Multi-level Financial Analysis of Residential Water and Wastewater Rates and Rate Setting Practices

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Abstract This paper examines North Carolina water and wastewater utilities' rates and rate structures and their impacts on utility financial health, customer financial capacity, and resource use. This research includes a survey of 360 rate structures and practices, for FY04-05, which together cover over 90% of North Carolinians who receive centralized water and sewer service. Unlike other studies, this investigation places rate data into a model that calculates residential charges/expenditures for water and/or sewer throughout the state for any quantity of water consumed by a household in any community, as opposed to calculating bills for a few discrete quantities of consumption. These rate data are then combined with information from existing databases maintained by other state and federal agencies to compare the modeled residential billings to other indicators, such as the community's median income and utility's operating revenues. Utility managers can use this information to gauge the relative affordability of their services to their customers. The models and analyses project the financial impacts – at the state, utility and household levels – of policy options currently being considered by local governments, state regulators, and funding agencies, such as statewide conservation efforts and changing state and/or federal eligibility criteria for different sources of funding.

Keywords Financial analysis, Rate-setting, Socio-economic analysis, Tariffs, Wastewater, Water

Introduction

North Carolina government-owned water and sewer utilities collected more than $1.4 billion dollars from their customers in 2002[1], yet utilities still report backlogs of funding needs with recent 20-year capital need estimates exceeding $11 billion dollars (North Carolina Rural Economic Development Center, 1998). North Carolina utilities use many different rate strategies and practices under an economic regulatory framework that has few rate setting standards (NCLM, 2002; Hughes, 2003). These different strategies and structures have financial impacts on revenue stability and customer expenditures. Different rate strategies influence resource use differently and, conversely, efforts to impact resource use (for example, conservation) have unique revenue impacts depending on a utility's rate structure and customer base. Furthermore, different rate structures have a fundamental impact on how revenue requirements are allocated among customer classes and customers with different usage patterns. An emerging issue for many utilities is how to mitigate the impacts of rates on low-income customers – a utility's rate structure can play a major role in determining the amount low-income customers must pay to meet their basic needs.

Despite the importance of these relationships, little analytical work has been done to examine rates and rate setting in the context of the impact they have on utility financial health, customer expenditures, and resource use on a statewide basis. This research begins to address that knowledge gap. This paper presents the results from an extended research project to study rate setting practices and the impact rates and rate setting practices have on residential and utility finances throughout North Carolina. This analysis sheds light on the financial impacts – at the state, utility and household levels – of policy options currently being considered by local governments, state regulators, and funding agencies, such as statewide conservation efforts or changing the eligibility criteria for different sources of funding.

This research incorporates rate structures from 360 government-owned water and wastewater utilities with financial and socio-economic analysis. The methodology and application of this project differs from previous rate studies. For the first time, we have created a model that uses rate information to calculate residential expenditures for water and/or wastewater in different household types served by all the different systems. The model enables us to calculate bills based on **any** quantity of water consumed by the household, as opposed to other research which typically computes and compares these figures at discrete consumption levels (e.g. 6,000 gallons/month). The paper then combines rate data with information from existing financial and environmental databases maintained by other agencies to compare household expenditures with 1) social indicators, such as the community's median household income and 2) financial indicators, such as the utility's operating revenue stream.

Methods

Water and sewer service in North Carolina is provided by utilities operating under a range of institutional and ownership models. Measured in terms of customers, government owned utilities including municipal systems, county systems, sanitary districts and authorities dominate the water and sewer market. Non-governmental utilities include both not-for-profit and for profit entities.

All units of government in North Carolina must submit annual financial information (but not rate information) to the state's Local Government Commission (LGC) within the Department of the State Treasurer. For profit utilities are overseen by the state's Public Utilities Commission and have similar reporting requirements. Not-for-profit utilities are not required to submit data to a centralized source.

