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Keeping Pace with Water and Wastewater Rates

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ABSTRACT

Water and wastewater treatment and delivery are the most capital-intensive of all utility services. The literature indicates that historically underpriced water and wastewater rates have exhibited steadily high growth in the past fifteen years, while the Consumer Price Index (CPI) of water and sewerage maintenance has outpaced the general CPI by an increasingly wide margin. This paper employs a chained analysis method to examine water and wastewater rates for a group of utilities across U.S. census regions between 2000 and 2014. Results demonstrate that water and wastewater prices for this sample group have consistently increased and have surpassed CPI growth since 2006. Current and upcoming challenges facing water and wastewater utilities suggests that rate increases are likely to continue in the foreseeable future.

1. INTRODUCTION

Water utilities have historically priced water treatment and delivery at artificially low levels (Beecher 1999). Low water and wastewater rates for consumers across the United States, enabled by delayed capital improvements and government grant programs, have prompted the widespread perception of potable water as a relatively cheap commodity. Between 2001 and 2013, however, water and wastewater rates[a] rose steeply, sometimes outpacing the Consumer Price Index (CPI)[b] by two and a half times (Black and Veatch 2015). Although rates have risen in the past, sustained, steep rate increases observed in recent years have exceeded previous water and wastewater rate trends.

Many factors have been tied to the rise of water and wastewater rates over the past 15 years. Water utilities face challenges of drought, source switching and diversification, aging infrastructure that often requires substantial capital investment, population growth and shifts to water-strapped areas or urban centers, and declining demand resulting from conservation efforts and technologies. These financial demands are reflected in rising rates, which may be approaching the actual economic cost of delivered potable water. Underlying drivers behind these rate increases are examined in an LBNL report (Stratton *et al.* 2016) and other existing literature.

Among other factors, financially sustainable rates must (1) enable the utility to recover expenditures through revenues, and (2) be affordable to consumers (Beecher & Shanaghan, 1999). Despite recent rate hikes, however, 72 percent of water utilities—up from 64 percent in 2015—reported their existing revenue streams are insufficient to cover their financial obligations, including maintenance, debt service, capital investment, and reserves (Black &

[a] For a residential household consuming 7,500 gallons per month.
[b] CPI data available here: http://www.bls.gov/cpi/data.htm.

Veatch 2016). Additionally, only 9 percent report that no changes are required to provide for cost recovery (AWWA & RFC 2014). Ultimately, the long-term and mounting financial pressures on water utilities suggest that recent patterns of steep rate increases that exceed the economic inflation rate are unlikely to abate in the near future.

This paper (1) discusses water and wastewater[c] rate trends in the existing literature; (2) employs a chained analysis method to calculate the percent change in water and wastewater rates for a sample of several hundred utilities, in comparison to the Consumer Price Index (CPI) for all urban consumers[d]; and (3) briefly examines changes over time in the underlying rate structure for this same sample. The rate trend estimates were determined from biennial surveys conducted by Raftelis Financial Consultants (RFC) and the American Water Works Association (AWWA) (AWWA & RFC 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014). The biennial surveys represent utilities serving from fewer than 500 to more than 9 million customers, and are organized by utility size and location. The chained analysis methodology, further described in section 4.1, allows the largest possible sample size instead of one restricted to utilities that participated every survey year.

The authors examined rate trends by the four U.S. census regions in which participating utilities are located. The authors do not suggest that these rate trends are representative of those in each of the U.S. census regions, as there is no certainty that the mix of sample utilities located in each census region are representative of the region (in terms of size, water source, population density, or other factors). The authors also aggregated the entire sample to depict a “full sample” category, which indicates the average water and wastewater rate change for the entire utility

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[c] Throughout this paper, potable water from the drinking water system is referred to as “water,” and sewage or effluent as “wastewater.”

[d] Throughout this paper, any reference to “CPI” or “general CPI” can be assumed to be the CPI for all urban consumers (CPI-U), unless otherwise noted.

sample. These results are not intended to be a "national" estimate *per se*, as there is no assurance that the utilities in the sample are representative of all water and wastewater utilities throughout the U.S. Section 4.1 discusses methodology and data considerations in more detail.

The authors are not aware of any nationally representative study that tracks changes in water rates, particularly those with publicly available data. Further, it is outside the scope of this paper to explore any underlying drivers behind water and wastewater rate trends (*e.g.*, cost recovery, rising infrastructure costs), or the variation in rate trends as they relate to various utility characteristics (*e.g.*, numbers and types of accounts, water source). Research that examines such issues would make valuable contributions to the literature. The authors believe that despite data limitations, this study's estimates of water and wastewater rate trends for utilities in the AWWA & RFC sample are still informative for water utilities, policymakers, and consumers.

2. BACKGROUND

In the past few decades, the United States has moved from an era of water resource development to one of allocation, while total demand for new water has exceeded new supply in parts of the country (Maxwell 2010, Maxwell 2012). Population migration trends generally have been toward more arid regions and toward urban centers, and protecting stream flows for recreation and wildlife has become more customary to include in water source planning. Meanwhile, options to develop new or alternative water supplies, such as new dams, desalination plants, or long-distance transfers, come at a higher cost. Ongoing and deferred maintenance and expansion of existing infrastructure has also strained financial resources. Such broader factors underlie a recent boost in rates for both raw and delivered water; on average, rates for delivered water have increased five to ten percent per year throughout the past decade, with the annual growth rate increasing over time. One report predicts this trend will continue to accelerate, as regional scenarios show that "sharply increasing water prices that we can empirically observe today in a few selected water-deficient regions are likely to be predictive of trends that will develop in many other parts of the world tomorrow" (Maxwell, 2010).

3. LITERATURE REVIEW

This section summarizes findings from a review of the water and wastewater rate literature and how increases in rates compare to the overall CPI.[e] With an estimated 54,000 community water systems, 14,780 wastewater treatment facilities, and 19,739 wastewater pipe systems (ASCE 2011) in the United States, the water industry is operationally dispersed. Although most communities have experienced rising water rates during the past decade, both rates and rate increases demonstrate great variability. For the 50 largest cities in the United States, the charge (in 2013$) for a monthly consumption of 7,500 gallons of water by residential users in 2013 ranged from a low of $14.74 in Memphis to a high of $61.43 in Seattle. Wastewater rates for the same 7,500 gallon amount demonstrated a wider range, from a low of $12.72 in Memphis to a high of $139.46 in Atlanta (Black & Veatch 2013). High water rates in a region do not always signify high wastewater rates, or vice versa. Of 50 cities studied, Jacksonville ranked 13th for water and 41st for wastewater rates, where a higher rank indicates higher rates (Black & Veatch 2013). The pace of rate adjustments is similarly varied. From 2013 to 2014 water rate increases for use of 100 gallons per person per day[f] ranged from no change in the cities of Phoenix, Santa

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[e] The CPI is one measure of inflation, as consumers experience it in their day-to-day expenses. It is defined by the BLS as "a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services" (http://www.bls.gov/cpi/cpifaq.htm). The goods and services included in calculating CPI are from recent *Consumer Expenditure Surveys* of around 7,000 families. Major groups are food and beverages; housing; apparel; transportation; medical care; recreation; education and communication; and other goods and services (*e.g.,* tobacco products, haircuts). Also included are government-charged fees, like vehicle registration or utility fees, and taxes directly correlated with prices of goods, like sales taxes. The CPI is continually revised along with shifts in demographics and consumer buying habits, and advances in statistical methods.

