. Further consultation with Bill Hoffman informed the Team that fast food restaurants often do have pre-rinse spray valves as do other establishments that are not included in the "food establishment" NAICS codes (such as school cafeterias and other non-food establishments). Therefore, the original total establishments of 5,100 remained as this would include some fast-food restaurants and account for non-food establishments. Commercial = 230; Institutional = 26.

7. **CII Kitchen Food Steamer Rebate:** This measure used the same data from the previous measure (Spray Rinse Valves) that concluded that there are around 5,100 food service establishments in Houston. The Team estimated that half of these food service establishments (5,100/2=2,550 establishments) may need a new food steamer over the programmed 20-year time span. Therefore, the annual activity level (2,550/20=127.5) is a rounded 128 food steamer rebates per year. Commercial = 115; Institutional = 13.

8. **CII Cooling Tower Conductivity Controller Rebate:** Bill Christiansen with the AWE used the forthcoming Alliance for Water Efficiency Cooling Tower Estimating Mode to generate an estimate of 9,545 cooling towers in Houston in 2020. He also advised that conducting 50 cooling tower conductivity controller rebates each year would be an ambitious goal for water conservation. Given that the details concerning each of the measures in this project are ultimately up to Houston Water to decide what is practicable for them, the ambitious 50 cooling tower rebates per year was selected. Commercial = 45; Institutional = 5.

9. **CII Tank-Type HE Toilet Rebates:** This measure's activity level was determined with the same source as the CII Valve-Type HE Toilet Rebates (read above), yielding 65 CII tank-type toilet rebates each year. Commercial = 59; Institutional = 7.

SCENARIO: OUTDOOR RESIDENTIAL

Worksheet: Define Activities

Activity Name:

Only one of the measures was selected from the Tracking Tool's built-in Activity Library: Residential Irrigation Controller, SF.

Residential Irrigation Controller Financing, Single Family was not selected for this scenario because the technology and cost of borrowing money both have considerably changed since this measure was originally set in 2008. This measure involves the utility buying down the interest rate for financing an irrigation controller that uses satellite pager technology or telephone line to adjust watering to the needs of the landscape. Current technology - which uses Wi-Fi and local weather stations - is more affordable and therefore does not warrant loans to purchase.

The other activity from the Tool's built-in Activity Library that was dropped from this scenario was the Residential Meter Installation, Single Family. This measure is meant to install meters in existing customer sites that do not already have meters. Since Houston is fully metered, this measure is not applicable.

The other available built-in measures (Efficient Irrigation Nozzles and Turf Replacement) were tested by applying an activity level of 1/year. Since the B/C ratio results for these measures were less than 1 – proving them unfeasible – they were also dropped from the scenario.

The outdoor residential measures from the TWDB Tool were tested for feasibility in the AWE Tool. Only one of these available measures proved feasible - the Multi-Family Rainwater Harvesting Rebate.

Initial Variable Utility Costs and Initial Participant Cost:

1. **Residential Irrigation Controller, SF:** Technology has changed since the Residential Irrigation Controller Rebates measure was first developed, so the associated costs for the utility and participant were updated to reflect the lower prices of current irrigation controllers. The original total cost of an irrigation controller was $350, but this was changed to $150 which is about the average cost for current smart irrigation controllers. The utility would contribute a $100 rebate towards the total and $50 in utility processing costs which equals a $150 utility cost. The participant would be left to pay $50 for the remaining controller cost.
2. **Rainwater Harvesting Rebate, MF:** This measure assumes that a 10,000-gallon collection tank costs approximately $7,500 including the tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line. A $2,000 rebate plus $50 processing costs equals a utility cost of $2,050. The participant is left with the remaining $5,500 cost.

Worksheet: Enter Annual Activity

Just like the other scenarios, the activity levels are programmed to begin in 2021 and extend to the end of 2040 for a total of 20 years of implementation.

1. **Residential Irrigation Controller, SF:** An estimated activity level was set for 52 irrigation controller rebates per year. This sets the goal for an average of one rebate per week.
2. **Rainwater Harvesting Rebate, MF:** An estimated activity level of 12 rainwater harvesting rebates per year was set. This averages to one rebate per month.

SCENARIO: OUTDOOR CI

Worksheet: Define Activities

Activity Name:

Three of the four built-in large landscape measures were ultimately selected for the Outdoor CI scenario: Large Landscape Surveys, Large Landscape Irrigation Controller, and Large Landscape Water Budgets. One built-in measure, Large Landscape Turf Replacement, was excluded because it resulted in an infeasible benefit-cost (B/C) ratio of zero.

Each of the selected large landscape measures build on each other. The Large Landscape survey is required and included, therefore, by each of the other large landscape measures. The survey-only measure can also exist on its own, however, since it provides value through a site visit, training, and device adjustments for the customer. Next, the Large Landscape Irrigation Controller Rebate includes the survey and the irrigation controller rebate. The Large Landscape Water Budget is the most comprehensive as it includes the survey, irrigation controller rebate, and a site budget.