Rate setting authority for government owned utilities resides with their local governing board. State statutes provide very minimal guidance, resulting in a wide range of rate setting practices throughout the state. For profit water and sewer providers must have all rates and fees approved by the Utilities Commission. The state's for profit water and sewer sector is dominated by a handful of large providers that operate systems across the state. In most cases, these companies maintain a single tariff that covers all of the communities they serve. Financial information is aggregated for these multi-community systems making community by community analysis almost impossible.

The decision regarding what utilities to include in the study was based on several criteria including the number of customers served, the availability of rate and finance data, and the ability to analyze information on a community by community basis. For these reasons, the researchers focused on government owned utilities and large not-for profit corporations. The North Carolina League of Municipalities (NCLM) identified 412 water and/or sewer municipalities in 2005. Using the list of counties, sanitary districts and water/sewer authorities which reported water/sewer financial data to the Local Government Commission for June 2003, 103 "active" non-municipal utilities were also identified (LGC, 2005). In addition, 27 not-for-profits serving a total of over 300,000 people were identified from data collected by the consulting teams working on a statewide water planning effort referred to as Water 2030 (2005). Information on the state's 10 largest for profit water and sewer utilities has been collected and will be analyzed in subsequent phases of the research.

Analysis of rates for fiscal year 2004-05 was conducted on a total of 360 utilities. In order to collect the necessary rate information, the Environmental Finance Center (EFC) collaborated with the NCLM to collect rate schedules for approximately 225 utilities. Follow-up phone calls made by the EFC and NCLM staff to another 150 municipalities that participated in the North Carolina League of Municipalities' 2005 water and sewer rate survey (NCLM, 2005) yielded rate information for another 135 municipalities.

This research represents, to the authors' knowledge, the first attempt to standardize rate information across hundreds of utilities and automate the process of computing the residential customer charges for water and sewer based on continuous quantities. In previous rate surveys (e.g.: NCLM, 2002; Raftelis and AWWA, 2004; see Table 1 for a sample of rate surveys), the common practice of computing customer billings was to either 1) require the respondent of a survey to specify the monthly customer bill for a few

(usually three or four) pre-selected quantities of consumption (e.g.: at 0 gallons, 3,000 gallons and 6,000 gallons), or 2) request the rate schedule from a utility so that the researchers would themselves manually compute the customer bill for a few pre-selected quantities of consumption. Aside from the time-consuming nature of computing the customer billings manually, both methods provide the same fundamental limitation in analyzing results: due to the nature of rate structures, where rates are often not uniform between two consumption quantities, it is impossible to accurately determine the customer billing between the pre-selected quantities simply through linear interpolation. Hence, it becomes difficult to compare different utilities' residential customer billings at consumption quantities other than those pre-selected by design which, for most utilities, do not include their customers' average consumption level. The main advantage of using a computer model to automate the process of computing the customer billings is the ability to almost instantaneously determine the bill for any quantity consumed for hundreds of utilities. This allows for better and fairer comparisons across utilities' bills based on each utility's average consumption level.

Table 1 – A Sample of Rate Surveys in the United States

Survey Authors	Year	Survey Area	Response Rate	Sample Size	Consumption Levels for Calculated Bills (per month)
American Water Works Association (Lafferty & Lauer)	2005	Nationwide	NA	202	7,500 gallons
Draper Aden Associates	2004	North Carolina	25%	78	5,000 gallons
Fitch Ratings	2004	Nationwide	NA	51	Service area average
GA Municipal Association	2005	Georgia	31%	92	5,000 & 10,000 gallons
NC League of Municipalities	2002	North Carolina	65%	247	0, 3,000, 10,000, 25,000, 100,000 & 1,000,000 gallons
Raftelis Financial Consultants, Inc. and AWWA	2004	Nationwide	~30%	256	0, 500, 1,000, 1,500 & 3,000 cubic feet for 5/8-inch meter, plus 4 other non-residential consumption amounts

** 1,000 gallons = 3,785 liters*

The EFC examined dozens of rate schedules and identified the key common variables needed to design the model. Key information included water and sewer variable rates, block ranges and rates, constant or meter-based fixed charges, quantity-based minimum charges and their corresponding quantities, billing periods, and whether a utility charged different rates for customers outside of their service boundaries.

