NATIONAL MULTIPLE FAMILY SUBMETERING AND ALLOCATION BILLING PROGRAM STUDY

EXECUTIVE SUMMARY

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DISCLAIMER

This study was funded by the following agencies and organizations: United States Environmental Protection Agency, National Apartment Association, National Multi Housing Council, City of Austin, City of Phoenix, City of Portland, City of Tucson, Denver Water Department, East Bay Municipal Utility District, San Antonio Water System, San Diego County Water Authority, Seattle Public Utilities, and Southern Nevada Water Authority. The sponsors assume no responsibility for the content of the research study reported in this publication or for the opinions or statements of fact expressed in the report. The mention of trade names for commercial products does not represent or imply the approval or endorsement. This report is presented solely for informational purposes.

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FOREWORD

As water utilities pursue options for new supplies, one option involves capturing savings from water conservation programs. This process also includes continually searching for additional water conservation opportunities through new measures and new technologies. Beneficiaries of improved efficiencies and cost-effective savings include water and wastewater utilities, the utility customer, and the environment.

One potential source of water savings is in the multi-family sector where utilities typically bill the owner through one master meter and the residents pay for their water and wastewater as part of the monthly rent. Embedded in this paradigm is little or no incentive for the end user, the resident, to save water because there is no direct pricing signal since water is paid for in the rent.

As water and wastewater costs increase faster than the rate of inflation, multi-family dwelling owners are seeking to shift these uncontrolled costs directly to the resident instead of including them as part of the rent. Owners are using two basic methods to bill residents. One method involves billing for actual consumption via metering. The second method involves billing based upon an allocation formula, such as the number of people, number of bedrooms, square footage, etc. However, the allocation method does not appear to provide an incentive for residents to save water because the pricing signal is diluted since the charge is based upon a pre-determined formula and not on actual use. One of the primary objectives of this study was to investigate the savings potential if multi-family residents are billed for their use either through actual metering or some type of allocation formula.

Nationally, up to 4% of multi-family residents may now metered and charged for their consumption based upon actual volume of use. Another 9% pay for their water through various allocation formulas and about 2% are billed through a combination of metering and allocation programs. That leaves about 85% of multi-family residents still paying for their water and wastewater as part of their rent, often referred to as “in-rent”. Because the water use of around 60 million people, 20-25% of all residents, could be reduced, there is a great deal of interest in the potential water savings, the cost and benefits involved in capturing savings, and the administrative issues associated with separate billing programs. While some utilities are metering individual multi-family dwelling units, most are not. And while still other utilities have

investigated local water savings associated with separate billing systems, such as the City of Austin, Las Vegas Valley Water District, San Antonio Water System, and Seattle Public Utilities, study funding partners agreed that much more empirical data were needed on this subject.

The study had five main objectives: 1) to determine the water savings potential in the multi-family sector resulting from both direct metering and allocation programs, 2) to understand the current regulatory framework governing separate billing programs across the U.S., 3) to access the current business practices in the billing service companies (read and bill industry), 4) to draw conclusions from the findings, and 5) to make recommendations that offer consumer protection, provide ethical business practices for the industry, and capture cost-effective water savings.

This report reflects the results of an effort that began over three years ago in cooperation with the EPA, two national apartment associations, and 10 water utilities. It is hoped that the information presented in this report will be found timely, useful, and objective; will add to the current body of knowledge; and that the appropriate organizations, including water utilities, will consider adopting and implementing the study's recommendations.

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This research would never have been completed without the cooperation of the multi-family property owners, managers, and residents that completed the various mail and telephone surveys conducted in this study.

This study would not have been possible without the vision and generous resource commitments from the following sponsoring organizations: United States Environmental Protection Agency; National Apartment Association; National Multi Housing Council; City of Austin; City of Phoenix; City of Portland; City of Tucson; Denver Water Department; East Bay Municipal Utility District; San Antonio Water System; San Diego County Water Authority; Seattle Public Utilities; and Southern Nevada Water Authority.

We are also deeply thankful for the assistance and time commitment provided by the following participating water utilities: City of San Diego, Hillsborough County Water Department, Southern Nevada Water Authority, Las Vegas Valley Water District, Irvine Ranch Water District, and Indianapolis Water.

We are grateful to the members of an ad hoc committee that helped us understand the various plumbing codes and the issues surrounding point-of-use meters. These individuals included Henry Oppermann, Steven Cook, Ken Lake, Jim Nehl, Don Faber, Brad Drier, Wade Smith, Al Dietemann, Eddie Wilcut, and Mike Kobel.

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Finally, this project would never have come to fruition without the guiding spirit of the project manager Dick Bennett of the East Bay Municipal Utility District. He conceived, organized, and administered the project from day one. His support, diligence, management skills, and enthusiasm were instrumental in every phase of this effort.

EXECUTIVE SUMMARY

More and more buildings in the multi-family housing sector are converting to systems where each multi-family dwelling unit pays for water and wastewater directly instead of including these charges as part of the rent. The three most common ways in which separate billing is accomplished are: (1) Through direct submetering of water use by means of a water meter installed on a single or multiple points of entry water line(s); (2) Through a Ratio Utility Billing System (RUBS), which bases the water bill on an allocation formula that uses floor space, number of occupants, etc.; or (3) A hybrid of the two where total water use is estimated based on the ratio of metered hot (or cold) water use (and sometimes selected appliances) in a unit to the total water use of all occupants. It is estimated that there are now more than 1.2 million apartment renter households that are billed separately for water and sewer using one of these billing system methods (NMHC 2001).[1]

RESEARCH OBJECTIVES

The goals of the National Multiple Family Submetering and Allocation Billing Program Study were to determine the merits of separate billing programs including the potential water savings, costs and benefits from various perspectives, and the accompanying administrative and regulatory issues. In the study, a retrospective analysis of water use in multi-family properties in 13 cities was conducted. The 13 study cities were weighted towards the West and southwestern region of the United States, but contain a wide variety of utilities serving a broad and diverse group of customers. Properties equipped with submeters or that have undergone a billing system conversion (impacted properties) were identified and compared against control (in-rent) properties where water and wastewater fees are included as part of the rent. The study compared the two groups using historic billing data provided by participating water utilities combined with an extensive series of mail surveys and site visits. The data collected for study provides a wealth of information about how submetering and allocation affect water use, property owners, and residents. Embedded in these data are insights into this developing industry, including the

[1] Based on data from the 2001 American Housing Survey. Assumes a multi-family property has at least five dwelling units. The number is higher if smaller properties are included in the analysis.

quantitative aspects of separate billing. The data are also useful for examining the impacts of the 1992 Energy Policy Act plumbing standards and other factors that may influence water use. It is anticipated that the database of submetered and allocated billing program information developed for this study will be a resource for researchers and planners to explore for years to come, particularly if it is maintained and updated.

TERMINOLOGY AND DEFINITIONS OF BILLING METHODS

The following terms and definitions are used throughout this report.

In-Rent Properties

In-rent properties refer to all properties where the owner does not separately bill residents for water and wastewater. A slight variation of this standard "in-rent" arrangement can occur when there is a homeowners association (HOA) at a property that collects flat monthly fees.

Impact Properties

Impact properties refer to all properties that bill separately for water and/or wastewater by submetering, ratio utility billing systems, or a hybrid of the two. Within these different billing methods, the party actually billing for water needs to be defined. The ***owner*** refers to either an individual or an organization that owns and/or manages a rental property. A third-party ***billing service company*** (billing company) is a private, for-profit entity that provides billing services for water, wastewater, trash collection, and energy to owners of multi-family properties. A ***utility*** is a regulated provider of water and/or wastewater service to a set of customers. Utilities may be public or private entities and they are responsible for treating, delivering, and billing for water and/or wastewater.

Submetering

Submetering in this report is defined as full capture metering that occurs downstream of a water utility master meter. There are three different types of submetering that can occur:

Single point of entry submetering

Dual point of entry submetering

Point-of-use submetering

Hybrid Metering

Hybrid metering, referred to as "hot water hybrid" (HWH) in this report, are billing systems where only a portion of the water such as the hot water consumption (or occasionally the cold water) for each unit in a multi-family dwelling is measured. This information is then typically used to extrapolate the total water bill.

Ratio Utility Billing Systems

Ratio utility billing systems (RUBS) use an allocation formula to estimate water consumption for each unit in a multi-family dwelling. RUBS systems are not based on the actual consumption at each unit, rather individual bills are prorated from the overall utility master meter bill based on one or a combination of quantitative measures such as square footage, number of occupants, or number of fixtures.

RESEARCH APPROACH

The project team developed a multifaceted approach to accomplish the research objectives set out for this study.

