STATE OF NORTH CAROLINA
UTILITIES COMMISSION
RALEIGH

DOCKET NO. W-100, SUB 59

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of		
Investigation of Rate Design for	)	COMMENTS OF
Major Water Utilities	)	THE PUBLIC STAFF

NOW COMES THE PUBLIC STAFF North Carolina Utilities Commission ("Public Staff"), by and through its Executive Director, Christopher J. Ayers, and respectfully submits the following comments for Commission consideration.

On March 20, 2019, the Commission issued an Order Establishing Generic Proceeding and Requiring Comments ("Order") in this docket. The Order makes the Public Staff, Carolina Water Service, Inc. of North Carolina ("CWSNC"), and Aqua North Carolina, Inc. ("Aqua") parties to the proceeding and requires them to file initial comments to include "a discussion of rate design proposals that may better achieve revenue sufficiency and stability while also sending appropriate efficiency and conservation signals to consumers." The Order specifically instructs the parties to address in their initial comments (1) "specific objectives that could be achieved from various types of rate structures (for example, but without limitation, irrigation rates, seasonal rates, surcharges when supply is low or in a drought situation, increasing block rates, multiple rate schedules, etc.)"; (2) "the impact on customers' monthly charges"; and (3) "the anticipated impact on efficiency and conservation." In addition to these topics, the Order instructs

CWSNC and Aqua to address several additional issues related to consumption data collected through advanced metering systems. Pursuant to the Order, all parties are to support their comments with references to "policy considerations beyond those arguments advanced in the recent general rate cases," including current North Carolina policy applicable to water utilities regulated and not regulated by the Commission and policies of other states, academic literature, and publications.

On May 10, 2019, Aqua and CWSNC filed a joint motion for an extension of time until May 22, 2019, for all parties to file initial comments, and until June 19, 2019, for all parties to file reply comments. The Commission issued an order granting the motion on May 13, 2019.

Impact of Water Efficiency and Conservation on Revenue Sufficiency and Stability

Under a volumetric rate structure, when consumers decrease their usage, the usage charges and total bill amounts paid to the utility decrease. Changes in individual customers' usage may be due to one or a combination of temporary or long-term factors including, but not limited to, leaks, irrigation, and replacement of older/inefficient fixtures and appliances. Similarly, changes in the total usage of an entire customer base from previous months or years may be the result of variable conditions (such as rainfall and temperature) or more permanent changes (such as higher efficiency fixtures and appliances). These factors can have short- and long-term effects on the sufficiency and stability of revenues. Revenue sufficiency is the adequacy of the total charges collected by the utility to cover the costs of providing service and allow for the opportunity to earn a reasonable rate of return. Revenue stability is the consistency and reliability of the total charges collected by the utility from month-to-month and/or year-to-year.

While a decrease in usage reduces revenues, it also reduces variable expenses such as purchased water/wastewater service, power/fuel, chemicals, and sludge removal. As detailed in the University of North Carolina School of Government Environmental Finance Center ("EFC") Studies of Volumetric Wastewater Rate Structures and a Consumption Adjustment Mechanism for Water Rates of Aqua North Carolina, Inc. ("Sub 363 EFC Report")[1], the short-term variable water and wastewater expenses of Aqua for the test year ending March 31, 2013, made up 11% and 17%, respectively, of operation and maintenance, depreciation, tax, and interest expenses. Furthermore, because privately-owned public utilities rely heavily on well water to meet customer demand, decreased usage results in decreased pumping which, in turn, increases the longevity and reliability of wells.

Decreased usage is a decrease in demand. In addition to the revenue and short-term variable expense effects, decreases in demand can delay or even eliminate the need to undertake capital-intensive projects such as the expansion of plant capacity. For the larger privately-owned public utilities, this can add up to

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[1] UNC School of Government Environmental Finance Center. (Filed in Docket No. W-218, Sub 363A, on March 31, 2016). *Report to the Public Staff of the North Carolina Utilities Commission and Aqua North Carolina, Inc. on the Studies of Volumetric Wastewater Rates Structures and a Consumption Adjustment Mechanism for Water Rates of Aqua North Carolina, Inc,* pages 6 and 11. Retreived from https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=a7fd9d58-46ed-425f-9298-c4419f319a1f

thousands or possibly millions of dollars of savings that would otherwise be booked as rate base recoverable in customers' rates.

In contrast, increased usage will increase revenues and short-term variable expenses. An increase in demand may accelerate and/or necessitate the expansion of existing plant capacity. While increased revenues resulting from increased usage will likely more than offset the increase in variable expenses, the cost of capacity expansion necessitated by increased demand may negatively impact revenue sufficiency until the expansion is accounted for as rate base in the next general rate case.

Descriptions of Rate Structures and Mechanisms

In its 2018 North Carolina Water & Wastewater Rates Report[2] ("2018 Report"), the EFC and North Carolina League of Municipalities ("NCLM") surveyed rate data of 366 water and wastewater providers, 99 water only providers, and 30 wastewater only providers. The 495 utilities, predominantly municipalities (366 or 74%), utilize a total of 550 rate structures.