The EFC designed the database and worked with NCLM staff members to enter the necessary information from each rate schedule into the database. The scanned rate schedules varied greatly in form and structure. A spreadsheet model was then developed to compute the water and/or sewer monthly-equivalent billing using the data exported from the database and input variables such as the type of bill (water, sewer or combined), the high or low season, bills for customers residing inside or outside the city limits, the meter size of the residential unit and the quantity of water billed per month for the household. Each input variable is categorical except for the quantity consumed which is a continuous variable. After the user enters in the consumption amount and descriptive variables, the model generates results in output tables for all the utilities. The program hence automates the process of reading and understanding the rate structure for each utility and computing the residential customer billing for any quantity of water consumed for all utilities in the database.

Several important data cleaning steps were required for quality control. The first data cleaning step was a logic check included at the end of data entry into the database. This specified 62 queries, many of which contained several sub-queries, to check that data are entered only in the valid fields based on selections made in other fields. For example, there should not be any data in the fields for block rates if the utility has a uniform rate structure, and consequently the uniform rate must be greater than zero in this case. This step

was important in detecting transcription errors as well as systematic errors to identify where additional staff training was needed. Data cleaning also helped to eliminate errors which would have caused the spreadsheet model to miscalculate the residential customer billings. The quality check step included randomly selecting 20% of the utilities and manually computing their water and sewer bills from their scanned rate schedules for four discrete quantities of water consumed per month (0 gallons, 3,000 gallons, 6,000 gallons and 12,000 gallons), for both inside and outside customers, and comparing the results with the output of the computer model. A 100% accuracy goal was targeted.

The EFC also collected supplemental utility and household financial information that could be analyzed with the rate information. Audited utility financial information for government owned utilities including operating revenues, operating expenses, capital expenses, and outstanding debt data was obtained from the state's Local Government Commission (LGC, 2005). Population and income data were obtained from the 2000 US Census. EFC also obtained recently completed information from the Water 2030 study, which allowed the researchers to cross-check some of their results and gain access to new sources of information such as geographic and watershed location data.

Results and Discussion

Residential Billing Results

Table 2 shows the breakdown of surveyed utilities based on institutional models and service provided. Of the 360 utilities analyzed, 346 utilities served water customers in 358 areas (including semi-autonomous county districts with unique rates) and 280 served sewer customers in 283 areas; the majority of utilities serving both water and sewer customers.

Table 2 – Number of Participating Utilities with Rate Data for FY 2004-2005

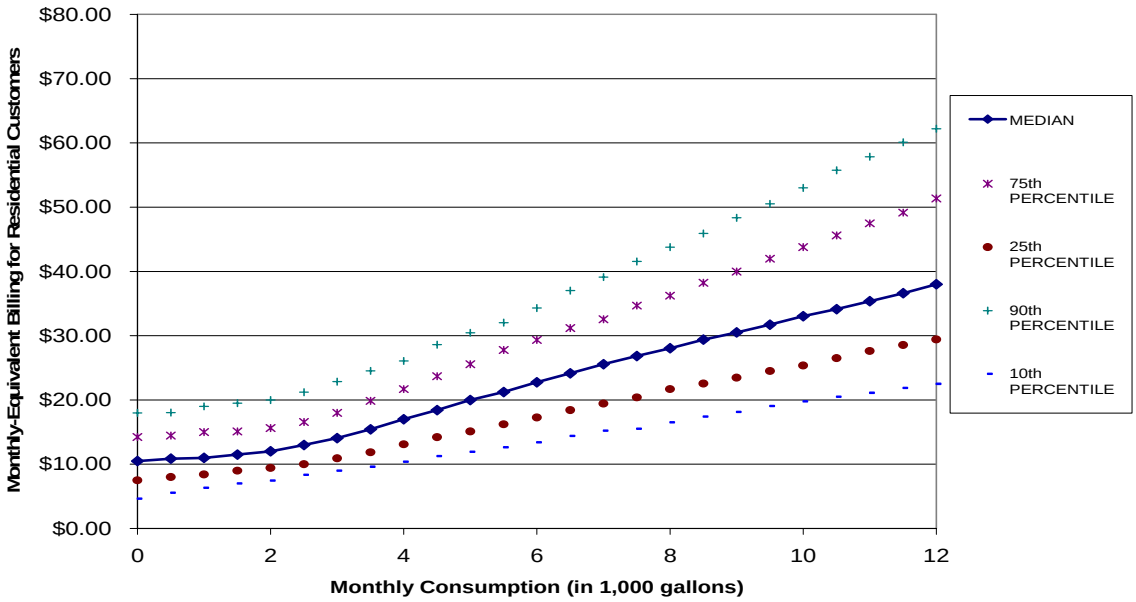
Service Provider	Water and Sewer	Water Only	Sewer Only	Total
Municipality	245	30	9	284
County[1]	13	18	1	32
Authority	3	2	0	5
Districts[2]	4	10	4	18
Not-for-profit	1	20	0	21
Total	266	80	14	360[1]