1. **Selection of participating study sites**: After invitations were sent to utilities and water providers across the United States and Canada followed by personal phone calls and contact, representatives from 13 study sites volunteered to participate and partially fund this research. These 13 participating water providers were: (1) Denver Water, Colorado; (2) Seattle Public Utilities, Washington; (3) City San Diego Water Dept., California; (4) Hillsborough County, Florida; (5) City of Phoenix, Arizona; (6) City of Tucson, Arizona; (7) City of Austin, Texas, (8) San Antonio Water System, Texas; (9) City of Portland, Oregon; (10) East Bay Municipal Utility District, California; (11) Irvine Ranch Water District, California; (12) City of Indianapolis, Indiana; and (13) Southern Nevada Water Authority & Las Vegas Valley Water District, Nevada. Participation required the utility to provide complete billing data for the multi-family subclass from their service area and project support.
2. **Quality assurance and quality control (QAQC)**: Procedures to ensure the quality of the data and the research methods were implemented throughout the study.

3. **Owner/postcard survey**: To identify "impact"[2] properties in each utility, owner surveys were developed, tested and implemented to all eligible properties in each utility. This survey was necessary because in most cases there was no independent source of information about what properties use the various billing systems in any utility service area, and the study did not want to rely on information supplied solely from the billing companies, many of whom could not share their client lists in any case. In order to avoid a fatal bias in the study group selection, postcards were sent to all owners of multi-family properties listed in the water providers billing databases. The responses from this survey were used to identify the impact properties.
4. **Database development**: All data collected in this study including historic water billing records and survey response data were stored in a customized Microsoft Access database.
5. **Manager survey:** To obtain detailed information about properties identified in the owner/postcard survey, a survey was developed, tested and sent to managers of impacted and in-rent properties.
6. **Regulatory and policy review:** To evaluate the administrative and regulatory issues surrounding third party billing programs throughout the country, surveys were sent to various potential regulators in all 50 states and to more than 100 of the largest water and wastewater utilities. Additionally a detailed policy literature review was conducted.
7. **Matched pair selection and site visits:** Study team utilized the results from the manager survey to make statistically similar pair matches for site visits and comparison. A site visit protocol was developed and the study team worked with participating utilities to conduct site visits.
8. **Resident survey**: To solicit resident opinions and experiences with different billing methods, a survey instrument was developed, tested, and sent to residents using addresses provided on the manager survey. Some residents also provided copies of their water and wastewater bills sent by various read and bill companies or owners.
9. **Read and bill company survey**: To obtain information about billing practices and policies a survey was sent to 36 third party billing companies.
10. **Statistical analysis and modeling**: Once the data collection and analysis was complete, the

[2] Impact properties – multi-family properties billing separately for water and/or wastewater services using RUBS, submetering, hot water hybrid, or other methods.

research team used all of the assembled information to develop analytical tools and relationships to quantify potential water savings and explain indoor multi-family residential water use.

11. **Final products**: The final products of this research project include this final report and the database.

RESEARCH FINDINGS

Prevalence of Billing for Water and Wastewater at Multi-family Properties

RUBS, submetering, or hybrid metering was reported in 13.4% of the 7942 properties that responded to the owner/postcard survey. However, looking at the number of units indicated on the postcard survey, 35.4% of units are billed through RUBS, submetering, or hybrid systems. This represents the best estimate from this study of the prevalence of this practice in the multi-family sector. The postcard survey was sent to the owner of every multi-family property in the billing databases of the participating study sites that fit the initial criteria[3]. Nation-wide the prevalence of separate billing for water and wastewater may be somewhat less because the study sites selected to participate in this study often had a notable concentration of properties receiving water and wastewater bills based on data provided by billing service companies.

Table ES. Error! No text of specified style in document.**.1 Breakdown of each billing method for all properties identified**

		Billing Method					
		In-Rent	**HWH**	**Sub.**	**RUBS**	**Other***	**Total**
All respondents	Properties	6760	42	311	717	142	7972
	% of properties	84.8%	0.5%	3.9%	9.0%	1.8%	100%
	Units	286,355	3,912	47,547	112,049	10,400	460,263
	% of units	62.2%	0.8%	10.3%	24.3%	2.3%	100.0%

*Includes "Other" as well as respondents who left the question blank.

Estimated Water Use By Different Billing Methods

One of the central purposes of this study was to determine the water savings associated with submetered and allocation billing programs in multi-family housing. This research question was the over-arching theme for the entire project and a majority of time and effort was spent collecting and analyzing data to provide information on the potential water savings from

[3] See Chapter 3 for details.

submetering and RUBS. Keep in mind that this study did not set out to estimate national "averages" of impact property water use, and the selected properties were not selected to be representative of the entire United States. Rather the primary goal was to determine the impacts of different billing programs.

Why are water savings so important? Water providers are keenly interested in identifying effective approaches to reducing water demand, as new supplies become increasingly expensive and difficult to obtain. National and state agencies are interested in improving water efficiency and promoting proven methods for achieving savings. The utility billing industry has promoted the practice of charging multi-family customers for water and wastewater services not only as a way to improve property owners' net operating income, but also as a way to effect water conservation. Water savings could provide justification for encouraging, promoting, and expanding billing programs and could unite water providers, regulators, and billing companies in a common goal. As a result there has been intense interest in this question.

To reach a conclusion regarding how water use differs between billing types, seven main analyses were conducted. The number of properties included in each analysis is included in Table ES.**Error! No text of specified style in document.**.2. The results of each analysis are discussed in the sections that follow.

Table ES. Error! No text of specified style in document.**.2 Number of properties included in each analysis, by billing type**

Description of Analysis	Number of Properties by Billing Method				
	In-Rent	Sub.	RUBS	HWH	Total
Postcard Survey	6493	273	595	41	7402
Manager Survey	858	118	177	22	1175
Statistical Model #1	705	101	150	-	956
Statistical Model #2	703	100	150	-	953
Statistical Model #3	531	79	136	-	746
Matched Pair	29	21*	14	-	64
Pre-Post Conversion	-	6	39	1	46

*7 HWHs were grouped with the submetered for this analysis

Submetering

Submetering was found to achieve statistically significant water savings of 15.3 percent (21.8 gal/day/unit) compared with traditional in-rent properties after correcting for factors such as year of construction (before 1995, 1995 or later), average number of bedrooms per unit,

presence of play areas, presence of cooling towers, utility's average commodity charge for water and wastewater, whether a property was a rental or individually owned, and classification of the property as a retirement community. Not all submetered properties used less water and the statistical model that demonstrated these savings predicted only about 25% of the variability in water use in the observed properties. Summarized water use analysis comparing submetered and in-rent properties is shown in Table ES.**Error! No text of specified style in document.**.4. Statistically significant savings from submetering was found in every single comparison and analysis conducted in this study. Water savings ranged from –5.55 to –17.5 kgal per unit per year, or –15.20 to –47.94 gallons per unit per day (gpd) which is between -11% to -26%. Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2, highlighted in blue, provides the "best estimate" of expected water use and savings at submetered properties[4]. The number of properties used in each analysis can be seen in Table ES.**Error! No text of specified style in document.**.2.

Table ES. Error! No text of specified style in document.**.3 Summarized water use analysis results, submetering**

Data source or Analysis	Annual Indoor Water Use per Unit kgal (gpd)		Estimated Difference in Water Use (± 95% confidence interval)	Statistically Significant at 95% confidence level?
	In-Rent (or pre-conversion)	Submetering		
Postcard Survey	53.21 (145.8)	44.87 (122.9)	-15.7% ± 6.2%	*yes*
Manager Survey	51.61 (141.4)	46.07 (126.2)	-10.7% ± 9.3%	*yes*
Model #1	52.33 (143.4)	43.73 (119.8)	-16.4% ± 9.3%	*yes*
Model #2	52.19 (143.0)	44.23 (121.2)	-15.3% ± 9.3%	*yes*
Model #3	53.19 (145.7)	43.14 (118.2)	-18.9% ± 10.3%	*yes*
Matched Pair	57.59 (157.8)	47.61 (130.4)	-17.3% ± 17.0%	*yes*
Pre-Post Conversion	68.21 (186.9)	50.71 (138.9)	-25.7% ± 27.2%	*yes**
Conclusion	**52.19 (143.0)**	**44.23 (121.2)**	**-15.3% ± 9.3%**	***yes***

* Test was significant at the 94% confidence level.

[4] Submetered properties were identified by manager survey responses. Through the site visits, it was found that 3 out of 20 properties visited (15%) had indicated on the manager survey that they were submetered, but were found to only be metering the the hot water. Thus, the submetered sample is likely to contain some hot water hybrids.