<u>Base Charge: Usage Charges Ratio</u>

The base facility charge is the amount charged for service before any consumption. The usage charge is the volumetric commodity charge per unit of measurement, typically per 1,000 gallons or per 100 cubic feet (equivalent to 748 gallons). The base facility charge and usage charge can be calculated by

[2] UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*, page 1. See Appendix.

proportionately distributing the service revenue requirement across the number of bills and total consumption during the test year. The base facility charge may vary according to specific factors, such as meter size or customer classification. Base facility and usage charges are inversely related – the higher the base charge, the lower the usage charge and vice versa. In addition, an increase in the base charge increases revenue reliability and sufficiency and reduces the incentive to use water efficiently and conserve. The converse is also true if consumption is highly variable – the higher the usage charge, the lower the revenue reliability. In addition, the higher the usage charge, the greater the incentive to use water efficiently and conserve. The usage charge most commonly used by Commission-regulated water utilities is a uniform volumetric rate, meaning that every metered unit consumed costs the same, fixed amount per unit. For example, if the uniform usage rate is $5.00 per 1,000 gallons, then a bill for 5,000 gallons would cost $25.00, plus the base facility charge.

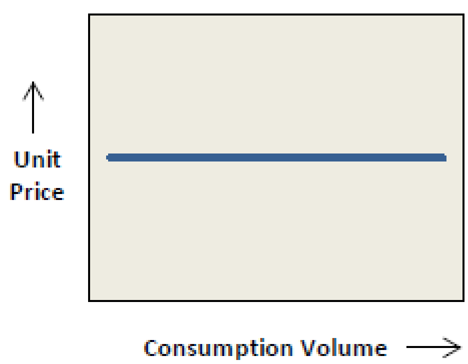

Figure 1. Unit Price versus Consumption Volume for Uniform Rates[3]

[3] Donnelly, K., & Christian-Smith, J. (June 2013). *An Overview of the "New Normal" and Water Rate Basics.* Pacific Institute, page 8. Retrieved from https://pacinst.org/wp-content/uploads/2013/06/pacinst-new-normal-and-water-rate-basics.pdf

Of the 510 residential water rate structures reviewed by the EFC, 58% utilize a uniform rate structure. Of the 425 residential wastewater rate structures reviewed by the EFC, 70% utilize a uniform rate structure. Only two Commission-regulated water and/or wastewater utilities, Aqua and CWSNC, were included in the EFC survey. In general, Aqua utilizes volumetric uniform rate structures for water service and flat rate for wastewater service, while CWSNC utilizes volumetric uniform rate structures for water and wastewater.

Increasing Block Rates

In an increasing block rate structure, the usage rate or unit price increases according to the level of use. For example, if a utility has a two-block rate structure and consumption in the first block, 0 to 10,000 gallons, is charged a usage rate of $5.00 per 1,000 gallons, and consumption in the second block, above 10,000 gallons, is charged a usage rate of $10.00 per 1,000 gallons, then a customer metered for 15,000 gallons would be charged $100 for usage plus the base facility charge. The number of blocks, the size of the blocks, and the magnitude of the unit price difference between blocks can significantly impact the effectiveness of the rate structure in promoting efficiency and conservation.

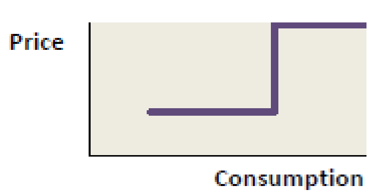

Figure 2. Unit Price versus Consumption Volume for Increasing Block Rates[4]

A more complicated variation of increasing block rates is a budget-based model. In this model, blocks are set based on certain criteria, such as number of people in the household, with the first block representing reasonable indoor usage, the second block for discretionary and/or irrigation usage, and any additional blocks for inefficient usage. Budget-based block rates may require waivers for special circumstances, such as medical needs.

Of the 510 residential water rate structures reviewed by the EFC, 32% utilize an increasing block rate structure. Of the 425 residential wastewater rate structures reviewed by the EFC, 18% utilize an increasing block rate structure.[5] For example, Orange Water and Sewer Authority ("OWASA") utilizes increasing block water usage rates for residential customers to promote conservation. Larger customers, such as businesses and institutions, are charged seasonal water usage rates. In addition to the residential increasing block rates, OWASA utilizes water shortage or drought surcharges. The severity of the water shortage conditions determines the surcharge multiplier applied to the block rate. These surcharges promote additional conservation and to counter revenue instability resulting from decreased usage and weather conditions.

Increasing block rate structures are consistent with marginal-cost pricing principles, meaning that increases in certain unit capacity costs that relate to growing demand and system expansion are captured in the increasing block rate.

[4] Id. at page 9.
[5] UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*, page 1. See Appendix.

For example, costs associated with source development would increase with growing demand, while the increase in demand would lead to the higher price and revenue of an increased block. Due to higher prices for greater consumption, increasing block rates also send a strong conservation signal to customers. During times when a system's capacity may be limited, such as during periods of increased irrigation, the demand increase is captured by a higher cost for above average water usage. This increased cost may encourage customers to focus on conservation measures.

Potential revenue instability is a disadvantage to utilities with increasing block rate structures due to demand fluctuations associated with customer conservation and weather changes. Due to higher rates for greater consumption, large users, such as industrial customers, may bypass a utility with an increasing block rate structure unless there is a rate structure specifically designed for industrial customers. Few, if any, of the Commission-regulated water utilities serve industrial customers. For utility companies that are promoting conservation or limiting the demand on a system, increasing block rates must be designed correctly to be effective. If block rates are not priced accurately or block thresholds are set too high, the average residential customer may not adjust their usage in response to an increased block structure.

Decreasing Block Rates

In a decreasing block rate structure, the usage rate decreases as consumption increases into higher blocks. For example, if a utility has a two-block rate structure and consumption in the first block, 0 to 10,000 gallons, is charged a usage rate of $10.00 per 1,000 gallons, and consumption in the second block, above 10,000 gallons, is charged a usage rate of $5.00 per 1,000 gallons, then a customer metered for 15,000 gallons would be charged $125 for usage. There has been a clear trend in the industry to phase out decreasing block rates, especially by government-owned public utilities, where the rate structure was more prevalent, because it sends a cost signal to promote usage instead of conservation.