[f] For a family of four.

Fe, Jacksonville, Columbus, and Atlanta to as much as a 43.1 percent rise in Fresno (Walton 2014).

Although reported rate increases for similar periods vary between sources, several studies provide evidence of recent jumps in water tariffs. The 2014 Water and Wastewater Rate Survey conducted by the AWWA & RFC of 318 water utilities and 231 wastewater utilities nationwide identified an average rate increase between July 2012 and July 2014 of 9.5 percent (water) and 9.7 percent (wastewater) for consumption of 1,000 cubic feet/month (approximately 7,480 gallons/month) (AWWA & RFC 2014). The 2012 AWWA & RFC survey document reported that from 1996 to 2012, the average residential price of water climbed 4.9 percent per year, compared to growth of 2.5 percent in the general CPI (AWWA & RFC 2012).[g] Circle of Blue has performed annual surveys of water rates for single-family residences in the nation's 20 largest cities plus 10 regionally representative cities, tracking trends since 2010. Water charges for a "medium consumption" scenario of a family of four each using 100 gallons per day[h] rose on average 6 percent between 2014 and 2015, and, for a 6-year period, climbed by 41 percent between 2010 and 2015 (LaFond 2015). Black & Veatch's 2013 report estimated a 5.6 percent compound average annual increase in water bills and a 6.1 percent increase in wastewater bills for residential consumers from 2001 to 2013, compared to a 2.4 percent average annual increase in CPI for the same period (Black & Veatch 2013). Fitch Ratings contends that water prices will continue to exceed inflation (Walton 2015). USA TODAY reporters expanded on the Black & Veatch and AWWA & RFC surveys by obtaining similar data from dozens of additional

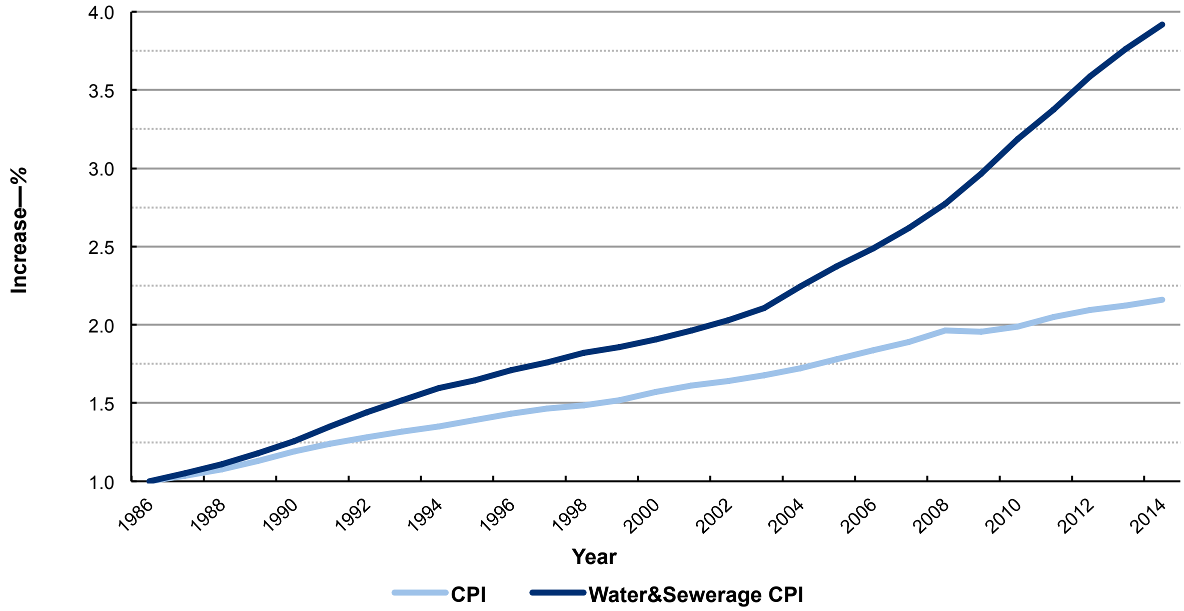
[g] The same estimate was not produced in the 2014 survey.
[h] The Circle of Blue per capita daily consumption is higher than the U.S. Geological Survey's estimated average of 89 gallons (Maupin 2014) and Vickers's estimate of 69.3 gallons per capita daily for a non-conserving home and 45.2 gpcd for a conserving home (Vickers 2001).

municipalities to cover a total of 100 water utilities, representing a mix of small and large utilities in all 50 states. They found that between 2000 and 2012, water rates have at least doubled in 29 percent of the municipalities examined (McCoy 2012).

Similarly, another study finds that recent water and sewer services show marked and consistent price inflation relative to the general CPI for all urban consumers, outpacing other utilities like telephone services, electricity, natural gas, and postage (Beecher 2012). The CPI specific to water and sewerage maintenance services increased from an indexed value of 50 in 1975, diverging from general CPI around 1990 to reach approximately 220 in 2000 and 400 in 2010. A plot of the water and sewerage maintenance CPI since 1983 shows a noticeable increase in the slope in the early 2000s, after which it increases more sharply than before (Figure 1).[i] The general CPI trend for all urban consumers was obtained from the BLS website. Table 1 summarizes cumulative and annual rate increases compared to the general CPI for various time periods from the existing literature. These studies together suggest that during the past decade, water rate increases have eclipsed historical prices of a market basket of goods and services.

[i] Increases as shown in Figure 1 are nominal.