RUBS

This study found no evidence that Ratio Utility Billing Systems (RUBS) reduced water use by a statistically significant amount compared with traditional in-rent arrangements, and the data showed that the difference between water use in RUBS and in-rent properties was not statistically different from zero. While some RUBS properties used less water on average than in-rent properties, others used the same or more water on average than in-rent properties. Summarized water use analyses comparing RUBS and in-rent properties are shown in Table ES.**Error! No text of specified style in document.**.6. Typically the 95 percent confidence interval for RUBS spanned a range that included an increase in expected water use as well as water savings. Statistically significant water use savings from RUBS were detected in only a single comparison test – the matched pair sample. The matched pair comparison relied on the smallest RUBS sample size in the study and, as explained in detail in the body of the report, the in-rent control sample did not appear to be representative of the population of in-rent properties in the study. Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2, highlighted in blue, provided the single "best estimate" of expected water use at RUBS properties. After correcting for a wide variety of factors and evaluating numerous different analytic models, the researchers concluded that no statistically significant impact from RUBS could be reliably expected. The number of properties used in each analysis can be seen in Table ES.**Error! No text of specified style in document.**.2.

Table ES. Error! No text of specified style in document.**.4 Summarized water use analysis results, RUBS**

Data source or Analysis	**Annual Indoor Water Use per Unit kgal (gpd)**		**Estimated Difference in Water Use** (± 95% confidence interval)	**Statistically Significant at 95% confidence level?**
	In-Rent (or pre-conversion)	**RUBS**		
Postcard Survey	53.21 (145.8)	52.10 (142.7)	-2.1% ± 4.3%	no
Manager Survey	51.61 (141.4)	53.45 (146.4)	3.6% ± 7.8%	no
Model #1	52.33 (143.4)	52.76 (144.5)	0.8% ± 7.4%	no
Model #2	52.19 (143.0)	52.58 (144.1)	0.7% ± 7.4%	no
Model #3	53.19 (145.7)	51.48 (141.0)	-3.2% ± 7.7%	no
Matched Pair	66.19 (181.3)	47.80 (131.0)	-27.8% ± 19.2%	*yes**
Pre-Post Conversion	55.32 (143.4)	52.85 (144.4)	-4.5% ± 8.8%	no

Conclusion	**52.19 (143.0)**	**52.58 (144.1)**	**0.7% ± 7.4%**	**no**

* Results from this analysis are further explained in Chapter 5.

Hot Water Hybrid

Hot water hybrid billing systems may achieve water savings, however in this study the sample of hot water hybrid properties was too small to produce reliable results that can be generalized to the broader population. Analysis of data from the limited sample of hot water hybrid properties does suggest that water savings, somewhat smaller than the magnitude found in submetering, *may* be achieved through this billing methodology. This study was unable to verify this finding of savings in a reliable, statistically rigorous manner because of the small sample size. Summary water use analysis results for hot water hybrid properties are shown in Table ES.**Error! No text of specified style in document.**.8. The number of properties available for each analysis can be seen in Table ES.**Error! No text of specified style in document.**.2. It should be noted that during the site visits it was discovered that 15% of the hot water hybrid properties had been mislabeled by the mangers as submetered. This indicates that HWHs may be more common that originally thought, and is suggestive that they may have comparable savings to submetering. However, further research is needed to verify this.

Table ES. Error! No text of specified style in document.**.5 Summarized water use analysis results, hot water hybrid**

Data source or Analysis	**Annual Indoor Water Use per Unit kgal (gpd)**		**Estimated Difference in Water Use** (± 95% confidence interval)	**Statistically Significant at 95% confidence level?**
	In-Rent (or pre-conversion)	**Hot Water Hybrid**		
Postcard Survey	53.21 (145.8)	49.61 (135.9)	-6.8% ± 15.7%	no
Manager Survey	51.61 (141.4)	44.79 (122.7)	-13.2% ± 20.5%	no

Multivariate Model Results – Best Estimate of Water Use and Savings

The purpose of the multivariate regression modeling and analysis in this study was to account or "correct" for factors that influence water use so that submetered and RUBS properties could be compared against in-rent properties on an equal basis. For example, if a submetered property was built in 1998 and equipped with water efficient fixtures it was important to correct for this so that water savings associated with the efficient fixtures not be incorrectly attributed to

submetering when comparing against in-rent properties built before EPACT plumbing standards were put in place.

Using the relevant factors identified through the ANOVA and Pearson Correlation analyses, numerous multivariate regression models were developed using identified factors as the independent variable and annual indoor per unit water use as the dependent variable.[5] Nearly all of these models included the billing methodology (submetering or RUBS) as a factor. The results of this methodology are a set of models that account for a variety of different factors shown to influence water use. At the same time these models also evaluate the impact of submetering vs. in-rent billing and RUBS vs. in-rent billing. Step-wise regression was also used to create a multivariate model that includes all of the relevant independent variables shown to have statistical significance.

The single most statistically powerful predictive multivariate regression model developed in this study was Model #2. This model was selected as the "best estimate" of water use and savings in submetered and RUBS properties because of the large sample size (n=953), because it had one of the highest coefficients of determination (R^2=0.245) of any of the more the 50 models examined by the researchers, and because the overall model was found to be statistically significant at the 95% confidence level. Model #2 includes eight independent variables identified as significant from the ANOVA and Pearson Correlation analyses. In addition, a ninth variable, the use of a RUBS, was forced into the model. Even though it was not found to be statistically significant whether a property used RUBS was central to this study and it was important that the variable be included explicitly. The resulting nine independent variables were:

- Average number of bedrooms per unit
- Year the property was built (1994 and earlier or 1995 and later)
- Rental property (private and government subsidized) vs. non-rental properties (i.e. condominiums, private resident owned, and other)
- Utility's average commodity charge for water and wastewater
- Presence of a play area
- Presence of a cooling tower

[5] Indoor water use was normalized by total number of units rather than on occupied units because vacancy rates were not found to be a statistically significant factor. Indoor water use was not normalized on a per occupant basis because many survey respondents left that question blank thus reducing the potential sample size. In addition, the site visits determined that the reported number of residents was a less accurate value than the reported number of units. Finally, the relationship between total indoor water use at a property and number of units was almost linear.

- Classification as senior citizen/retirement community
- RUBS
- Submetering

Fundamental information and statistics from the regression model are presented Table ES.**Error! No text of specified style in document.**.10. The adjusted coefficient of determination (R^2) for Model #2 is 0.245. This indicates that the model explains about 25 percent of the variability in the data. The coefficient of determination (R^2) is a measure of the goodness of fit of the model to the actual data on which the model was based. A model with a perfect fit would have an R^2 value of 1.0. The P-value for the model itself is 0.00 indicating that whatever fit does exist is statistically significant at the 95% confidence level.

Table ES. Error! No text of specified style in document.**.6 Model #2 summary statistics, coefficient of determination, and significance**

R	R Square	Adjusted R Square	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0.502	0.252	0.245	21.39659	952	35.366	0.000

Predictors: (Constant), submetering, rental property (compared to non-rental property), play area, cooling tower, is the property considered a senior citizen/retirement community, average price utility charges for water and wastewater, RUBS, property built before 1995 (compared to properties built 1995 or later), average number of bedrooms per unit
Dependent Variable: Indoor water use per unit (average 2001, 2002)

The coefficients presented in Table ES.**Error! No text of specified style in document.**.12 present the magnitude of the "effect" of the different independent variables in the model. The coefficients are additive, and details about how to formulate the generic equation from these coefficients are found in the body of the report. Of particular interest are the coefficients for RUBS and submetering. In Model #2, eight of the nine independent variables were statistically significant. The only factor that wasn't statistically significant was RUBS. The B coefficient shows the magnitude of the effect, and is graphically displayed in Figure ES.**Error! No text of specified style in document.**.1 and Figure ES.**Error! No text of specified style in document.**.3. For submetering the B coefficient was –7.96 indicating that submetered properties used 7.96 kgal per unit *less* water than in-rent properties after adjusting the other significant independent variables. This effect was statistically significant at the 95% confidence level.

The B coefficient is a measure of the effect of each factor in the model. It is worth noting that three factors in this model were found to be more significant influences on multi-family water use than submetering. These are: (1) whether the property was built before 1995; (2) whether the property has a cooling tower; and (3) the average number of bedrooms per unit.

Another three factors were found to have an influence on water use with similar magnitude to submetering. These are: (1) whether the property is a senior/retirement community; (2) whether the property has a play area; and (3) whether the property is a rental.