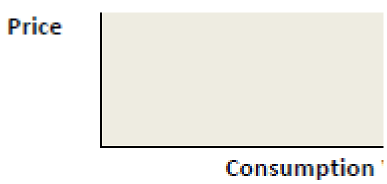

Figure 3. Unit Price versus Consumption Volume for Decreasing Block Rates[6]

[6] Donnelly, K., & Christian-Smith, J. (June 2013). *An Overview of the "New Normal" and Water Rate Basics.* Pacific Institute, page 9. Retrieved from https://pacinst.org/wp-content/uploads/2013/06/pacinst-new-normal-and-water-rate-basics.pdf

Of the 510 residential water rate structures reviewed by the EFC, 6% utilize a decreasing block rate structure.[7] Only 3% of the water structures analyzed in the survey are designed to charge residential customers using less than 15,000 gallons/month decreasing rates as water use increases.[8] Of the 425 residential wastewater rate structures reviewed by the EFC, 5% utilize a decreasing block rate structure.[9] An example of the use of decreasing block rates described in the EFC and NCLM's 2018 Report demonstrates how some utilities design rate blocks in order to distinguish residential customers from the large non-residential customers. By designing rate blocks to distinguish between residential and commercial customers, the utilities avoid using separate rate structures for residential and commercial customers.[10]

Decreasing block rates may encourage economic development and attract customers that use large amounts of water. As described in NRRI's Financing and Ratemaking Alternatives report, certain costs of water provision are fixed by nature (e.g., depreciation of distribution mains) and thus, the pro rata unit cost declines with increasing water consumption.[11] Decreasing block rates allow these savings to be passed along. However, this type of analysis does not account for the

[7] UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*, page 6. See Appendix.
[8] Id.
[9] Id.
[10] Id. at page 7.
[11] Beecher, J. A., Mann, P. C., & Stanford, J. D. (1993). *Meeting Water Utility Revenue Requirements: Financing and Ratemaking Alternatives.* The National Regulatory Research Institute, page 73. Retrieved from http://ipu.msu.edu/wp-content/uploads/2016/12/Beecher-Revenue-Requirements-93-13-Nov-93-1.pdf

incremental capital costs to increase capacity to meet the increased usage.

Disadvantages of decreasing block rates include encouraging consumption over conservation and the difficulty in tracking costs with precision. This difficulty arises because some unit costs (such as those for pumping) tend to increase with an increased volume of service, while other unit costs (such as those for treatment) tend to remain relatively constant with an increased volume of service.[12] Applying cost causation principles, decreased block rates and volume discounts may not be justified.

In 2008, the General Assembly enacted N.C. Gen. Stat. § 143-355.4, which provides, in part:

> (b)To be eligible for State water infrastructure funds from the Drinking Water State Revolving Fund or the Drinking Water Reserve or any other grant or loan of funds allocated by the General Assembly whether the allocation of funds is to a State agency or to a nonprofit organization for the purpose of extending waterlines or expanding water treatment capacity, a local government or large community water system must demonstrate that the system:
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> . . . .
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> > (5) Does not use a rate structure that gives residential water customers a lower per-unit water rate as water use increases.
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> . . . .

<u>Seasonal Rates</u>

Seasonal rate designs apply different schedules of rates, typically usage rates, at different times of the year. Seasonal rate structures commonly set the unit price higher during the summer months when discretionary customer usage is

[12] Id.

at its highest during the year. Irrigation usage can increase the amount of usage by many times over. The EFC and NCLM 2018 Report specifically highlighted that another EFC study[13] of "customers in five cities in North Carolina show[ed] that residents with irrigation meters tend to use, on average, two to seven times as much water outdoors in the summer months as they do indoors." Generally, the irrigation seasons for Commission-regulated water utilities differ by region and even the type of grass grown, with areas growing primarily Bermuda or centipede grass irrigating May through August and areas growing fescue irrigating April through October.

Seasonal rates may be combined with other rate structures to address seasonal fluctuations in water usage. The rationale underlying seasonal rate designs is that increased seasonal use of water increases the capital costs of constructing water systems capable of meeting peak demands.

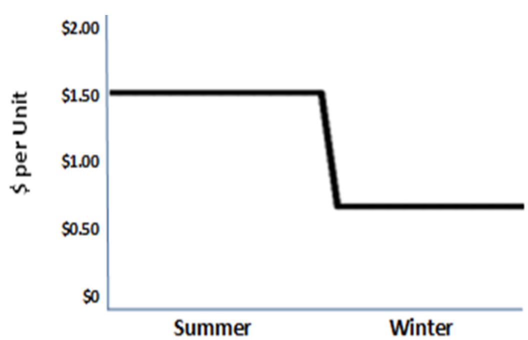

Figure 4. Effect on Unit Price of Seasonal Rates[14]

[13] Wyatt Tiger, M., Eskaf, S., & Hughes, J. A. (2011). Implications of Residential Irrigation Metering for Customers' Expenditures and Demand. *Journal AWWA, 103*(12), pages 30-41. See Appendix.
[14] Adapted from Alliance for Water Efficiency. www.financingsustainablewater.org. Retrieved from https://www.financingsustainablewater.org/building-rates/efficiency-oriented-rate-structures

The EFC and NCLM 2018 Report includes seasonal rates in the “other” rate category that made up 2% of residential water rate structures surveyed.[15] A survey by the EFC of water and wastewater systems in Alabama, Arizona, Connecticut, Georgia, Hawaii, and North Carolina showed that seasonal rates were employed in only six out of 1,879 water rate structures and one out of 1,179 wastewater rate structures.[16]

Advantages of seasonal rate designs include increased operational efficiency and reduced peak demands, which can postpone or eliminate the need to expand capacity.[17] Seasonal rate designs also help to ensure that, if additional capacity is needed due to seasonal discretionary water use, customers with high seasonal consumption bear the bulk of the associated costs.