FIGURE 1 CPI for water & sewerage maintenance versus general CPI



CPI trend derived from the BLS, 2014. http://www.bls.gov/cpi/data.htm

TABLE 1 Summary of water and wastewater rate increases from the existing literature[j]

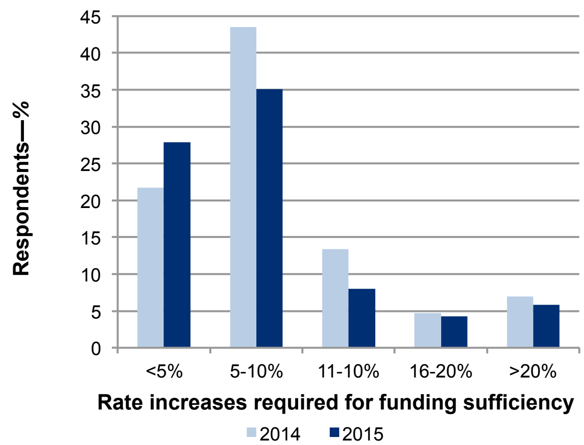
Study	Time Period	Cumulative vs. Annual	Monthly Consumption	Water Rate Increase	Wastewater Rate Increase	Increase in CPI	Real or Nominal
Circle of Blue	2010–2015	Cumulative	100 g/p/d, family of 4	41%	-	-	Nominal
	2014–2015			6%	-	-	
AWWA & RFC	2006–2008	Cumulative	7,480 gallons	12.3%	15.1%	10.9%	Nominal
	2008–2010			13.6%	8.6%	-0.9%	
	2010–2012			13.7%	14.8%	5.1%	
	2012–2014			9.5%	9.7%	4.0%	
Black & Veatch	2001–2013	Annual	7,500 gallons	5.6%	6.1%	2.4%	Not specified

These trends may continue in the foreseeable future. Over half (55 percent) of water and wastewater utilities project that annual rate increases of five percent or greater are necessary over the next ten years (Black & Veatch 2015) to meet utility needs. Water and wastewater utilities reported that annual rate hikes will be necessary to fully cover services and ensure funding

[j] An effort was made to contact surveyors to determine whether these increases were real and norminal. If no response was received, we indicated that it was "not specified."

sufficiency over the next decade, including operation and maintenance, debt service, replacement and renewal, capital improvements, and sufficient reserve funding (Black & Veatch 2015). Figure 2 indicates that while the degree of these projections has declined slightly as compared to 2014, many utilities consider rate increases to be necessary to future financial stability.

FIGURE 2 Annual rate increases required for funding sufficiency by percent of respondents



TRENDS IN WATER AND WASTEWATER RATES

This section analyzes the changes in historical water and wastewater rates calculated from the eight AWWA & RFC water and wastewater surveys performed every even-numbered year between 2000 and 2014. A brief overview of the rate structure for utilities in the sample is included as well. These biennial surveys cover a large and diverse sample of water and wastewater utilities, from those with fewer than 500 consumers to those that serve more than 9 million. The water utilities that responded to the 2014 survey serve approximately 38 percent of the U.S. population; responding wastewater utilities serve about 26 percent (AWWA & RFC 2014). While rate trends for both water and wastewater are explored in this analysis, particular emphasis was placed on water rates (for example, the authors augmented the sample with additional data and conducted a subsample analysis for water only).

Nearly all participating utilities report a municipal governance model: 97 percent and 99 percent of respondents for water and wastewater utilities, respectively (AWWA & RFC 2014). The AWWA & RFC surveys analyze the water and wastewater industries separately. The water survey asks utility respondents to provide the fee consumers pay for a given volume of water. The total consumer tariff is divided into fixed and volumetric charges; separate examination of these two components is outside the scope of this study. The survey reports utilities by state and region, with geographic groupings similar to that of the U.S. Census regions, with the exception that the District of Columbia and Delaware are grouped in the Northeast, rather than the South. For this analysis utilities were grouped by the census regions in which they are located, and water and wastewater rate change results were aggregated at the regional level. As mentioned previously, the sample of utilities located in a particular census region may not be representative of the region as a whole.

4.1 Methodology and data considerations A chained analysis was conducted in order to determine rate increases and examine the trends in water and wastewater prices for the study period (2000 to 2014). The methodology used was nearly identical for water and wastewater prices, with the exception of peak pricing (there was no information on peak rates for wastewater). Water and wastewater prices and the change in rates were calculated using the steps outlined below.

1. Ensure all rates are reported in the same units, dollars per thousand gallons ($/thous-gal) in 2014$ using CPI data from the BLS (BLS 2014). Inflation adjustments factors for each survey year were calculated by dividing the annual average CPI for the given survey year by the annual average CPI for 2014 (U.S. Inflation Calculator). For example,

$$Inflation\ Adjustment\ Factor\ for\ 2000 = \frac{(CPI_{2000})}{(CPI_{2014})}$$

2. For water rates, peak prices were incorporated into the price using the equation below.[k] Year-round values are used without weighting.

$$Water\ Charge = [(\frac{2}{3} \times WaterPrice_{off-peak}) + (\frac{1}{3} \times WaterPrice_{peak})]$$

3. Determine utilities that participate in back-to-back survey years (*e.g.*, 2000 and 2002), and calculate the percent change in the inflation-adjusted water rates between the two years.

$$\%\ Change\ in\ Water\ Rates\ Between\ 2000\ \&\ 2002 = \frac{(WaterPrice_{2002})}{(WaterPrice_{2000} - 1)}$$

4. Divide the number of residential service accounts of a given utility by the total number of residential service accounts in the appropriate census region to derive the weight for each utility.
5. Multiply the percent change in rates for a given utility by its weight in the census region. Sum these results for each census region to obtain the weighted average water/wastewater rate change for utilities located each census region.
6. Calculate average water and wastewater rate changes for the utility sample by weighting results from step 5 by the census region population estimates for the given survey year (BLS).

The AWWA & RFC survey has collected rates for almost two decades and represents a significant portion of accounts served in the US by water and wastewater utilities. However, several matters must be kept in mind when viewing the results. One consideration to note is that over the years, the participant pool has grown to include a greater number of utilities. Another

[k] Peak water prices represent an average of four months of the year across sampled years.

consideration is the set of utilities that are sampled for each year of the survey is not consistent over time. While many utilities have participated in the majority (in some cases all) of the surveys, each survey year is composed of a mix of different utilities. The primary purpose of this paper is to examine how water and wastewater rates have changed throughout the past 14 years, and how these adjustments have compared with the CPI. An evolving sample can produce trends that are not solely reflective of the rate changes throughout the study period, but that are potentially influenced by utilities with generally higher or lower rates entering or exiting the sample year to year. Thus, the authors employed a chained analysis method to reduce the unknown effects on price trends of inconsistencies in the sample between survey years.