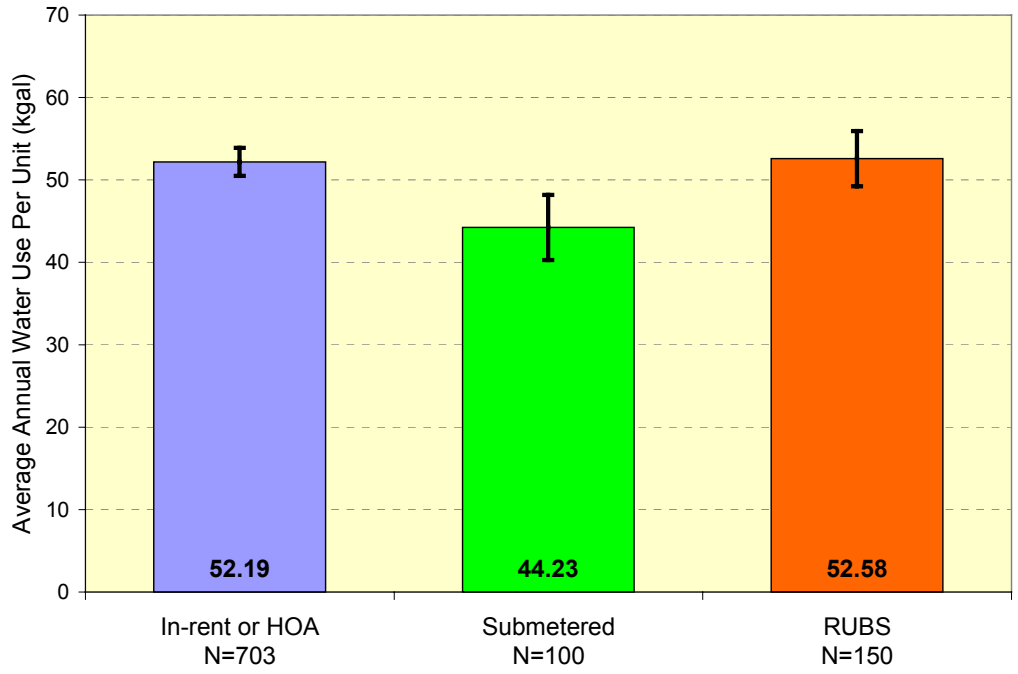

Figure ES. Error! No text of specified style in document..**1 Adjusted average annual water use per unit – Model #2**

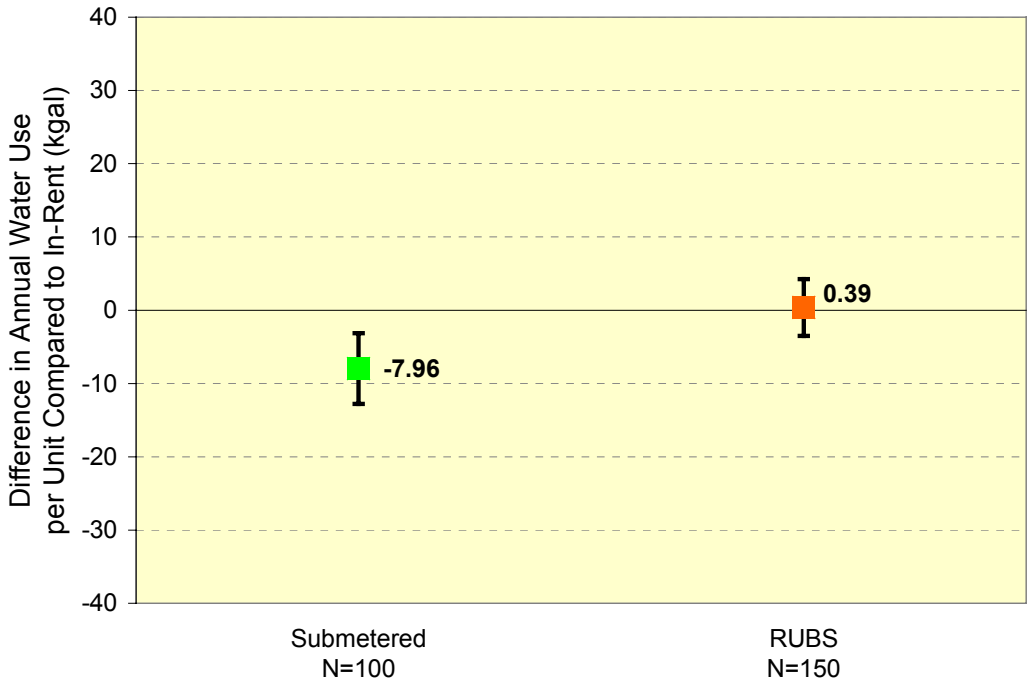

Figure ES. Error! No text of specified style in document..**2 Difference in adjusted average annual water use of impacted properties compared to in-rent properties – Model #2**

Table ES. Error! No text of specified style in document..**7 Model #2 coefficients and significance of independent variables**

Independent Variable	B*	Std. Error	t	P-value
(Constant)	19.95	4.61	4.323	.000
Property was built before 1995	10.84	2.29	4.736	.000
Property is a senior citizen/retirement community	-6.70	2.56	-2.618	.009
Property has a play area	6.80	1.94	3.513	.000
Property has a cooling tower	11.55	3.31	3.493	.001
Property is a rental†	6.84	1.74	3.926	.000
Property is billed through RUBS method	0.39	1.98	0.197	.844
Property is submetered	-7.96	2.47	-3.225	.001
Average commodity charge for water/wastewater‡	-2.01	.28	-7.072	.000
Average number of bedrooms per unit‡	17.44	1.54	11.313	.000

Dependent Variable: Indoor water use per unit (average 2001, 2002)

* Represents the magnitude of each independent variable in kgal per year per dwelling unit

† Rentals include private and government subsidized rentals. (Non-rentals include condominiums, private resident owned, and other).

‡ Continuous variables, change is seen for every dollar or bedroom added.

Besides submetering, seven other independent variables (listed in Table ES.**Error! No text of specified style in document.**.12) in the model were also statistically significant. Properties built before 1995 used 10.8 kgal per unit *more* than properties built after 1995 – this is presumably largely the result of the high efficient plumbing fixtures (toilets, showerheads, and faucet aerators) mandated for new construction by the 1992 Energy Policy Act (EPACT). The average number of bedrooms per unit is a reasonable surrogate for the number of people living in each dwelling unit. These models suggest that for every additional bedroom water use is *increased* by an average of about 17.4 kgal per unit. Rental properties used 6.8 kgal per unit *more* than properties that were non-rentals (condominiums, private resident owned, and other). Properties classified as senior citizen or retirement communities used 6.7 kgal per unit *less* than standard mixed-age multi-family properties. For every dollar increase in the average price charged by a utility per kgal, the water use at a property decreased 2.0 kgal per unit. Properties that reported having a play area used 6.8 kgal per unit *more* than properties without that amenity. The presence of a cooling tower increased per unit water use by 11.6 kgal. The prevalence of each of these characteristics in the manager survey respondents can be found in Chapter 4's section on "Manager Survey Results" or in the enumerated manager survey results in Appendix B.

COSTS AND BENEFITS

Beyond quantifying the water savings that can be measured by implementing a multi-family water and wastewater billing program, there are many issues that arise concerning these systems for utilities, for property owners, and for residents. As is true with any developing field, there are clear advantages to these systems, as well as costs and drawbacks that need to be addressed.

Utility Perspective

Supporting the installation of submeters represents an opportunity for water utilities to capture cost-effective water savings. Savings can be captured in new construction by either requiring the individual metering of multi-family units or by offering incentives in both existing and new multi-family dwellings. Because RUBS has not been found to render reliable savings, it is not cost-effective for utilities to offer incentives promoting RUBS programs. However, since

the findings of this report indicate that the savings from fixture upgrades are more substantial than from submetering, utilities should consider offering cost-effective incentives for change-outs for all multi-family properties.

Table ES.**Error! No text of specified style in document.**.14 shows a range of avoided costs for utilities, assuming annual savings of 7.96 kgal per dwelling unit (du) (21.8 gallons/du/day) from submetering. A utility avoided cost of $500/AF would translate into a present value savings of $152 for each dwelling unit that is submetered, assuming a 20 year useful life. The present value of benefits to the utility could be considered a justifiable subsidy that the utility could offer for submetering or other conservation efforts. Obviously, agency avoided cost and assumptions about product life impact the value of submetering for each utility.

Owner Perspective

In most cases, billing separately for water and wastewater will increase the owner's net operating income and property value. Despite the initial capital investment, submetering can be a cost-effective option for owners. In addition, submetering technology has improved so that the cost for submetering new construction and submetering most existing properties is reasonable. In the case of allocation, there is no initial investment and the payback is immediate. Owners could use this increase in income to improve overall water efficiency on the property, including fixture upgrades. Nevertheless, before converting to a separate billing system, owners should be aware of the applicable federal, state, and local regulations.

Table ES. Error! No text of specified style in document.**.8 Avoided costs from submetering, utility perspective**

Annualized Combined Water and Sewer Avoided Cost		Equivalent PV Avoided Cost*	Water Saved	Submeter Useful Life†	Value of Water and Sewer Benefits	PV of Benefits to Utility‡
($/acre-ft)	($/kgal)	($)	(gal/du/year)	(years)	($/year)	($)
$200	$0.61	$3,432	7,957	20	$5	$61
$300	$0.92	$5,148	7,957	20	$7	$91
$400	$1.23	$6,864	7,957	20	$10	$122
$500	$1.53	$8,580	7,957	20	$12	$152
$600	$1.84	$10,295	7,957	20	$15	$183
$700	$2.15	$12,011	7,957	20	$17	$213

$800	$2.46	$13,727	7,957	20	$20	$243
$1,000	$3.07	$17,159	7,957	20	$24	$304

* Assumes discount rate of 5% and a term of 40 years.
† Assumes that AMR submeters will be replaced twice in twenty years.
‡ Assumes discount rate of 5% and the assumed term of the submeter useful life (in this case, 20 years).