Establishing seasonal rates that will send appropriate conservation signals is a complex undertaking and can be a disadvantage of seasonal water rates. Prerequisites to effective seasonal pricing include: 1) peak demands that occur consistently during the same season; 2) substantial variations in demand between peak and off-peak periods; 3) determination of installed capacity based on maximum system demand; and 4) the capability of the utility to estimate cost differences between meeting peak and off-peak demands.[18] This, in addition to

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[15] UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*, page 6. See Appendix.

[16] Kirk, E. (2017, May 22). 'Tis the Seasonal Rates: A Quick Look at Seasonal Rates Across Six States. Retrieved from http://efc.web.unc.edu/2017/05/22/tis-seasonal-rates-quick-look-seasonal-rates-across-six-states/

[17] Beecher, J. A., Mann, P. C., & Stanford, J. D. (1993). *Meeting Water Utility Revenue Requirements: Financing and Ratemaking Alternatives.* The National Regulatory Research Institute, page 160. Retrieved from http://ipu.msu.edu/wp-content/uploads/2016/12/Beecher-Revenue-Requirements-93-13-Nov-93-1.pdf

[18] Id. at pages 162-63.

necessary changes to billing practices, may make the implementation of seasonal rates infeasible for some utilities.

Drought/Low Supply Rates

Similar to seasonal rates, a utility can have set criteria such as drought conditions or low supply which trigger surcharges to the basic rate schedule to send a cost signal to customers to curtail discretionary usage. Drought/low supply surcharges may be applied only to the volumetric portion of the rate, and can be designed to target a specific subset of customers. Drought/low supply surcharges may be implemented coincident with usage restrictions such as alternating days of even and odd house number irrigation or a moratorium on irrigation. Drought/low supply surcharges are typically put into effect for a limited period of time and, therefore, do not function as a tool to promote conservation over the long-term. With regard to revenue stability, while drought/low supply surcharges may result in declines in water usage and corresponding declines in revenue, surcharges may offset any revenue declines.[19]

In the state of North Carolina, OWASA and Asheville have adopted drought surcharges.[20] OWASA has water shortage (drought) surcharges that are multipliers to its higher increasing blocks and has three levels of magnitude

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[19] American Water Works Association. AWWA Manual M1 Principles of Water Rates, Fees, and Charges, Seventh Edition, page 180. Retrieved from https://www.awwa.org/portals/0/files/publications/documents/samples/M1WaterRates-ChV3.pdf

[20] Tiger, M. Developing a Drought Surcharge for Conservation and Revenue Stability. Environmental Finance Center, UNC School of Government. Retrieved from https://efc.sog.unc.edu/sites/default/files/Drought_Surcharge_Handout_0.pdf

depending on the urgency of the conditions.[21]

Drought/low supply surcharges have the advantage of being relatively easy to calculate (although surcharges tied to multiple stages of drought may be more complex).[22] However, the implementation by Commission-regulated utilities of drought/low supply surcharges could prove difficult if utilities have systems located in different areas of the state with varying drought conditions.

Irrigation Rates

An irrigation rate can be a separate volumetric rate, usually higher than the standard rate, for consumption measured by an irrigation meter that is separate from the main domestic meter. The use of irrigation meters saves customers the wastewater charges that would apply to water used for irrigation under a combined charge. The rationale for these savings is that water used for irrigation typically does not enter the wastewater system and, therefore, the utility does not incur wastewater transmission and treatment costs for that water.[23]

According to the EFC's and NCLM's 2018 Report, 70 of the 550 North Carolina rate structures surveyed for the report included irrigation water rates.[24]

Because irrigation rates are typically set higher than the corresponding

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[21] Orange Water and Sewer Authority. (2018). Schedule of Rates, Fees and Charges. Retrieved from https://www.owasa.org/Data/Sites/1/media/customerService/rates/18-07-01-summary-rates-schedule.pdf

[22] American Water Works Association. AWWA Manual M1 Principles of Water Rates, Fees, and Charges, Seventh Edition, page 179. Retrieved from https://www.awwa.org/portals/0/files/publications/documents/samples/M1WaterRates-ChV3.pdf.

[23] UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*, page 16. See Appendix.

[24] Id.

standard water rates, they have the potential advantage of sending a cost signal to customers to conserve water. However, achieving conservation is dependent upon achieving the correct relationship between standard and irrigation water rates. A comparison of standard water bills and irrigation water bills performed by the EFC and NCLM as part of their 2018 North Carolina Water & Wastewater Rates Report showed that the irrigation water bill for the volume 15,000 gallons/month was higher than the bill would have been for the same volume under the standard water rate in 47 out of the 70 rate structures reviewed.[25] However, 13 of the rate structures reviewed effectively provided a price discount for irrigation water usage, thereby discouraging conservation.[26] As described above, irrigation rates also ensure that customers are not charged wastewater treatment costs for water they use for irrigation which largely does not enter the wastewater system. However, the implementation of irrigation rates is dependent on the presence of a separate irrigation meter, which, including plumbing costs to extend a water line from the meter and install a backflow preventer, can range from a few dollars to thousands of dollars to install.