[1] *Several county systems operated in semi-autonomous county districts with separate rate schedules. There are 11 additional districts served by the county systems and 2 additional areas served by the district systems that have different rates than the rest of the service area of their utilities. These areas are treated as individual records, increasing the number of "rate service areas" to 373 for many of our analyses.*

[2] *Districts include Sanitary Districts, Water Districts and Metropolitan Water/Sewer Districts.*

The model was used to calculate what utilities would charge their customers at different monthly consumption levels from 0 to 12,000 gallons in intervals of 500 gallons. Figure 1 shows the median charge for water by utilities at different consumption amounts. The median amount charged for 3,000 gallons among utilities across the state is $14.08. Furthermore, households served by 90% of the utilities in the sample pay under $22.87 for the same 3,000 gallons. The variation in what utilities charge across the state becomes higher in absolute and percentage terms as consumption increases. At 12,000 gallons per month, 25% of the utilities charge more than $51.38 while another 25% charge less than $29.43.

Figure 1 – Water Utilities' Residential Billing for Inside Customers in 358 NC Communities



** 1,000 gallons = 3,785 liters.*

Financial Impacts

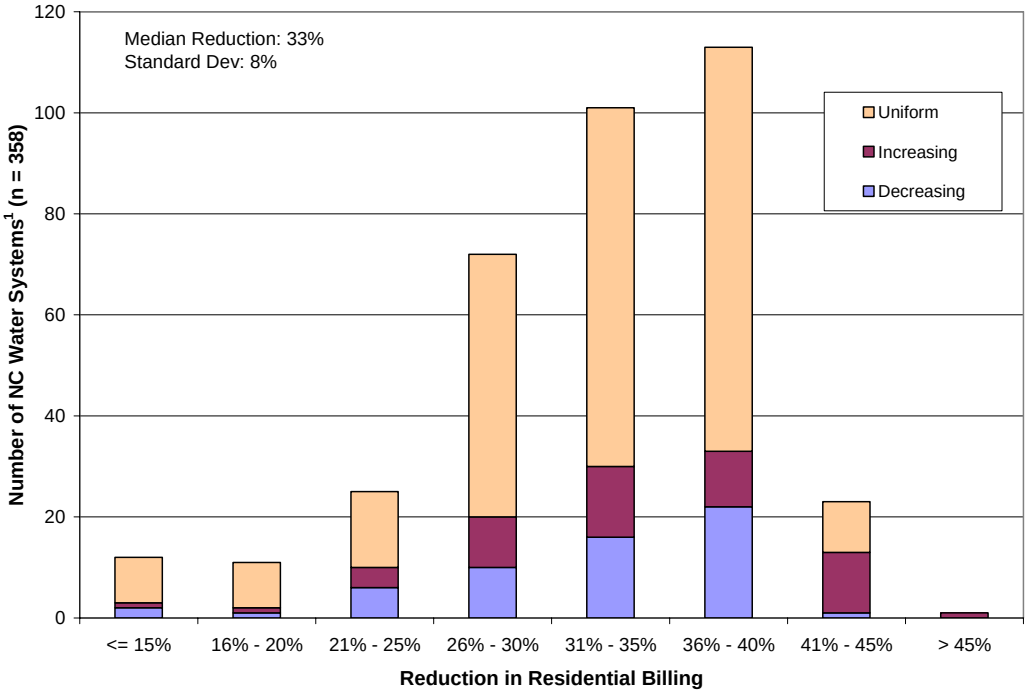
The concept of "full cost pricing" is often cited as an important financial management goal for utilities. The U.S. Environmental Protection Agency (EPA) identifies full cost pricing as one of its four principal pillars to sustainable infrastructure (EPA, 2005). Raw rate information from almost all rate surveys says very little about full cost pricing. Without additional financial information, it is impossible to know whether a utility's rates cover the actual cost it incurs to provide service. Even with financial information, determining the extent to which rates cover full costs is extremely difficult due to diverse reporting practices. Studying the operating ratio (operating revenue/operating expenses) from the audit reports of the LGC provides some insight into the prevalence of full cost pricing in North Carolina. Table 3 shows the operating ratio for a sample of utilities with similar monthly rates – all of which fall into the lower spectrum of rates in North Carolina. The finance data show that not all low rates are created equal and that many of the utilities have set rates at levels that do not cover their financial needs.