Table ES.**Error! No text of specified style in document.**.16 shows the benefit/cost analysis for the life-cycle of a variety of submeter installation costs. In all of the cases, the owner is assumed to pay the monthly service fee. The benefit/cost ratio varies from 1.9 to 5.1 in all of the cases, assuming a utility water and wastewater commodity charge of $5.27[6]. It should be noted that many owners would not stay with a property for the life cycle of submeters, rather most only own a property for an average of five years. If one looks at the simple payback for owning a property for five years, using the same assumptions from Table ES.**Error! No text of specified style in document.**.16, the simple payback is less than one year for all cases. Table ES.**Error! No text of specified style in document.**.18 shows the benefit/cost ratios for owners who chose to allocate. Here, the benefit/cost ratios range from 4.9 to 7.6.

A key component in these analyses is an assumption that the owner does not reduce the rent to the residents as part of a submetering program. The result is a net increase in rental costs to residents, and the researchers found that this was the most common practice during billing conversion. It is possible that an owner might choose to reduce rental rates in an amount similar to what each resident is paying for water every month. If the owner were also to pay the monthly service charge, then the resident would experience no net increase in rental costs and the owner's benefit/cost ratio would be reduced substantially. This does not appear to be a common practice.

Resident Perspective

Based on the results obtained in the resident survey, consumers have varied opinions on water billing programs. Often these programs result in a water bill in addition to a monthly rent charge. While consumers receive electric or gas bills, many have come to expect that water charges are included in the rent. As currently practiced, water and wastewater billing programs do not appear to be an appealing option for residents of multi-family dwellings. Also, residents are typically charged a service fee (in conformance with applicable state and local law) in

[6] This was the average of the water and wastewater commodity charges for the thirteen study sites.

addition to their volumetric or allocated charge. Thus, in the short term, these billing programs cause an increase in monthly costs for residents. While there may be environmental benefits such as increased water conservation, there are many uncertainties involving separate billing that could be perceived as negative. Until separate billing for water and wastewater has some definitive standards and protections for residents, it is unlikely that most residents will embrace it. Direct metering and billing of water for apartment residents encourages water efficiency and promotes a water billing system that is as transparent as other utilities like gas and electricity, phone and cable whereby residents pay for what they use.

If a property owner were to reduce the rent in the approximate amount of the total water and wastewater bill (including the service fee), then the resident might experience no net increase in rental costs if all else is held constant. As noted above, this does not appear to be a common practice. If the property owner were to pay the service fee as recommended (see Recommendation 8, subsection 9), then the overall cost impact to the resident might be reduced. However as practiced today, it appears that water and wastewater billing programs result in increased costs for residents.

Table ES. Error! No text of specified style in document.**.9 Cost and benefit per unit analysis for owners who chose to submeter**

Submetering Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life† (years)	Annual Value of Water and Sewer Benefits‡	PV of Benefits§	Capital or "First" Costs ($/du)			Annual Service Fee§§	Meter Replace-ment***	PV of Costs †††	B/C Ratio
						Meter, Transmitter, and Installation**	Receiver, Computer, and Software††	Fixture Replace-ment ‡‡				
Submeter - New Construction	Yes	52,195	20	$275	$3,428	$125	$25	$0	$ 36	$125	$675	5.1
Submeter - Retrofit	Yes	52,195	20	$275	$3,428	$300	$25	$0	$ 36	$125	$850	4.0
	No	52,195	20	$275	$3,428	$300	$25	$255	$ 36	$125	$1,105	3.1
POU metering‡‡‡	Yes	52,195	20	$275	$3,428	$560	$25	$0	$ 36	$300	$1,597	2.1
	No	52,195	20	$275	$3,428	$560	$25	$255	$ 36	$300	$1,852	1.9

* Based on the total water use of the average in-rent unit (143.0 gal/du/day)

† Assumes that Automatic Meter Reading (AMR) equipment is used, and that based on current technology, that the battery life is limited to 10 years, and it is best to replace the entire meter, register, transmitter, and battery at same time (even though standard life for a meter is 15 years). Assumes that POUs will need to be replaced every 5 years.

‡ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites).

§ The present value of annually occurring benefits is calculated with a discount rate of 5%.

** May vary by property and location.

†† Calculated on a per property basis. This assumes a $2,500 base cost spread over 100 units.

‡‡ Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.

§§ Assumes monthly service fee of $3 is paid by owner.

*** Replacement costs for submeters (which will be replaced every 10 years) and POU meters (which will be replaced every 5 years).

††† The present value of annually occurring costs is calculated at a discount rate of 5%.

‡‡‡ Assumes 7 meters per apartment, and $80 per meter (includes hardware and installation).

Table ES. Error! No text of specified style in document.**.10 Cost and benefit for owners who choose to allocate**

Billing Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life† (years)	Annual Value of Water and Sewer Benefits‡	PV of Benefits§	Fixture Upgrade Cost** ($/du)	Annual Service Fee†† ($/du)	PV of Costs	B/C Ratio
RUBS	Yes	52,195	20	$275	$3,428	$ 0	$ 36	$449	7.6
	No	52,195	20	$275	$3,428	$ 255	$ 36	$704	4.9

* Based on the total water use of the average in-rent unit (143.0 gal/du/day).
† Assumes that the program will be in place for 20 years.
‡ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites).
§ The present value of annually occurring benefits is calculated with a discount rate of 5%.
** Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.
†† Assumes monthly service fee of $3 is paid by owner.
‡‡ The present value of annually occurring costs is calculated at a discount rate of 5%.

ANALYSIS OF PRICE ELASTICITY

Economic goods have a downward sloping demand curve. This means that the higher the price of the good, the less of it that is purchased. Within this broad statement, specific goods respond very differently to price. Some goods respond very little to price change, and others respond strongly. Economists have developed the concept of "price elasticity of demand" to characterize these differences. Price elasticity of demand is defined for each point on the demand curve as: The percentage change in consumption per percentage change in price. Since elasticity is a percent divided by a percent, it is a unitless number.

The elasticity analysis examined the price elasticity of water use based on utility water and wastewater rates. To simplify the analysis, the average non-seasonal (indoor) water use per unit per year in kgal (using 2001 and 2002 billing data) was calculated for each participating study site. These values were then plotted against the combined utility water and wastewater rate in $/kgal. The results are shown in Figure ES.**Error! No text of specified style in document.**.5. The cost for water and wastewater ranged substantially from $2.83/kgal to $10.11/kgal, providing a useful data set for analysis. To improve the model fit, the data point from Indianapolis was removed from the elasticity model. Indianapolis was the only study site to feature a declining block rate structure (i.e. the more water used, the lower the price). All other utilities had either flat rate or increasing block rate structures designed to send an increasing price signal as demand increases.

Two regression equations and curves were fit to these data to determine the price elasticity of demand – a straight line and a power curve. The fit of both models was quite good and the range of elasticities calculated fits well with previous research in this area. The straight line model had the highest coefficient of determination (r^2) value of 0.6437. Elasticities calculated through the straight line model ranged from -0.12 at $2.83/kgal to –0.65 at $10.11/kgal with an average of –0.29 and a median of –0.20. The constant elasticity power curve model had a coefficient of determination value of 0.5477. The elasticity calculated through this power model was –0.275. These results are shown in Table ES.**Error! No text of specified style in document.**.20. The research team concluded that if a single elasticity value were to be selected, the preponderance of the results from this analysis point to an elasticity of –0.27. However, the linear model result clearly shows that elasticity varies with price

and this should be taken into account when applying these values to planning and rate models.