In the case of selling reuse water, typically effluent from a wastewater treatment plant, which is distributed through purple pipes, a separate service line is required. In most cases that service line will be metered and charged an irrigation rate or other distinct rate. The commodity charge for reuse water is commonly less than the drinking water unit price to promote usage and avoid

[25] Id.
[26] Id.

storage or other means of discharge.

Volumetric Wastewater Rates

The Commission has historically approved flat rate residential wastewater rates and volumetric commercial wastewater rates. However, CWSNC has Commission approved volumetric residential wastewater utility service rates. Flat rates provide revenue stability, while sufficiency is more dependent on costs of service. Flat rates eliminate entirely any cost signal intended to support and encourage water efficiency and conservation. As such, the Commission's approval of volumetric residential wastewater rates would materially accomplish the goal of balancing revenue stability and conservation of water.

The Commission could establish the wastewater volumetric rates based upon the customers' water meter readings when the utility provides the residential customer both water and wastewater utility service. If a government entity or authority provides the water utility service, the Commission-regulated wastewater utility may be able to obtain the monthly water meter readings from the government entity or authority. Historically, many of these entities have either been unwilling to or have sought compensation for, sharing customers' information and meter readings, thereby potentially outweighing any benefit. If the Commission-regulated wastewater utility cannot obtain those monthly water meter readings, or the customers receive water from their private wells, the Commission can approve a reasonable monthly flat rate for those customers.

The Sub 363 EFC Report stated that, of the 393 government-owned utilities with wastewater rates surveyed in the study, 391 or 99% charged volumetric wastewater rates in January 2015. A review of Rate Table 3 in the EFC Water and Wastewater Rates and Rate Structures in North Carolina as of January 2019[27] reflects a total of five government owned wastewater utilities with residential flat rates as shown in Exhibit 1 to these comments. All five are small wastewater systems, with four of the five systems servicing a population of less than 1,000.

The Commission, in approving volumetric residential wastewater rates, would decide whether to establish a cap whereby customers would not be charged for wastewater beyond a cap established for metered water gallons. There are currently four government-owned wastewater utilities in North Carolina with a monthly wastewater cap, as shown in Exhibit 2 to these comments. Exhibit 2 shows rate structures for government-owned wastewater utilities serving populations above 80,000, plus Aqua and CWSNC. Eleven of the fifteen government-owned utilities listed have uniform volumetric wastewater rates without a cap. A residential volumetric wastewater rate schedule with or without a cap would encourage prudent use of water and conservation.

Consumption Adjustment Mechanism (CAM)

In the most recent general rate case proceedings for Aqua (Docket No. W-218, Sub 497) and CWSNC (Docket No. W-354, Sub 360), the utilities proposed a CAM be adopted and implemented by the Commission. The details of the proposals can be found in the rate case applications filed in those dockets.

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[27] UNC School of Government Environmental Finance Center, North Carolina DEQ Division of Water Infrastructure, and North Carolina League of Municipalities. (2019). Water and Wastewater Rates and Rate Structures in North Carolina as of January 2019. Retrieved from https://efc.sog.unc.edu/sites/default/files/2019/NCLM_EFC_AnnualW%26WWRatesTablesExcel_2019.pdf

The CAM is a rate adjustment mechanism that balances the risks and impacts on customers and shareholders from variances in the levels of consumption, either higher or lower, from the levels of consumption that were used to set rates. The mechanism "decouples" a utility's revenues from its sales, thereby removing the utility's disincentive to encourage conservation of the commodity being sold. Rates are allowed to change with consumption to more closely meet the set revenue requirement. Other names and terms for the CAM include "decoupling," "revenue stabilization," "water revenue adjustment mechanism," "lost revenue adjustment mechanism," and "conservation adjustment." These mechanisms are used for many gas utilities, and are becoming more prevalent for water utilities.

Mechanisms for variance in consumption/revenues have been adopted by legislation and/or state commissions and are being utilized by privately owned public utilities in at least seven states, most of which were adopted in recent years.

California established a pilot program in 2008 that is in use today.[28] It is a Water Revenue Adjustment Mechanism (WRAM) with a Modified Cost Balancing Account (MCBA). The WRAM corrects for the difference between the revenue requirement from the last rate case proceeding and the actual revenue recovered through rates. The MCBA corrects for the difference between the approved variable costs from the last rate case proceeding and the actual variable costs.

[28] California Public Utilities Commission, Order Instituting Investigation to Consider Policies to Achieve the Commission's Conservations objectives for Class A Water Utilities, Decision 08-02-036 (issued February 29, 2008), additional Decision 2012. Retrieved from http://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/79434.htm

The MCBA offsets some of the difference in the WRAM, and the two are used together to calculate a surcharge.[29]

Connecticut passed legislation in 2013 which requires its Public Utilities Regulatory Authority to include a revenue adjustment mechanism in final decisions for water company rate cases. Concurrent with implementation of a revenue adjustment mechanism, the statute also required the Authority to establish an earnings sharing mechanism that provides for any earnings in excess of the allowed return on equity to be shared equally between ratepayers and shareholders.[30]

Maine passed legislation in 2015 stating that "the commission may establish or authorize a reasonable rate-adjustment mechanism to decouple water utility revenues from water utility sales through revenue reconciliation when changes in sales are due to a change in the number of customers or a change in the volume of consumption." [31] It further states that "to the extent . . . risks are transferred between the utility and its customers, the Commission shall consider the effect of the transfer of risk in determining a utility's allowed rate of return."[32]

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[29] California Public Utilities Commission, Decision Addressing Amortization of Water Revenue Adjustment Mechanism Related Accounts and Granting in Part Modification to Decision, Decision 12-04-048 (issued April 30, 2012). Retrieved from http://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/165222.htm

[30] Conn. Gen. Stat. § 16-262y (2013). Retrieved https://law.justia.com/codes/connecticut/2013/title-16/chapter-283/section-16-262y/

[31] 35-A M.R.S. § 6102-A. Retrieved from http://legislature.maine.gov/statutes/35-A/title35-Asec6102-A.html

[32] Id.