As previously mentioned, the chained analysis method determines the percent change in rates for each individual utility that partook in paired consecutive survey years; for example, one that participated in 2002 and 2004, but may have dropped out of the sample in 2006. Maintaining a consistent sample between adjacent survey years helps ensure that changes in rates are not merely an effect of fluctuations in the survey samples. Once each pair of survey years were analyzed individually and the percent change in water/wastewater rates are calculated, the results were chained together to produce water and wastewater price trends from 2000 to 2014. One benefit of this methodology is preserving the largest possible sample size; even if some utilities only participated in several survey years, their data can be included in the rate trend calculations. As such, a uniform sample was not used for the entire analysis as it would have limited the overall sample size (for example, the water and wastewater rate changes calculated between 2000 and 2002 had a slightly different composition of utilities than those used to calculate the rate change between 2002 and 2004). Most utilities, however, are represented in a number of the chained analysis year calculations.

The calculation of various CPI indices by the BLS relies on an analogous chaining method. The Chained Consumer Price Index for All Urban Consumers (CPI-U) chains together indices of one-month price change to construct the long-term index series in order to reflect ongoing changes in consumer purchases on a granular level. In addition, the Consumer Price Index for All Urban Consumers (CPI-U) and the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) are chained on a biennial basis (BLS, 2016). Another index that rests on a chaining methodology is the Bureau of Economic Analysis's price index for personal consumption expenditures, which is linked together on a quarterly basis (Cage *et al*. 2003).

The survey is not designed to be nationally representative. The participating utilities are not necessarily representative of a particular census region or the nation as a whole. The regional estimates simply represent the sample of utilities that opted into the AWWA & RFC surveys and are located in a particular census region. It should be mentioned, however, that these samples tend to be composed of a diverse mix of participating utilities (*e.g.,* large/small and urban/rural). Certain regions had more participating utilities than others: the South is particularly well-represented, and the Northeast under-represented. Once the survey data were filtered to include utilities that participated in back-to-back survey years, some chained analysis years for utilities located in the Northeast had as few as six utilities. Because of this, the analysis was augmented with results from the Massachusetts Water Resources Authority (MWRA's) annual Water Retail Rate Survey (Favaloro, 2014). MWRA results from even survey years between 2002 and 2014 were included. Data from 2000 were not available. While some of these surveys are available publicly, full data for all survey years, as well as the number of residential service accounts for the MWRA's core communities'[1] Annual Statistical Reports (ASRs), were obtained over email from MWRA Library staff. This inclusion of the MWRA data resulted in the addition of 21

[1] Communities that receive water/wastewater service exclusively from the MWRA

utilities in Massachusetts for all survey years of the chained analysis, except the interval from 2000 to 2002. The authors acknowledge that because of this additional data, Massachusetts utilities are over-represented in the Northeast census region, representing the majority of the region. Despite this, however, the authors believe that the inclusion of the MWRA's survey results is beneficial to the overall analysis. Because the number of residential service connections was only available for water rates and not wastewater rates from the MWRA, only water rates in the Northeast were supplemented. Thus, results for wastewater rates in the Northeast have a limited sample size (see Table 2 below for sample sizes of all survey years).

TABLE 2 Number of participating utilities

Chained Analysis Year	MW	S	NE	W	Full Sample
WATER					
2000 to 2002	26	41	13	24	104
2002 to 2004	21	36	32*	21	110
2004 to 2006	32	63	40*	43	178
2006 to 2008	21	56	34*	32	143
2008 to 2010	33	82	33*	48	196
2010 to 2012	36	90	35*	55	216
2012 to 2014	30	66	30*	44	170
WASTEWATER					
2000 to 2002	24	42	6	22	94
2002 to 2004	9	33	6	15	63
2004 to 2006	16	50	9	26	101
2006 to 2008	15	50	9	19	93
2008 to 2010	19	73	7	26	125
2010 to 2012	20	75	7	34	136
2012 to 2014	23	56	6	33	118

*Supplemented with MWRA data

Because the percent change in water or wastewater rates for each utility was weighted by the number of residential service accounts, some populous utilities have significant impact on the rates—particularly for census regions with fewer participating utilities. For example, between 2002 and 2004, Philadelphia accounted for 41 percent of the change in water rates in the Northeast, and Los Angeles, 24 percent of the change in water rates in the West.[m]

[m] For the following results, a populous utility held the following regional weight for the wastewater calculation:
2000–2002: Philadelphia (55% of NE), Los Angeles (20% of W)
2002–2004: Philadelphia (41% of NE), Los Angeles (24% of W)

The full sample results represent the average water and wastewater rate changes in the entire utility sample. These estimates were calculated by weighting the average results for the utility sample in each census region by its corresponding census population for a given survey year. These results are not nationally representative, as they are composed of aggregated census region results that may not be representative. Regardless, the authors assume that in order to produce results most indicative of the "typical" water and wastewater rate trends consumers in the U.S. face, it was appropriate to weight the full sample results by census region population.

Finally, it is important to note that all rates have been adjusted to 2014$; thus all results presented in the following section are real rates or rate increases. Additionally, because all rates are adjusted to 2014 dollars, if nominal rates remained constant between two survey years, they would actually appear as a slight dip in real terms adjusted for purchasing power parity (given inflation).

4.2 Water trends discussion Table 3 presents the weighted average percent change in water rates between each survey for all participating utilities as well as by the census region in which they are located (AWWA & RFC 2000–2014). In accordance with the literature, these results show water rate trends rising consistently year to year. Rate increases are evident at the beginning at the study period and become more pronounced, peaking between 2008 and 2010. Examination of rate changes by the census region groupings shows a marked overall increase in water rates. All census regions also exhibit at least one significant rate hike (defined as an increase of at least 15 percent).

2004–2006: New York (30% of NE)
2006–2008: Columbus (21% of MW), New York (35% of NE), Los Angeles (21% of W)
2008–2010: Cleveland (23% of NE), New York (40% of NE), Philadelphia (24% of NE)
2010–2012: Philadelphia (21% of NE), New York (36% of NE)
2012–2014: Cleveland (22% of MW), Philadelphia (20% of NE), New York (35% of NE)

TABLE 3 Percent (%) change in (real) water rates by region, 2000–2014

Survey Years	UTILITY SAMPLE					CPI
	MW	S	NE	W	Full Sample	
2000–2002	5%	2%	4%	5%	4%	4.5%
2002–2004	1%	2%	14%	0%	4%	5.0%
2004–2006	4%	1%	7%	0%	2%	6.7%
2006–2008	14%	8%	8%	15%	11%	6.8%
2008–2010	17%	15%	20%	17%	17%	1.3%
2010–2012	12%	6%	10%	9%	9%	5.3%
2012–2014	9%	6%	6%	5%	6%	3.1%

The trend in water rates for the full sample was also compared to the general CPI, shown in Figure 3 below. Results are compared to the general CPI rather than the water and sewerage maintenance CPI because this study is intended to shed light on how increases in water rates have outpaced inflation for a market basket of goods and services.The change in CPI between survey years was calculated in the same way as the change in water rates, detailed in step 3 of the methodology. Each point value represents the percent change in either water rates or CPI between the two year period indicated on the horizontal axis (*e.g*., between 2012 and 2014 the percent increase in water rates was 6 percent and the percent increase in CPI, 3 percent). The results indicate CPI increases were slightly higher than water rate increases between 2000 and 2004, and rose even higher between 2004 and 2006. Between 2006 and 2014, however, the reverse is true—water rate increases have remained higher than CPI, with a significant difference in rate increases between the two measures occurring between 2008 and 2010.