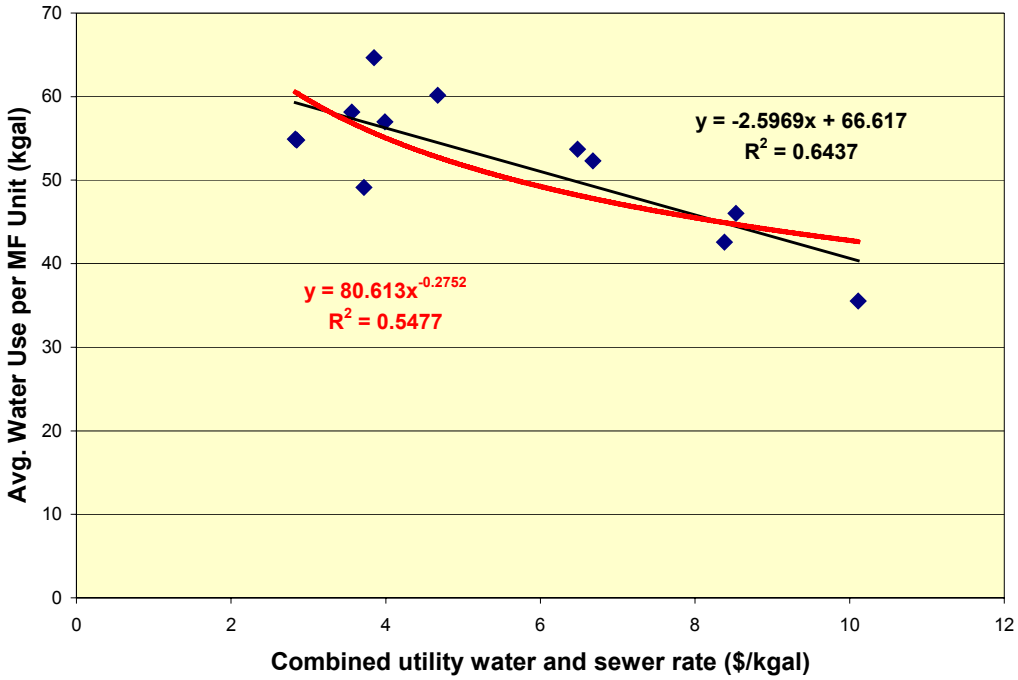

Figure ES. Error! No text of specified style in document..**3 Demand curve and demand equations, elasticity analysis #1 (utility rates)**

Table ES. Error! No text of specified style in document..**11 Elasticity values, analysis #1 (utility rates)**

Price ($/kgal)	Straight Line Model Elasticity	Power Curve Model Elasticity
2.83	-0.1240	-0.2752
2.85	-0.1250	-0.2752
3.56	-0.1611	-0.2752
3.72	-0.1696	-0.2752
3.85	-0.1766	-0.2752
3.99	-0.1842	-0.2752
4.67	-0.2226	-0.2752
6.48	-0.3380	-0.2752
6.68	-0.3521	-0.2752
8.38	-0.4852	-0.2752
8.53	-0.4982	-0.2752

10.11	-0.6505	-0.2752
Conclusion: Elasticity = -0.27		

A second elasticity analysis examined the price elasticity of water use based on water and wastewater rates charged by third party billing service companies. A preponderance of the results from this analysis point to a likely range of elasticity values from -0.07 to -0.16 for submetered properties.

Policy Implications of Price Elasticity Analyses

The results of the elasticity analysis indicate that multi-family dwelling owners and managers are significantly more responsive to price than are residents who are submetered because the calculated percent difference in price elasticity is larger in the utility rate analysis by 70% or more. This result suggests that property owners are more likely to take action to conserve water on their properties in response to a change in price. It also implies that the owners have more opportunities to conserve water because they have a wider variety of uses over which they have control than do the residents, who basically control just their own domestic use. This has significant policy implications because as properties are converted to submetering and RUBS billing programs, owners no longer receive an effective price signal from the utility bill. This implies that the impetus to reduce demand and conserve water on the part of managers and owners is all but lost once a billing program is implemented. While the impact of water pricing is then passed on to the residents, it is apparent that they are much less sensitive to price than are the owners. Because many residents rent or lease their dwelling units, they are unlikely to invest in water conserving fixtures such as toilets, clothes washers, showerheads, faucets and leak repair. In many cases residents may not be permitted to install new fixtures. Leak repair remains the responsibility of the property manager and should be performed as a routine matter.

Interior Retrofits and Billing Programs

These results suggest that if utilities are interested in accelerating the installation of water conserving fixtures and appliances in their service area, it may be necessary to mandate these installations as a condition of conversion to a water and wastewater billing program. Once a water and wastewater billing program is implemented, most incentives to make these changes will be lost (except in common areas) and it is unlikely that residents will make these

changes to their own units. Incentive based programs have spurred fixture change out and utilities may wish to encourage installation of water efficient fixtures in conjunction with their approval of water billing program in their service area.

REGULATORY FRAMEWORK REVIEW

The framework of regulations and related policies for multi-family water and wastewater billing systems is complex, quickly evolving, and unsettled, both at the federal level and in many states. During the time this research study has been in preparation, significant changes in the policy framework have been adopted by the federal government, several states, and major local jurisdictions, and important issues remain in flux.

Safe Drinking Water Regulation

In August 2003, seeking to encourage water conservation benefits attributed to submetering, the Assistant Administrator for Water proposed a significant re-interpretation of the Safe Drinking Water Act regarding submetered systems. In a policy shift that was finalized in December 2003, EPA noted that the "sale" of water had not actually been defined in the Safe Drinking Water Act, and that henceforth a multi-family property with submetered billing to residents would not be subject to the national primary drinking water regulations. Calling submetering an "effective but little-used tool" to promote water conservation, EPA clearly signaled a pullback from any insistence at the federal level that submetered systems would be required to perform the monitoring and record-keeping tasks of public water utilities, even if they nominally remained "public water systems." But citing a lack of evidence to support water saving benefits, the *new policy pointedly excluded RUBS and hot water hybrid allocation systems* from its scope, and urged states to consider whether flexibility was warranted for such systems as well. A challenge to EPA exclusion of RUBS and hybrid systems from this new policy has been mounted by a consortium of interested parties.

State Regulatory Survey

A survey of state policies toward multi-family billing systems is maintained by the National Submetering and Utility Allocation Association (NSUAA), a trade association for companies involved in multi-family billing for all types of utility services, i.e., water,

wastewater, electric, natural gas, solid waste, etc. NSUAA attempts to track state and local policies toward both submetering and RUBS, as well as whether service fees are allowed as part of a billing system.

NSUAA cautions readers not to rely on this summary information as legal advice, noting that information is subject to frequent change and deals with matters of interpretation. With the permission of NSUAA, the latest (March 2004) overview of state policies regarding water and wastewater billing systems is presented in Table ES.**Error! No text of specified style in document.**.22.

Table ES. Error! No text of specified style in document.**.12 NSUAA Summary of State Regulatory Policies**

State	Submetering Allowed?	RUBS Allowed?	Service Fees Allowed?
Alabama	Yes	Yes	Yes
Alaska	Yes	Yes	Yes
Arizona	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes
California	Yes	Yes	Yes
Colorado	Yes	Yes	Yes
Connecticut	Yes	Yes	Yes
Delaware	Yes	**NO** (only prior to 1996)	Yes
Florida	Yes	Varies by county	Yes
Georgia	Yes	Yes	Yes
Hawaii	Yes	Yes	Yes
Idaho	Yes	Yes	Yes
Illinois	Yes	Yes	Yes
Indiana	Yes	Unclear	Yes
Iowa	Yes	Yes	Yes
Kansas	Yes	Yes	Yes
Kentucky	Yes	Yes	Yes
Louisiana	Unclear	Yes	Yes
Maine	Yes	Yes	Yes
Maryland	Yes	Yes	Yes
Massachusetts	**NO** (legislation pending)	**NO**	**NO**
Michigan	Yes	Yes	Yes
Minnesota	Yes	Yes	Yes
Mississippi	Yes	**NO**	**NO**
Missouri	Yes	Yes	Yes
Montana	Yes	Yes	Yes
Nebraska	Yes	Yes	Yes
Nevada	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes
New Jersey	Yes	Yes	Yes
New Mexico	Yes	Yes	Yes
New York	Yes	Yes	Yes
North Carolina	Yes	**NO**	Yes
North Dakota	Yes	Yes	Yes
Ohio	Yes	Yes	Yes
Oklahoma	Yes	Yes	Yes
Oregon	Yes	Yes	Yes
Pennsylvania	Yes	Yes	Yes
Rhode Island	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes
South Dakota	Yes	Yes	Yes
Tennessee	Yes	Yes	Yes
Texas	Yes	Yes	**NO**
Utah	Yes	Yes	Yes
Vermont	Yes	Yes	Yes
Virginia	Yes	Yes	Yes
Washington	Yes	Yes	Yes
West Virginia	Yes	Yes	Yes
Wisconsin	Yes	Yes	Yes
Wyoming	Yes	Yes	Yes
D.C.	Yes	Yes	Yes

Data developed by Marc Treitler and Brian Willie, Co-chairs of the Legislative and Regulatory Committee of the NSUAA. Information about the NSUAA can be found at <www.nsuaa.org>. March 2004.

RECOMMENDATIONS

Guiding Principles for Submetering and RUBS Billing Programs

In light of the key findings and issues identified in this report, six principles are offered here to guide the development of policies to address separate billing systems for multi-family water and wastewater charges.

1. Submetering is a practice that offers documented water savings. As such, submetering should be fostered by public policies seeking to encourage water savings, together with appropriate measures to protect the consumer.