The fourth selected measure came from the TWDB Tool - C/I Rainwater Harvesting Rebate. This measure is the same as the Multi-Family Rainwater Harvesting Rebate for a 10,000-gallon tank and supplies.

Initial Variable Utility Costs and Initial Participant Cost:

In the other scenarios the Team adjusted the utility and participant costs of most measures back to the original 2008-dollar values that had been set in the User Guide. In this Outdoor C/I scenario, however, the Team allowed the Tool to automatically adjust the default costs to 2016-dollar values since most of the costs associated with the large landscape measures are attributable to labor rather than physical products.

- **Large Landscape Surveys –** The user guide lists the utility variable cost in 2008-dollars as $571, but the Tool updates to this in 2016-dollars as $633.81. The participant cost is $1,500 in 2008-dollars but updated to $1,665 in 2016-dollars.
- **Large Landscape Irrigation Controller -** This irrigation controller rebate measure includes the initial landscape site survey and the controller rebate. The user guide lists the utility variable cost in 2008-dollars as $2,071 but the Tool updates to this in 2016-dollars as $2,298.81. The participant cost is $1,500 in 2008-dollars but updated to $1,665 in 2016-dollars.
- **Large Landscape Water Budgets -** This water budget measure includes the initial landscape site survey, creation of a site budget (the water budget), and irrigation equipment upgrades (irrigation controller rebate). The user guide lists the utility variable cost in 2008-dollars as $2,952, but the Tool updates to this in 2016-dollars as $3,276.72. The participant cost is $3,000 in 2008-dollars but updated to $3,300 in 2016-dollars.
- **C/I Rainwater Harvesting Rebate -** This measure assumes that a 10,000-gallon collection tank costs approximately $7,500 including the tank, pump, filter, pressure tank, site preparation, labor, downspouts, and trunk line. A $2,000 rebate plus $50 processing costs equals a utility cost of $2,050. The participant is left with the remaining $5,500 cost.

Worksheet: Enter Annual Activity

Since the three selected large landscape built-in activities include some combination of each other, Houston Water should keep in mind that adjusting the activity level of one activity does not affect the activity levels of the other related measures. In other words, if the intension is to increase only the number of irrigation controllers, the independent surveys do not also need to increase since a survey is included in the controller measure, as previously mentioned.

- **Large Landscape Measures -** The Team set the activity level of each of the three large landscape measures to 100 per year. Since many of these measures include parts of the other related measures, the same activity level across all large landscape measures allows Houston Water to adjust the implementation levels to what is thought to be most appropriate.
- **C/I Rainwater Harvesting Rebate -** Just like the multi-family version, the C/I Rainwater Harvesting Rebate was set to 12 per year for an average of one rebate per month.

APPENDIX D. COMMERCIAL/INSTITUTIONAL WATER USE BY SUBSECTOR

Subsector	Subcategory (when applicable)	NAICS Code	Employment	Establishments	Gallons Employee Day (GED)	Estimated Annual Water Use (GED x # of Employees x Workdays per year)	Annual Water use per Establishment
Food Service	-	722	142,654	6,642	265	8,505,744,750	1,280,600
Accommodation	-	721	16,602	598	240	896,508,000	1,499,177
Hospital/ Nursing Homes	-	622	86,682	84	124	2,418,427,800	28,790,807
Grocery	-	44511	32,260	617	170	1,233,945,000	1,999,911
Misc. Retail	-	44 or 45	159,513	9,493	152	5,455,344,600	574,670
Schools*	-		36,431	648		2,209,944,825	3,410,409
	Houston ISD	6111	29,402		308	2,037,558,600	
	Other	611X	7,029		109	172,386,225	
Offices	-		578,226	27,000	127	16,522,807,950	611,956
	Information	51	34,541	1,317	127	987,009,075	749,437
	Finance and insurance	52	93,483	5,336	127	2,671,276,725	500,614
	Real estate and rental and leasing	53	35,135	4,321	127	1,003,982,625	232,350
	Professional, scientific, and technical services	54	153,689	10,488	127	4,391,663,175	418,732
	Administrative and support	561	226,487	3,708	127	6,471,866,025	1,745,379
	Social Assistance	624	28,853	1,186	127	824,474,475	695,172
	Religious/Civic Organizations	813	6,038	644	127	172,535,850	267,913
Laundry	-		4,535	294		1,000,504,575	3,403,077
	Drycleaning and Laundry Services (except Coin-Operated)	81232	1751	255	981	386,489,475	1,515,645
	Linen Supply	812331	750	*	977	164,868,750	
	Carpet and Upholstery Cleaning Services	56174	284	39	984	62,877,600	1,612,246
	Industrial Launderers	812332	1,750	*	981	386,268,750	

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