FIGURE 3 Average annual (%) change in (real) water rates for full sample compared to CPI

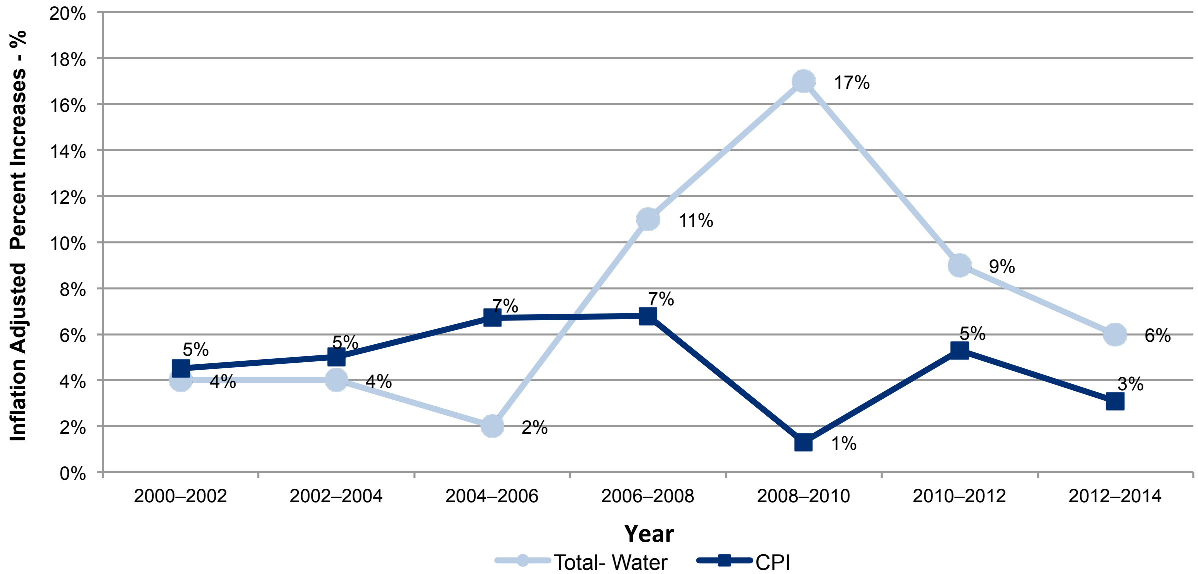
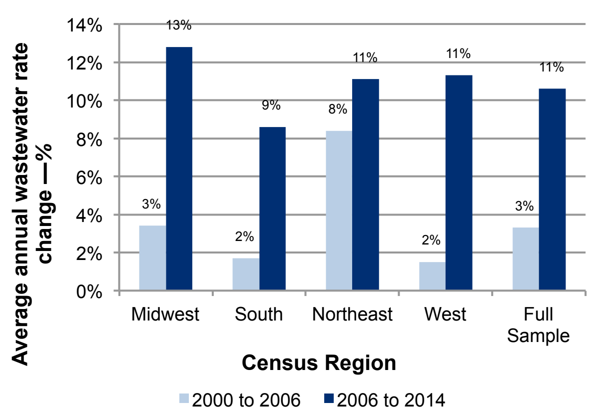


Figure 4 below indicates the average annual rate increase over two time periods: the beginning of the study period (2000–2006), and another for the latter part of the study period (2006–2014). The figure indicates that steeper rate increases have occurred in more recent years. This observation is in line with the data presented in Figure 3 above, as well as Figure 1, which shows a steeper slope for water and sewerage maintenance CPI in more recent years.

FIGURE 4 Average annual (%) change in (real) water rates by region and time period



4.2.1 Water rate subsample results While the primary focus of this study is the trend of water rates, average water rates (per 1,000 cubic feet) were also calculated. Average water rates have been adjusted for inflation and are presented in 2014$. Because many utilities in the AWWA & RFC surveys were excluded from the sample used in the chained analysis on the grounds that they did not participate in back-to-back surveys, the authors developed a subsample of utilities that consistently participated. A consistent sample of utilities that participated in all eight surveys is ideal for the subsample; however, the resulting small sample size compromised other aspects of the analysis. Thus, the subsample was expanded to include all water utilities that had participated in at least six of the eight surveys, or 93 nationally.

This subsample analysis was conducted to provide a check against the chained analysis sample. Average water rates were also calculated for the sample used in the chained analysis. The methodology for determining the subsample results is the same as is outlined for the chained analysis in section 5.1,with the exception of calculating percent change. As is the case with the chained analysis, results from these subsamples are at times drawn from small samples (particularly for the Northeast[n]), and they are not necessarily representative of each census region.

Average water rates for the subsamples are compared to the chained analysis average water rates in Figure 5 through Figure 9 below. Rates are provided for a consumption volume of 1,000 gallons. The charts appear to corroborate the chained analysis rate results, with the full sample, West, Midwest, and South trend lines following very closely and reporting similar linear equations. The Northeast diverges more substantially, but given the extremely small size of the subsample, its results should be viewed more critically. Overall, the analogous subsample trends

[n] MWRA results are not used to supplement the subsample.

substantiate the chained analysis. No similar data were found to augment the wastewater utility representation in the Northeast.