Missouri passed legislation in 2018 that provides for decoupling tools, but the state has no real experience in the use or results of the legislation.[33] At this time the commission has not approved the mechanism for a water utility. The commission has approved a weather stabilization mechanism for two gas companies, but with a corresponding drop in return on equity to reflect the reduced risk.

Nevada adopted a regulation in 2014 that "provides for the recovery by water and sewage utilities of certain costs relating to: (1) the anticipated effects of implementing a plan of water conservation, including . . . the anticipated effects of decreased consumption of water by customers of the utility as the result of the implementation of a plan for water conservation or the charging of rates to encourage water conservation; or (2) the provision of service without respect to the difference in the quantity of water actually sold by the utility by taking into account the adjusted and annualized quantity of water sold during a test year and the growth in the number of customers of the utility."[34]

New York authorized a "Revenue Reconciliation Clause" as part of a projected three-year rate case for United Water New Rochelle Inc. in 2000. The annual reconciliations permit the utility to recover or refund from metered customers the net variances in metered revenues, property taxes and production

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[33] § 386.266 R.S.Mo. Retrieved from http://revisor.mo.gov/main/OneSection.aspx?section=386.266&bid=35101&hl

[34] Adopted Regulation of the Public Utilities Commission of Nevada, LCB File No. R078-14, effective December 22, 2014. Retrieved from https://www.leg.state.nv.us/register/2014Register/R078-14A.pdf

costs associated with purchased water, power and chemicals.[35]

Pennsylvania passed alternate ratemaking legislation that was signed into law on June 28, 2018, which allows for decoupling mechanisms.[36] The Pennsylvania Utilities Commission issued an Implementation Order in Docket No. M-2018-3003269 on April 25, 2019.[37]

Triggering Levels

Some of the statutes/rules/policies referenced above include a triggering level or variance threshold that must be met before an adjustment in rates is considered. Differences between the actual consumption or revenues and the levels determined in a general rate case proceeding would have to be greater than the predetermined triggering level prior to the consideration, calculation, and implementation of an adjustment. For example, if the average customer usage was approved as 5,000 gallons per month during the general rate case, and in the following year the average customer usage was 5,100 gallons per month, a surcredit would be triggered because the variance exceeds the threshold of 1%.

Adjustments for Variable Costs

Some of the statutes/rules/policies referenced above include adjustments

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[35] State of New York Public Service Commission, Case 04-W-1221, Order Establishing Four-Year Rate Plan, issued and effective August 24, 2005 and State of New York Public Service Commission Opinion No. 00-10, Opinion and Order Concerning Rates and Related Issues, issued and effective August 21, 2000. Retrieved from http://documents.dps.ny.gov/public/MatterManagement/MatterFilingItem.aspx?FilingSeq=10786&MatterSeq=24118

[36] 66 Pa.C.S. § 1330. Retrieved from https://www.legis.state.pa.us/cfdocs/legis/LI/consCheck.cfm?txtType=HTM&ttl=66&div=0&chpt=13&sctn=30&subsctn=0

[37] Pennsylvania Utilities Commission Tentative Implementation Order for Act 58 of 2018. Retrieved from https://www.pabulletin.com/secure/data/vol49/49-19/735.html

in calculating any surcharge to account for variable costs that change with changes in consumption. If consumption decreases, a savings in expenses such as chemicals and power would be expected. If consumption increases, additional expenses would be expected.

Adjustments for Customer Growth

In any given period of decreased average consumption, customer growth could offset the lower consumption revenues. In a year of increased average consumption, growth would contribute to the utility potentially earning above and beyond the Commission's approved rate of return. Customer growth should be considered in any calculation of a CAM surcharge.

Transfer of Risk and Return on Equity

Implementation of a CAM or similar mechanism transfers some risk from the utility to the customer. During a general rate case proceeding when a CAM is being implemented, the Commission should consider this reduction in risk to the utility when determining an appropriate rate of return. In Maine, the statute specifically states that "the Commission shall consider the effect of the transfer of risk in determining a utilities allowed rate of return."

Effect on Customer Bills

California appears to be the state with the most prevalent use of a decoupling mechanism, due in large part to the aggressive water conservation measures in the state. Due to the large reductions in consumption, the mechanism has resulted in significant increases in rates as a result of the surcharges. Some districts had under-collections of over 20% of the last authorized revenue requirement in a year, and cumulative surcharges representing multiple years of large under-collections.[38]

In the Sub 363 EFC Report, a test of the impact of a proposed CAM on Aqua customers based on consumption data from 2011 to 2015 showed a steady increase in rates from a CAM surcharge as water consumption decreased. The report also noted a leveling off of Aqua's average customer usage at around 5,000 gallons per month.

Special Considerations for Commission Regulated Utilities

Privately-Owned Public Utility Implications

The Commission regulates a total of 99 water utilities. The water systems are located throughout North Carolina from the Outer Banks, coastal Carteret, Onslow, Pender and New Hanover counties, to the Piedmont and mountains including, but not limited to, Cherokee, Macon, Transylvania, Henderson, Buncombe, Avery, Watauga, and Ashe counties. Some Commission-regulated water utilities purchase bulk water from a nearby municipal, town, county, or authority.