2. RUBS is a practice lacking statistically reliable water savings, while offering both similar and distinctive drawbacks compared with submetering. As such, RUBS implementation should be carefully bounded by public policy.

3. Any water and wastewater billing system – whether submetering, RUBS, or various hybrid systems – will reduce a multi-family property owner's incentive to invest in in-unit plumbing efficiency upgrades in pre-1995 structures. The initiation of any separate billing system in pre-1995 dwellings should be coupled with complete plumbing fixture upgrades within a specified time period.

4. The potential drinking water quality issues that may arise within the water systems of multi-family properties – such as backflow, cross-connection, metal uptake, and deterioration of buried distribution lines – should be approached with solutions that address all properties with comparable vulnerabilities, rather than narrowly focusing on properties that implement a water and wastewater billing program.

5. Best Management Practices for the billing of water and wastewater in multi-family housing should be implemented by the appropriate regulatory agency to ensure consumer protection for property owners and residents and to promote adoption of multi-family submetering.

6. Submetering equipment manufacturers, professional installers, third-party billing services, and owners should be held to reasonable standards of accuracy, reliability, and professional competence and conduct.

Public Policy and Business Practices

A transformation is taking place in the responsibility for water and

wastewater service in multi-family properties across the United States. Consistent with the guiding principles outlined above, the researchers offer the following recommendations to increase the likelihood that this transformation advances the public interest while fairly rewarding private investment and initiative.

Policies for Water and Wastewater Utilities

Water and wastewater utilities should implement the following measures to encourage submetering and to secure the benefits of improved efficiency for their systems.

Recommendation 1 – Require notice. Utilities should require multi-family property owners that seek to implement or convert to any billing system, or which have converted in the past, to notify the utility and/or agency. The utilities should keep permanent records of the properties using any water and/or wastewater billing system. As this report demonstrates, the water savings resulting from submetering can be substantial, and the water savings resulting from plumbing upgrades can be even more substantial. But the value for utilities is greatest if these savings can be recognized, plotted into trends, and incorporated into capital facility planning. If a utility does not know what fraction of its multi-family housing has already converted to separate water and wastewater billing methods, it will be hard-pressed to estimate the additional savings potential that remains from additional conversion. The status of separate billing and associated plumbing conversion (as recommended above) should be kept as current as possible.

Recommendation 2 – Apply volumetric billing to all multi-family properties. Ensure that volumetric billing is applicable to all multi-family properties for both water and wastewater charges. Although the prevalence of flat or fixed rate structures (where no portion of the charge varies with volume of use) for multi-family structures is unknown, it persists for single-family residences in many communities[7] and may be broadly applicable at least to duplexes, 3-family, and 4-family dwellings in such locations. If multi-family resident billing is to be effective in sending a price signal to consumers in multi-family housing, then a responsive price signal has to be sent by the utility in the first place. Where outdoor use and attendant seasonal variation is

[7]In a survey of 420 California cities and districts in 2000, 86% of those surveyed maintained flat (non-volumetric) charges for wastewater service. Surveys in other states by the same firm found non-volumetric charges at 66% of surveyed utilities in Washington, 46% in Oregon, and 32% in Arizona (Black & Veatch 2000).

large, many communities offer seasonal adjustment factors for wastewater service billed from the water meter and/or exemptions from wastewater charges for submetered outdoor use. Submetering of irrigated landscapes offers an additional opportunity to manage outdoor water use efficiently, and should be encouraged in its own right for large parcels, such as multi-family dwelling complexes.

Recommendation 3 – Promote submetering and fixture retrofit. Encourage submetering through judicious targeting of utility water conservation incentives to multi-family submetering conversions. Utilities with active water conservation programs should consider steps to encourage full and partial capture submetering as well as plumbing fixture replacement in pre-1995 buildings. Since submetering offers substantially more savings than RUBS, utilities should consider directing some or all of their plumbing retrofit incentives in the multi-family sector to properties that choose submetering. Tiered incentives to provide additional benefits for properties electing to submeter is another approach. Fixture retrofit should also be promoted in properties that have already undergone billing conversion. While the design and absolute levels of incentive programs are highly site-specific, utilities should look to their incentive programs as an important tool for tipping the balance toward submetering.

Recommendation 4 – Explore direct billing of multi-family residents in new construction. In the interest of encouraging water efficiency gains, utilities should be open to expanding their role beyond traditional master metering of multi-family properties, particularly in new construction. As automated meter reading technology becomes more widely adopted by utilities themselves, the need for direct access by utility personnel to water meters serving multi-family dwellings becomes far less frequent. New construction allows flexibility for the placement of meters in locations designed to be accessible from, or in close proximity to, public space. Duplexes, 3-family, and 4-family units may be easily plumbed for meters from public space. These and other opportunities will present themselves to utilities willing to take the initiative to improve water efficiency and customer service. It should be noted that some utilities may not be interested or willing to venture into multi-family billing that would add a large number of new customers with a high turnover rate.

Policies for State and Local Governments

State law should clearly establish the legal framework for all forms of

multi-family billing systems. In lieu of a patchwork of state agency administrative actions, enactment of statutory language that specifically addresses multi-family billing for water and wastewater service is preferable, and would help ensure consistent policy across all agencies and localities. Similarly, state legislation is preferable to a local ordinance, but local action may well be necessary if state legislation is not forthcoming.

Recommendation 5 – Metering for all new multi-family construction.[8]

a. Low-rise multi-family construction: All new multi-family structures of one to three stories should provide for the measurement of *all* of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, the installation of utility service meters for each unit, *or* the installation of multiple submeters affixed at every point of use in each unit. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices.

b. High-rise multi-family construction: All new multi-family structures of more than three stories constructed after a date which is four years after the effective date of the low-rise requirement above, should provide for the measurement of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, multiple submeters affixed at points of use throughout each unit, or metered hot (or cold) water use as the basis for allocating all in-unit water use. The allowance of four additional years should be sufficient to resolve any remaining technical issues posed by high-rise plumbing configurations and meter placement. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices, or through an approved hot/cold water hybrid allocation system.

Recommendation 6 – Efficient plumbing fixtures required when implementing a billing program. Owners may institute a billing system or continue an already existing billing system for water and wastewater charges *provided* that prior to the institution of any separate billing program or for an existing program within 12 months of official notification, owners comply with the applicable provision (a or b) below:

[8] Subsidized and low income housing developments will likely need to be exempted from this regulation because of various national, state, and local regulations governing the maximum allowable charges for rent and utilities. In addition it may be prohibitively expensive to redesign and submeter some high rise buildings designed with a central boiler.

a. **Older Properties:** Owners of multi-family structures constructed *before* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for all new toilets, if earlier), must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet aerator is either newly manufactured and installed within the previous 12 months, or operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

b. **Newer Properties:** Owners of multi-family structures constructed *after* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for all new toilets, if earlier) must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet is operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

Recommendation 7 – Once submeters are installed a RUBS system cannot be used. Formula allocation systems (RUBS) may not be used in buildings where total-capture meters or partial-capture hybrid systems for individual units have been installed, even if the submetering billing program has been abandoned. To preserve the potential for water savings and maintain the relative benefit to consumers to more equitably distribute costs, abandonment of submetered systems should be discouraged. Limited allocation and estimated billing may be permitted in submetered properties on a temporary basis when specific meters cannot be read or are being serviced or replaced.

Recommendation 8 – Consumer protection. State or local landlord-tenant law or similar legal framework should address the special concerns arising from multi-family water and wastewater billing systems. The section below contains recommended practices for property owners, billing service companies, and water utilities to ensure that consumers are treated fairly. Any number of these practices could be fashioned into a statutory requirements. The degree to which some or all of these provisions are written into law will be based upon the experience of each jurisdiction.

Best Management Practices for Billing of Water and Wastewater Service in Multi-Family Housing[9]

The researchers believe a comprehensive set of best practices in the form of regulated

[9]These best practices were adopted from and expand upon the guidelines published by the NSUAA

industry standards, would benefit all parties involved, including residents, property owners, water providers, regulators, and the billing service providers themselves. The best management practices (BMPs) should be implemented by the appropriate regulatory oversight agencies. BMP standards could greatly improve resident understanding and satisfaction with third party billing, and reduce consumer complaints to regulators.

Based on the research results, the following standards for best management practices for water and wastewater billing practices are recommended. BMPs for the billing service industry and for property owners are essentially the same and apply equally. In many cases, property owners and managers handle their own billing for water and are in fact the billing entity. Regardless of who produces the bill, either the owner/manager or a third party billing service company, it is incumbent upon the owner/manager to ensure the proper implementation of these best management practices. The owner maintains the underlying responsibility for the way the billing program is implemented and managed.

Resident rights related to water billing are closely tied to the BMPs for the water billing industry and provide a set of reasonable expectations for residents receiving water and wastewater bills from largely unregulated billing entities.