FIGURE 5 Average (real) water rate for utilities in the full sample, 2000–2014

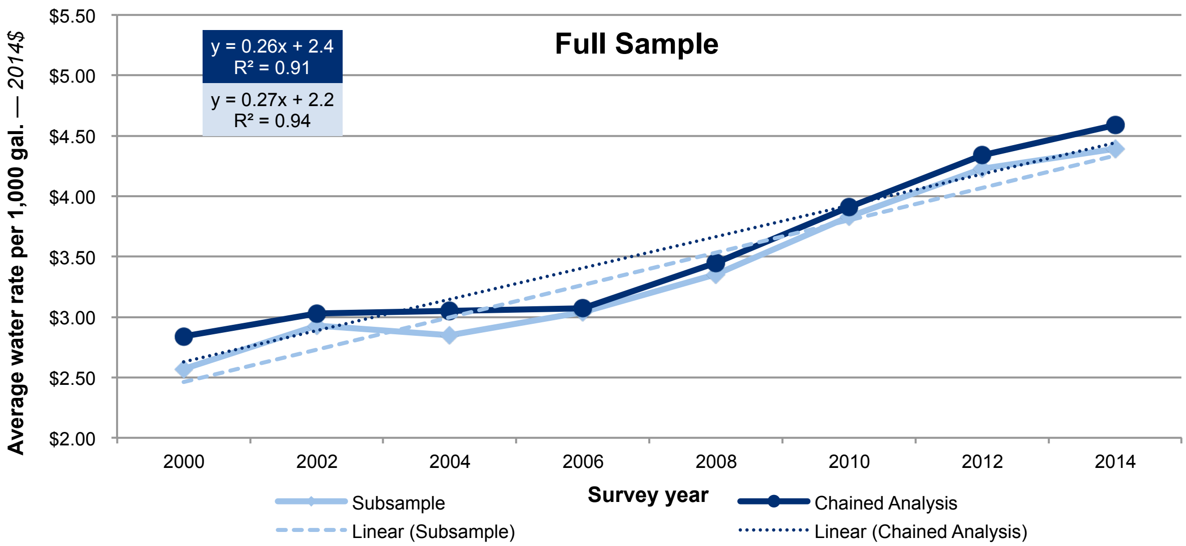


FIGURE 6 Average (real) water rate for utilities in the Midwest, 2000–2014

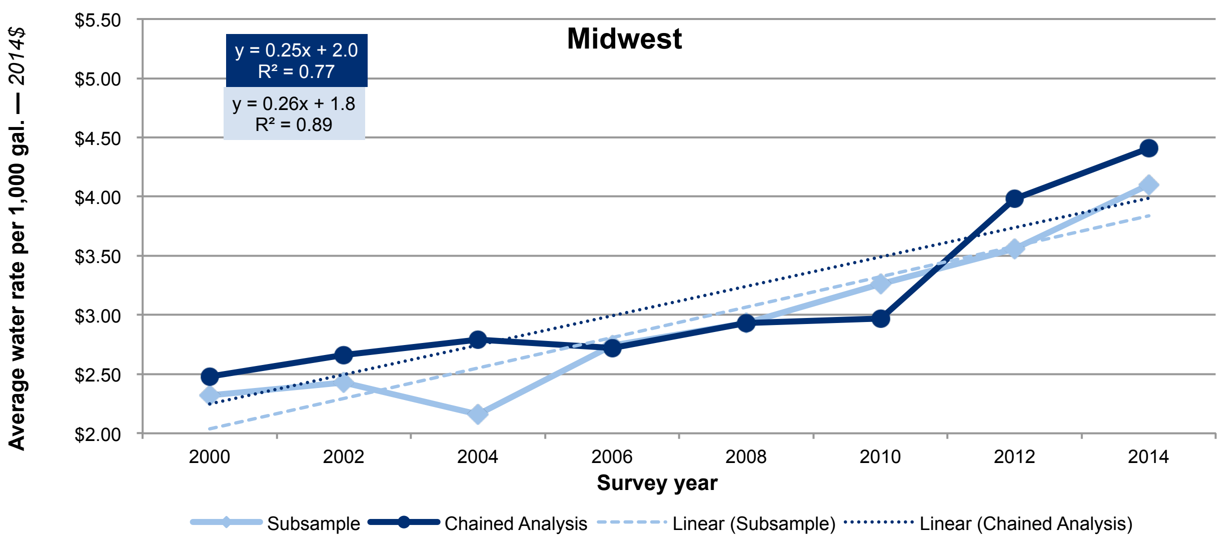


FIGURE 7 Average (real) water rate for utilities in the South, 2000–2014

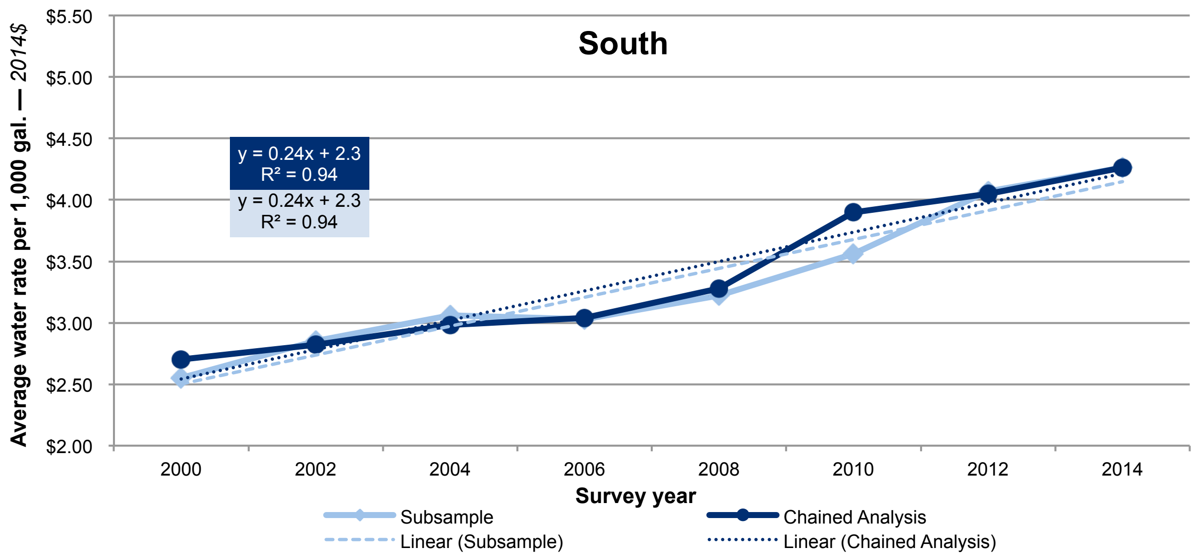


FIGURE 8 Average (real) water rate for utilities in the Northeast, 2000–2014

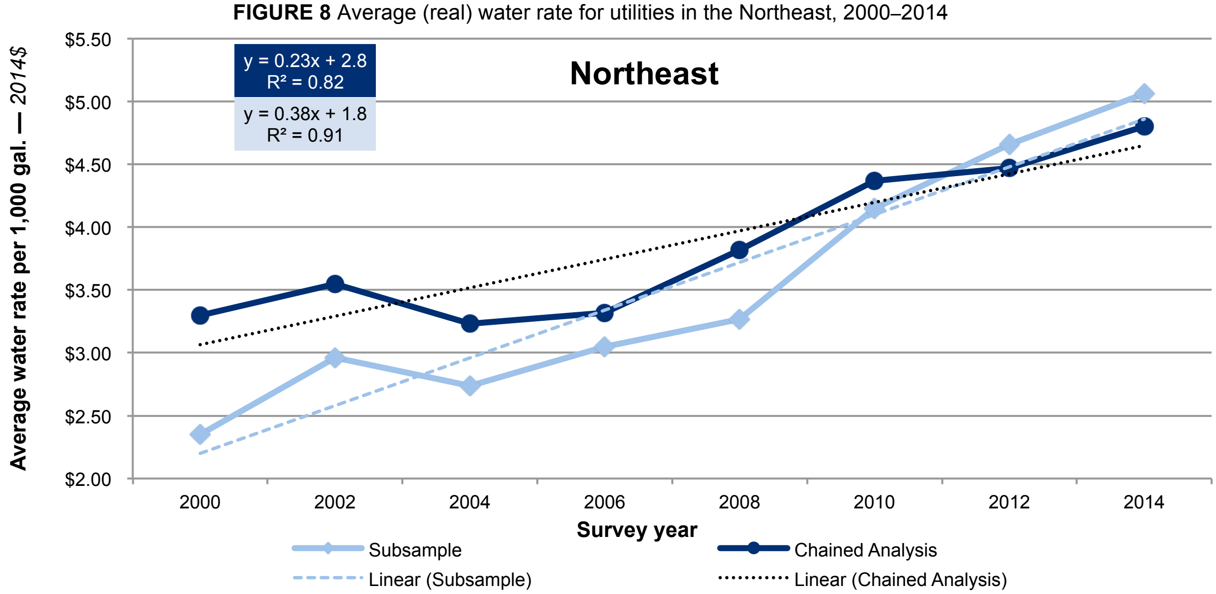
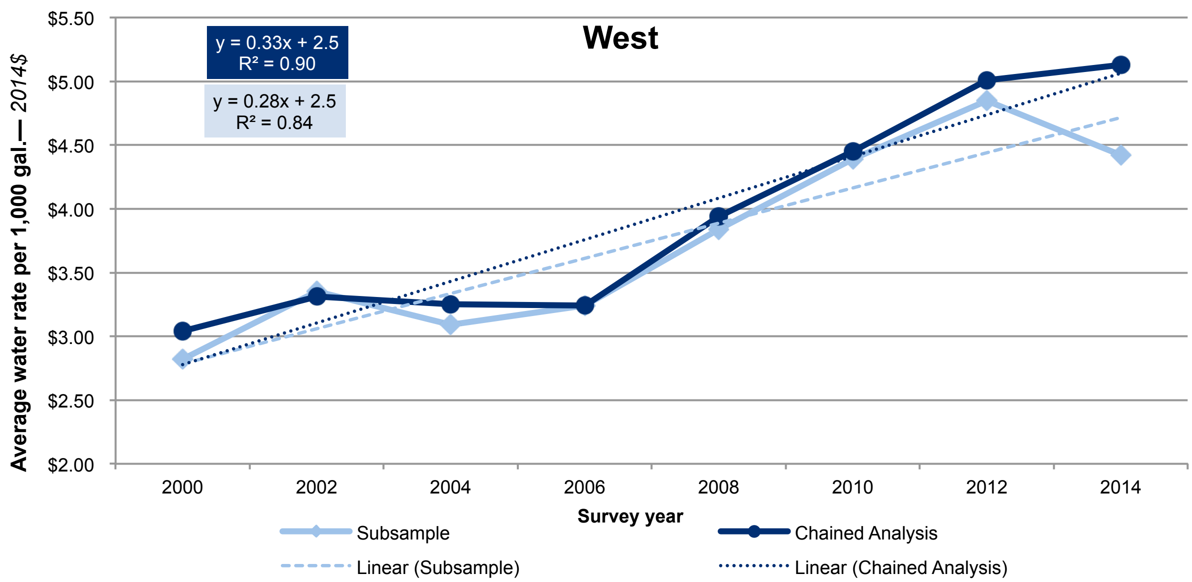


FIGURE 9 Average (real) water rate for utilities in the West, 2000–2014



One inconsistency between the subsample and the chained analysis is the apparent dip in water prices between 2012 and 2014 for utilities located in the West. Rates for utilities located in the West in the chained analysis, as well as in the 2014 AWWA & RFC survey report, indicate an increase in water rates between 2012 and 2014. The subsample, however, is relatively small, with about 20 utilities. Closer examination of the subsample indicated that on a utility-by-utility basis, water rates generally increased between 2012 and 2014. Several utilities with notably higher rates and a large number of residential service accounts participated in the 2012 survey, but not in 2014. These changes in the sample between 2012 and 2014 may explain the discrepancy between the average water rates in the subsample and the chained analysis and survey report.