All the Commission-regulated water utilities that produce their water supply obtain the water from drilled water wells. None of the Commission-regulated water

[38] California Public Utilities Commission, Decision Addressing Amortization of Water Revenue Adjustment Mechanism Related Accounts and Granting in Part Modification to Decision, Decision 12-04-048 (issued April 30, 2012). Retrieved from http://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/165222.htm

utilities have surface water intakes. In contrast, virtually all of the larger government-owned water systems produce their water supply from surface water sources.

The water storage of Commission regulated water utilities is a material component of the utility's capability to meet system demands including irrigation. There are few Commission regulated water utilities with elevated water storage tanks. Aqua has elevated water storage tanks on just nine of its more than 700 water systems. Those systems are: Bayleaf/Leesville Master, Medfield, Brookwood, Chapel Ridge, Hasentree, Woodlake, Castle Bay, LaGrange, and the Diamond Head Master. In addition, Aqua has several systems in the mountains with ground storage tanks at or near the top of a mountain that function similar to an elevated water storage tank.

CWSNC has elevated water storage tanks at Whispering Pines, Brandywine, Bradfield Farms, Bear Paw, Abbington, Carolina Trace, Carolina Forest, Groundview, Quail Ridge, and Woodrun Master Systems. CWSNC also has mountain top ground storage tanks on its numerous mountain water systems.

The remaining Aqua and CWSNC and other Commission-regulated water systems have hydropneumatic water storage tanks. These are air volume controlled pressure tanks of relatively small size, predominately 5,000 gallons, and a lesser number 10,000 gallons, for larger systems served by Aqua and CWSNC. Smaller water companies with smaller systems may have smaller hydropneumatic tank sizes of 1,000, 2,000, 3,000 gallons, etc.

Hydropneumatic water storage tanks have only a 25% effective usable water supply storage. A 5,000 gallon hydropneumatic tank has 1,250 gallons of effective usable water supply storage, and a 2,000 gallon hydropneumatic tank has 500 gallons of effective usable water supply storage.

The hydropneumatic storage plus the well pumping supply must meet peak demands, including irrigation. Meeting irrigation demands has become much more problematic with the installations of in-ground residential irrigation systems, which became increasingly prevalent beginning in the early 1990s. These in-ground irrigation systems are usually set to operate on time clocks, either with or without moisture sensing controls.

Each in-ground residential irrigation system with a 5/8' x 3/4" water meter can use up to 20 gallons per minute depending upon the water system pressure. In 60 minutes, three in-ground residential irrigation systems can consume 2,700 to 3,600 gallons of water for irrigation only. With a 5,000 gallon hydropneumatic water storage tank (1,250 gallons effective storage) and a 30 gpm well supply to serve 45 residential customers (0.667 gallons per minute per customer), the effective storage of 1,250 gallons plus well pumping 30 gpm x 60 minutes = 1,800 gallons, results in a combined total supply of 3,050 gallons compared to the irrigation demand of 2,700 to 3,600 gallons. Basically, that leaves zero gallons of supply for the other 42 residential customers. These problems are accentuated in hilly areas in the Piedmont and mountains where customers at lower elevations still have water and water pressure when customers at higher elevations have no water.

A recent example is the KRJ Utilities, Inc., general rate case in Docket No. W-1075, Sub 12, with customer testimony at the June 20, 2018 evidentiary hearing relating to the Southern Trace water system in southern Wake County. Customers on the higher elevations testified to experiencing outages while other customers on lower elevations were irrigating lawns with in-ground residential irrigation systems.

The North Carolina Department of Environmental Quality Public Water Supply Section requirement for well pumping supply of 0.556 gpm per residential customer was developed in the early 1970s, and was designed for inside-the-residence water usage, not irrigation, and certainly not the significant demand of residential in-ground irrigation systems.

For Commission-regulated water utility systems that do not purchase bulk water from government owned utilities, there is no backup water supply available. It is extremely rare for government-owned water systems to provide Commission-regulated water companies an emergency backup water supply as the City of Raleigh recently did for Aqua's Stonehenge/Wildwood Green water system. In that case, Raleigh already had water mains adjoining Aqua's water mains.

When the demand exceeds the well pumping supply and effective storage capacity, the customers can experience low pressure, degradation of water quality, and/or a complete outage. There are no interconnected water grids similar to electric grids from which electric utilities can purchase power as needed. The service areas of Commission regulated water companies, which are typically very small or fragmented with large widespread footprints, are significantly different from the densely concentrated service areas of towns, cities, counties, and authorities. Drought and seasonal rate structures would be much more complicated to implement for Aqua or CWSNC because rainfall, temperature, soils, and landscaping conditions vary drastically across the state and such rate structures could not be applied across all uniform rate customers.

On October 24, 2007, the Commission issued its Order Requiring Curtailment of Nonessential Water Usage in Docket Nos. W-100, Sub 46, and WR-100, Sub 6.[39] On May 1, 2008, the Commission issued its Order Requesting Comments on proposed modifications to the water restrictions.[40] On May 23, 2008, the Commission issued its Order Modifying Restrictions Concerning Nonessential Water Usage and Requiring Notice, which set forth water usage restrictions and enforcement measures based on county level drought severity classifications maintained by the North Carolina Drought Management Advisory Council.[41] In addition, the Commission has historically quickly issued non-essential restriction use orders when Commission regulated utilities have made prudent and reasonable requests. Water usage restrictions during different levels of drought severity discourage nonessential or discretionary water usage. The customer water supply issues during droughts normally arise from excessive lawn and shrub irrigation and the failure of the water utilities to enforce the Commission's drought policies, in the W-100, Sub 46, Order dated May 23, 2008.