These best practices are intended to apply generally to *both* submetering and RUBS billing unless specifically noted.

1) Billing entity. Where permitted by law, water and wastewater utility bills may be issued by a property owner or qualified billing agent. Billing agents shall have appropriate insurance coverage.

2) Water cannot be dedicated to public use. Water and wastewater service will only be provided to residents of the property. Non-residents and the general public will not be served. (In many states, this ensures that the property owner is not deemed to be a public utility).

3) Common area and vacant units. The property owner shall pay for water and wastewater service used in common areas, administrative offices, vacant dwelling units, and other portions of the property not designated as dwelling units. Residents are only financially responsible for their own water and wastewater service costs. In RUBS properties, common areas should be separately metered. If not possible, a reasonable estimate of common area usage can be made that is based on the property's specific common area amenities.

4) Water audit and leak repair. Before instituting any separate billing system,

the property owner/manager shall conduct a water audit of all units and common areas, testing for leaks, including toilet tank flapper valve leaks, and repair all leaks identified. Upon institution of the separate billing system, the property owner/manager shall commit to a reasonable standard of leak repair in all units, and shall maintain sufficient supplies of materials as may be necessary to ensure that common types of leaks (such as toilet flappers) are promptly repaired. When properly reported, non-emergency leakage at any plumbing fixture or fitting should be repaired within 5 business days. The process for reporting leaks and the owner/manager's commitment to leak repair shall be clearly stated in each resident's bill, and shall also be disclosed as part of the lease agreement.

5) Pass through of water and wastewater costs. Both the commodity and fixed service charges for water and wastewater shall be equivalent to the commodity charges contained in the property owner's bill from the local water and wastewater utility.[10] Neither the billing entity nor the owner/manager shall inflate the costs of these charges. Utility commodity charges and the billing entity charges shall be clearly stated on every bill provided to residents and such rates and charges shall also be disclosed as part of the rental agreement.

6) Submetering and RUBS methods and notification. Water and wastewater bills to residents shall be calculated on the basis of fair and reasonable methods of cost allocation, including submeter readings or allocation formulas. The measurement or allocation method and/or formula is considered a matter of public record and shall be clearly stated on every bill provided to residents. The water and wastewater billing arrangement shall be fully disclosed to the resident in the rental agreement. When a new billing program is started, owners shall provide residents with at least 60 days notice prior to implementation. Billing can only begin after lease signing/renewal.

7) Billing practices. Water and wastewater bills shall be sent promptly after meter readings are made or after the master-meter bill from the utility is received. This is essential to ensure that the price signal is received in reasonably close proximity to the time of consumption. A reasonable amount of time (minimum of 10 business days) shall be allotted between the residents' receipt of a bill and the date payment is due.

8) Records retention and inspection. The property's master water and wastewater utility bills shall be retained for a period of not less than 24 months, and shall be available for inspection by any resident at reasonable hours and without charge. However, a nominal fee can be charged for any requests to copy bills.

9) Fees. The billing entity may charge reasonable fees. Fees are divided into two categories: (a) ***recurring service fees***; and (b) ***other fees***. ***Recurring service fees*** (also called monthly fees, administrative fees, or meter fees) shall be charged to the property owner/property manager, not to the residents. Where not subject to regulation, the owner

[10] In most cases, these charges will be based on the local utilities' rate schedules for multifamily housing, often priced by the size of the service connection to the master meter. In the case of duplex, 3-family, and 4-family units, the smaller service connections to these structures may result in their being charged at the same rate as single-family residences.

is in the best position to negotiate favorable service fee charges with the billing company and responsibility for recurring service fees gives the owner an interest in negotiating the best fee. Property owners should pay the meter service fee since it is part of the infrastructure of the building and as such would be like repair and maintenance of any building supplied fixture or appliance. ***Other fees*** (new account fees, late fees, returned check fees, and other reasonable fees that relate to a specific resident account) shall be paid by the residents.

10) Complaints and disputes. A fair method for promptly resolving complaints and billing disputes shall be established by the billing entity that should have parity to the process that exists for the property owner contesting a bill to the local water utility. The billing entity shall be available during normal business hours via a toll free number, printed on every bill, to handle billing questions and complaints.

11) No shutoff of service. As stated by law, water and wastewater service cannot be shutoff to residents by the owner or his agents. The rental agreement can provide for a utility deposit or other legal remedy through which unpaid utility bills can be collected.

12) Information to be included in regular bills. The bill is the fundamental communication between the billing entity and the resident. As such, bills must be clear, comprehensible, and comprehensive. Billing entity water and wastewater bills shall include:

(a) Clear statement of the current water and wastewater commodity charges and fees as well as any overdue or pending amounts;

(b) Billing period covered by the bill;

(c) Date payment is due;

(d) Date after which payment is overdue;

(e) Explanation of the billing method (Submetering, RUBS, hybrid);

(f) Explanation of how charges are determined for current billing period. For ***submetering*** this will simply be a beginning and ending meter read, the volume consumed, and the commodity rate per unit volume. For ***hybrid metering*** this will be a beginning and ending meter read, the (hot or cold water) volume consumed, the calculation for allocating the remaining water volume, and the commodity rate per unit volume. For ***RUBS*** this should include the total volume of water used at the property (as measured by the utility at the master meter(s)), the deductions for common area, the percent of remaining amount allocated to the individual unit, the volume allocated to the unit, and the commodity rate per unit volume.

(g) Utility commodity charges and the billing entity commodity charges (to assure equivalence);

(h) Information for reporting leaks;

(i) Toll free or local telephone number for customer complaints and billing disputes, and a brief description of the dispute resolution process.

Policies for the US Environmental Protection Agency

Recommendation 9 – Property owners should not be subject to the full suite of National Primary Drinking Water Regulations. Property owners should not be subject to the full suite of National Primary Drinking Water Regulations, with attendant registration and monitoring requirements, solely by virtue of their action to adopt a billing system for water and wastewater service, whether submetering or RUBS. The implementation of either billing system is unlikely to change the quality of water provided to customers on the property.

During the course of this study, EPA's interpretation of the requirements of the Safe Drinking Water Act have undergone substantial change on this issue, and the Assistant Administrator's memorandum to Regional Administrators dated December 16, 2003, goes a long way toward adopting this recommendation. The new guidance was drawn to focus on submetering, due to the potential of submetering to support full-cost pricing and the lack of documented water savings attributable to RUBS. EPA should, however, recognize that the value added to a property owner's balance sheet by instituting a billing system – either RUBS or submetering – creates an opportunity to fund the conversion of long-lasting but inefficient plumbing fixtures and fittings to EPACT compliant plumbing. Plumbing conversion will achieve immediate and significant water use reductions in properties of either billing type.

Recommendation 10 – EPA should promote water efficiency in multi-family housing. As part of its "Sustainable Infrastructure Program," the EPA Office of Water should devise a road map for the research, demonstration, and deployment of emerging technologies and practices that can make significant breakthroughs in multi-family water use efficiency. Property owners and their trade associations, water and wastewater utilities, state and local governments, tenant associations, landscape contractors, building contractors, and environmental advocates are all potential stakeholders and partners in such an effort. EPA should help accelerate the transformation of water and wastewater billing practices in multi-family housing through targeted research, technical assistance, model ordinances, voluntary bench-marking, and public recognition. While this report advances our understanding of the benefits of submetering,

the report has also found several other variables that significantly effect the water consumption of multi-family housing. The transfer of utility bill payment to residents is an important foundation upon which to build additional gains in water use efficiency.

Policies for Point of Use Meters

Recommendation 11 – Explore policies for POU standards. The current plumbing codes do not adequately address POU meters on a number of issues. Industry consensus standards are needed for application condition accuracy, installation protocols, product labeling, and maintenance. IAPMO[11], NIST[12], and ASME[13] must evaluate the recommended changes in the plumbing standards.

Based upon the conclusions drawn from the ad hoc committee discussions the following recommendations are offered as standards for POU meters:

Labeling and Identification: Meters shall have the name of the manufacturer, model and serial number, approved orientation positions, and approved temperature ranges.

Manufacturer: Shall specify installation criteria.

Maintenance: Maintenance requirements for POU meters should be consistent with larger utility meters.

Low Battery Voltage: Data transmission needs to be deterministic in that either the data is transmitted accurately or not at all.

Visible Meter Reads: The meter shall have an encoded non-volatile memory. Metered customers shall have ready access to current reading values.

Accuracy: Changes to the current accuracy standards need to be addressed through applications to the appropriate plumbing organizations.

Installation Standards: Use or cite AWWA M6 Manual as reference and follow manufacturer installation specifications. Create a new IAPMO installation standard for water submeters.

[11] International Association of Plumbing and Mechanical Officials
[12] National Institute of Standards and Technology
[13] American Society of Mechanical Engineers