Table 3 – Comparison of Operating Ratios for Seven Utilities with Monthly Combined Water and Sewer Billings of $30.00 – $31.00 (at 6,000 gallons consumption per month)

Water and Sewer Billing for 6,000 GPM	Operating Revenues / Expenses Ratio
$30.00	0.86
$30.40	1.11
$30.60	0.91
$30.64	0.88
$30.65	0.91
$30.73	0.77
$30.80	1.02

These models also allow researchers to project utilities' sensitivity to changes in consumption patterns and analyze the effects of different rate structures on the magnitude of revenue changes. Figure 2 simulates the revenue impact of a large drop in consumption from 10,000 gallons/month to 6,000 gallons/month, as might be the case during drought years when conservation mandates are enforced in the summer. Although actual revenue decline depends on the number of residential customers who would be affected by the conservation mandates and on the number of commercial, industrial and other non-residential accounts, this chart provides a rough estimate on the decrease of residential-attributable revenue for different utilities across the state. In general, most utilities will experience a 31-40% drop in revenue for this 40% drop in consumption. However, some utilities may experience a greater drop in revenue while many others have a rate structure in place that provides a buffer to this change in consumption patterns. It is evident that decreasing blocks and uniform rates produce, in general, less of a shock to revenues than increasing block rates. On the other hand, even increasing block rate structures, which are generally believed to cause at least or greater than 1:1 drop in revenues, can be designed in a way that restricts the drop in revenue to a lower ratio. In these cases, the use of minimum and fixed charges, minimum quantities, and block cutoffs greatly affect the vulnerability of a utility's revenues to changes in average consumption.

Figure 2 – Reduction in Residential Water Billing from 10,000 GPM to 6,000 GPM (40% Reduction in Consumption), by Type of Commodity Rate Structure



[1] *Includes 12 county districts that are charged different rates than the rest of the areas served by their utility.*