4.3 Wastewater trends discussion Table 4 below illustrates the observed change (%) in wastewater rates between each survey year. Like water, wastewater rates have largely risen between each survey. It should be noted that the sample size for utilities located in the Northeast is small (see Table 2 for sample sizes) and, therefore, more sensitive to major utilities—primarily in New York and Philadelphia—and should not be taken to be indicative of regional trends.[o] For example, between 2002 and 2004, Philadelphia (which represented 74% of the Northeast region in the chained analysis due to its large survey population) saw a 50% increase in rates, thus driving the estimate for rates increases up to 42%. Like water, the trends show an increase in wastewater rates throughout the study period. Total wastewater rate growth exhibited more variation by region than water rates, however. Additionally, it appears that high rate increases were even more common for wastewater services than water—with several instances of rate increases of 20 percent or more.

TABLE 4 Percent (%) change in (real) wastewater rates by region, 2000–2014

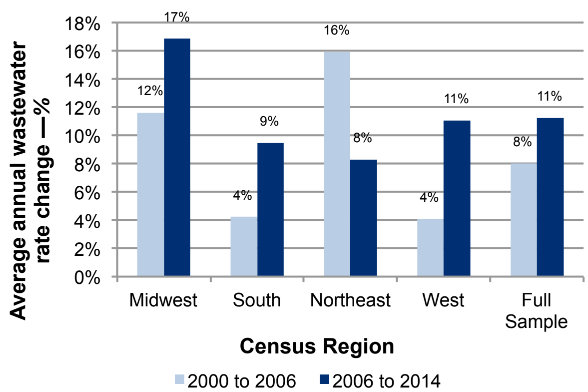
Survey Years	REGION					CPI
	MW	S	NE	W	Full Sample	
2000–2002	-1%	3%	5%	16%	5%	4.5%
2002–2004	26%	7%	42%	-1%	16%	5.0%
2004–2006	10%	3%	1%	-3%	3%	6.7%
2006–2008	20%	5%	7%	13%	11%	6.8%
2008–2010	21%	13%	20%	23%	19%	1.3%
2010–2012	15%	8%	8%	6%	9%	5.3%
2012–2014	11%	11%	-3%	2%	7%	3.1%