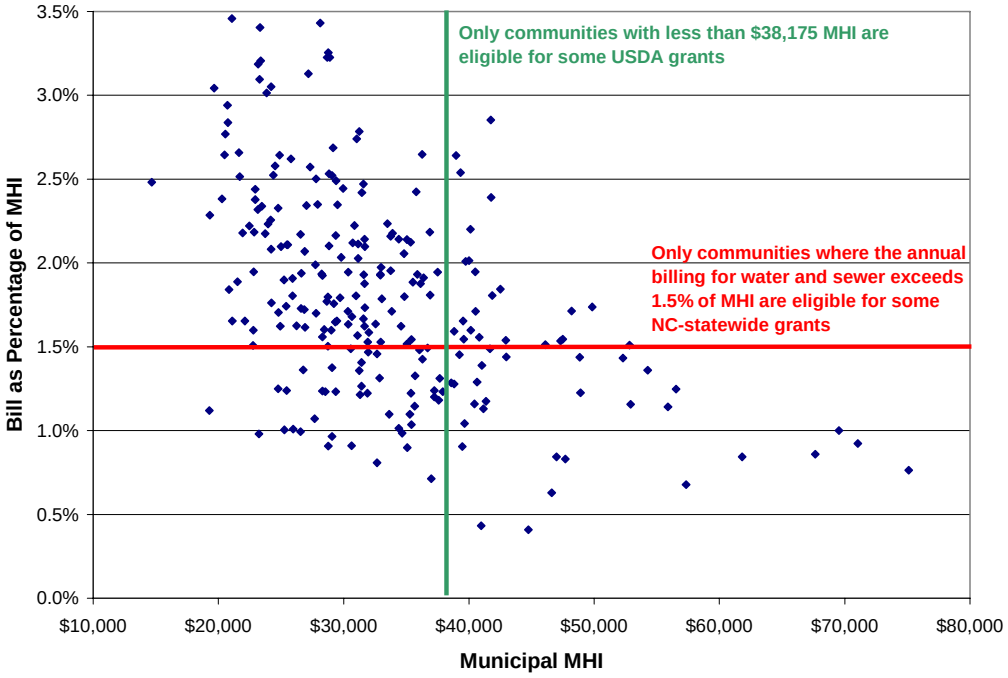
Impact on Low Income Customers

While an imperfect measure of community affordability, the use of water and sewer expenditures as a percentage of a community's median household income remains one of the most common indicators of affordability. Funding agencies set grant criteria based on acceptable (or unacceptable) percentages of Median Household Income (MHI) that are used for water and sewer services. The large sample size in our survey allows us to study the impact of current rates on hundreds of North Carolina communities using these traditional measures.

Figure 3 shows the percentage of median household income currently expended for 6,000 gallons of water and sewer service across the state. Several state grant programs use 1.5% of median household income as the break point for grant eligibility. Until now, the lack of statewide data on actual rates has made determining the impact of this important criterion difficult. The large number of utilities (clearly a majority) that qualify for affordability assistance may be a sign that this eligibility criterion needs to be adjusted. The figure also shows that many "wealthy" communities with median household income levels as high as $50,000 also would qualify for assistance.

Other funding programs use different criteria that can also be tested and analyzed. For example, the U.S. Department of Agriculture's Rural Development Program uses a two tier test for grant eligibility. No utility with a MHI above $38,175 can receive grants (although they are eligible for loans). In addition, a utility must also charge at least $29 per month for 5,000 gallons of water before they are eligible for grants. Of the 285 water providers in our sample with municipal MHI and water rate data, 10 (or 4%) would be eligible for grant funds. This type of analysis provides insights into both household affordability and funding criteria to help meet the needs of the poorest communities in North Carolina.

Figure 3 – Annual Combined Water and Sewer Residential Billing at 6,000 GPM as a Percentage of Median Household Income of the Municipalities within which 248 Utilities Provide Water and Sewer



Conclusion

This paper represents a unique, indepth analysis of rate structures on household billing at multiple units of consumption. Households pay comparatively similar prices for water and sewer service in North Carolina at low levels of consumption, yet there is considerable variation as consumption increases. While many equate higher rates with higher costs, our results among a small set of utilities with similar average household bills indicate that cost recovery appears to depend on other practices besides rate setting. This research also modeled the effects of conservation conditions on utility revenues in the state. While utilities with increasing block tariffs generally face higher reductions in revenue as a result of these conditions, other rate structure factors – such as the use of fixed charges and the design of minimum and block cutoff amounts of consumption – can help shield a utility from dramatic decreases. Finally, our analysis of affordability found that, while there is an approximate inverse relationship between municipal household

income and residential billing as a percentage of MHI, utilities' rate structures exhibit a wide degree of variation in this relationship. This complicates the use of using affordability standards. Differences in state and federal standards for community eligibility result in affordabilty criteria that may exclude some poorer communities (defined by median household income) while including other wealthier ones.

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End Notes

[1] Based on the authors' calculations on data received from the Local Government Commission (2005).

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