Figure 10 below indicates the average annual wastewater rate change for the beginning half of the study period (2000–2006), and the latter part of the study period (2006–2014). With the exception of the Northeast (which had a small sample size), all regions exhibited higher wastewater rate change between 2006 and 2014 than 2000 to 2006. Compared to water rates, however, the differences in the pace of change in wastewater rates between these two parts of the

[o] For the following results, a populous utility held the following regional weight for the wastewater calculation:
2000–2002: Philadelphia (75% of NE), Los Angeles (28% of W)
2002–2004: Cleveland (30% of MW), Philadelphia (74% of NE), Los Angeles (32% of W)
2004–2006: Philadelphia (67% of NE), Los Angeles (25% of W)
2006–2008: Columbus (23% of MW), Philadelphia (64% of NE), Los Angeles (30% of W)
2008–2010: New York (59% of NE), Philadelphia (35% of NE), Los Angeles (21% of W)
2010–2012: Cleveland (24% of MW), Philadelphia (33% of NE), New York (56% of NE)
2012–2014: Cleveland (22% of MW), Philadelphia (36% of NE), New York (58% of NE)

total study period is less stark. Wastewater rates appear to have experienced more significant increases in the earlier part of the study period than water rates. Utilities located in the Midwest, in particular, exhibit an average increase of 12 percent between 2000 and 2006, much higher than any average water rate increase between 2000 and 2006.

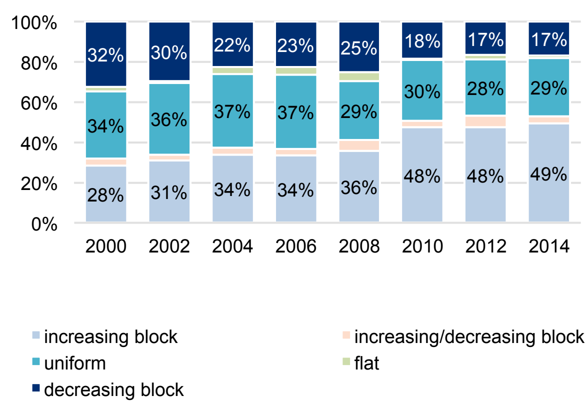
FIGURE 10 Average annual (%) change in (real) wastewater rates by region and time period



4.4 Underlying rate structure As mentioned previously, evaluation of factors potentially impelling water and wastewater rate increases is outside the scope of this paper. Nevertheless, this section presents the underlying rate structure of the utilities in the study sample, as changes in these structures may provide some explanatory power for rate changes over time. Water and wastewater utilities distribute total costs among residential customers in various ways to reflect expenditures, priorities, institutional capacity, and/or billing system technology. Most residential water and wastewater bills are broken down into two separate types of charges: fixed and variable. Typically, variable charges for utilities are structured as (1) *uniform* volumetric rates, where the unit price of water does not change with use but the total price increases as customers use more water; (2) *decreasing block* rates, where customers are charged a lower unit price as their water use rises; or (3) *increasing block* rates, where the unit price of water grows along with its consumption, sending a price signal to conserve water. A small proportion of utilities have no variable charges, instead relying upon a *flat* charge. *Increasing/decreasing block* rates, a combination of increasing and decreasing block rates, are rarer still. Finally, service providers that implement seasonal rates atop any rate structure apply a higher unit price during certain times of the year, typically during months of greater outdoor irrigation.

While the nature of the utility sample limits the authors' ability to assess the impact on varying rate structures on rate trends, we include here an overview of the trends in rate structure over time. Figure 11 displays the prevalence of residential water rate structures from 2000 to 2014 among all participating utilities in the AWWA & RFC survey samples. These data are unweighted and exclude non-responses. The proportion of water service providers relying on a decreasing block rate structure steadily diminishes from 2000–2014, almost by half, while those with an increasing block rate structure make up three tenths of the sample in early years, rising to almost one half in 2010–2014. The authors note that the use of each type of rate structure also differs across regions.

FIGURE 11 Residential water rate structure among full AWWA & RFC sample of utilities



For wastewater service providers in the full AWWA & RFC sample, uniform volumetric rates are by far the most common (ranging from 65–79% over the 2000–2014 period), followed by flat charges (6–18%). Decreasing block wastewater charges became slightly less common over time (10% in 2000 to 6% in 2014), while increasing block rates show a small uptick in occurrence in recent years (9–14%) relative to 2000–2002 (6–7%). On balance, there is a substantial shift towards increasing block rate structures amongst the water utility sample. However, the inherent variability of the sample precludes definitive conclusions about to what extent this contributes to observed rate increases.

4. CONCLUSION

In the earlier years of this analysis (2000 to 2006), water rate increases were roughly on par with, and in some instances less steep than, corresponding increases in the general consumer CPI. These findings strengthen the observation that water and wastewater rate increases in recent years (2006 to 2014), however, have outstripped CPI by margins not observed in previous years. This difference was most dramatic between 2008 and 2010, when the full sample of utilities exhibited an average water rate increase of 17 percent, while CPI grew by only 1.3 percent.[p] Nevertheless, after this peak of water rate increase, rate increases at utilities in most census regions have nearly doubled the CPI. Wastewater rates, in most instances analyzed, exhibited increases that exceed CPI throughout the entire study period. Despite the fact that the AWWA & RFC sample upon which the authors relied is not necessarily representative of census regions or the nation as a whole, this work highlights the variation in water and wastewater rate increases by region.

Future infrastructure needs, shifts and growth in population, and intensifying drought in certain regions of the country—paired with resultant issues of water supply shortages and conservation pricing—are all likely to become more pronounced over the coming years,

[p] The recession of 2007–2009 curbed CPI increases.

indicating rate increases are likely to continue. Rate hikes for water and wastewater will absorb only a part of the financial needs of utilities. This paper indicates a trend of more accelerated rate increases for wastewater than for water, a pattern shown in existing literature (see Table 1). On balance, the literature is clear that against the backdrop of higher rates across the country, rates are markedly variable by region. While it was outside the scope of this paper to explore and quantify various factors assumed to impel water price increases—such as drought, water source, infrastructure needs, changes in population patterns, and conservation effects—measuring the impacts of these drivers on tariffs would improve understanding of the institutional rationale behind these higher rates. Definitive conclusions regarding causation cannot be made due to the changing sample of utilities from year to year. Likewise, the non-representative nature of the sample precludes conclusions regarding water and wastewater rates in each of the four census regions, as well as the U.S. as a whole. Further research and data collection efforts on water and wastewater prices and utility characteristics are necessary to reduce uncertainty of the price trends and contribute to better insight into water and wastewater rate trends.

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