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[39] Retrieved from https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=bf867c74-5782-4037-a60d-69a8ed80ac08
[40] Retrieved from https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=9bdcb30e-8f61-459d-8146-7f03452f97fc
[41] Retrieved from https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=f108d306-3b46-46ce-bba1-b6ad2b950134

In the past, water utilities have stated that enforcing mandatory water restrictions is challenging, with customer disconnection being the most effective means of securing compliance. Advanced metering systems give the utility the ability to access hourly meter reading data to verify reports of noncompliance with mandatory water restrictions.

On page 4 of the Sub 363 EFC Report, the Public Staff posed a number of questions that the EFC provided responses to, including:

> 1. What percentage of North Carolina wastewater utilities surveyed by the UNC EFC bill volumetric wastewater, excluding those regulated by the North Carolina Utilities Commission?
>
> The EFC has data on the January 2015 wastewater rates charged by 392 local government utilities and 1 not-for-profit utility not regulated by the North Carolina Utilities Commission. These rates were collected from the (by then) latest annual rates survey conducted by the North Carolina League of Municipalities (NCLM) and the EFC. Of the 393 utilities with wastewater rates, 391 (99%) charged volumetric wastewater rates in January 2015.

On page 41 of the Sub 363 EFC Report and as of August 2015, 10,683 or less than two-thirds of Aqua’s wastewater customers had volume data available. This is a hindrance to the feasibility of implementing volumetric wastewater rates for its customers. In addition, the demand for irrigation meters and irrigation rates is very low because, without a volumetric wastewater charge based on metered water usage, there is no incentive to differentiate outdoor from indoor consumption. For example, there are approximately 6,200 Aqua water customers served by the Bayleaf Master System and over 5,300 of those customers are not wastewater customers and, therefore, irrigation usage is not subject to volumetric wastewater charges. The only Aqua wastewater utility system on the Bayleaf Master System is the Hawthorne Wastewater System that serves approximately 800 residential equivalent units. Utilities that provide both water and wastewater service can send stronger signals to support and encourage water efficiency and conservation by charging volumetric rates for both water and wastewater service.

Small Utility Implications

Smaller utilities with financial and staffing limitations may not have the infrastructure or capabilities to implement some of the more costly and/or complicated rate designs. For example, a utility with advanced metering infrastructure can impose drought rates effective on a certain day, or even hour, from actual meter readings between bill dates, instead of prorating the bill by the number of days of service. The cost-benefit analysis of costly metering equipment, software, hardware, and information technology expertise may not be justified due to the lack of economies of scale in small systems. Smaller utilities have much thinner margins and may benefit from a simpler rate structure with a larger proportion of the bill in the base charge than the usage charges. Under such a rate structure, revenues would more likely be sufficient and stable. Small utilities have historically filed rate cases far less often than their larger, more sophisticated counterparts. This may result in a greater disparity between test year usage and actual usage which negatively affects revenue stability and possibly sufficiency.

Recommendations

Based on the foregoing review of rate structures, and based on its experience and expertise, the Public Staff is of the opinion that, to best balance the objectives of sufficient and stable revenue for the utility with appropriate signals to consumers that support and encourage efficiency and conservation, water and wastewater rates should be volumetric with one or more increasing blocks. Including a significantly higher usage rate in the increasing blocks provides a cost signal to customers that incentivizes and promotes efficiency and conservation. The blocks should be designed to equitably balance all socioeconomic classes of customers, such as individuals and families. If the first block of usage is set too high, or the usage rates of the increasing blocks are set too low, water efficiency and conservation will not be appropriately encouraged. Customer education is critical to ensuring customers understand the policy goals behind a new rate design, rather than assuming it is a covert attempt by the utility to collect more revenue. Exhibit 3 to these comments shows rate structures for government-owned water utilities serving populations above 80,000, plus Aqua and CWSNC. Thirteen of the seventeen government-owned utilities listed have increasing block water rates, including two with increasing block rates which decrease at the highest block.

The following are potential increasing block rate structures for Commission consideration, particularly for larger water utilities:

	Gallons Monthly		
	First Block	Second Block	Third Block
Base Facility Charge (zero usage)(1)	Up to 5,000	5,001 – 10,000	10,001 and above
Base Facility Charge (zero usage)(2)	Up to 8,000	8,0001 and above	
Base Facility Charge (zero usage)(2)	Up to 10,000	10,001 and above	

(1)The commodity charge in the second block could be 150% of the first block and the commodity charge in the third block could be 200% of the first block.

(2)The commodity charge in the second block could be 200% of the first block.

When resources and feasibility are a major concern, the implementation of uniform volumetric usage rates for water and wastewater service is the best alternative to increasing block rates to achieve balance between the objectives of revenue stability and conservation. The ratio between the base charges and usage charges will significantly impact the balance between the desired objectives. Historically, the Public Staff has recommended the Commission approve for water utilities a base facility charge that is approximately 40% of the average monthly bill. For example, if the average monthly customer consumption was 5,000 gallons, and the revenue requirement justifies an average monthly bill of $50.00, the base facility charge (40%) would be $20.00 for zero usage and the commodity charge would be $6.00 per 1,000 gallons, which equals a $50.00 average bill.

By decreasing the base facility charge there is an incentive for residential customers to use water prudently and conserve. As a continuation of the example above with an average monthly bill of 5,000 gallons for $50.00, if the base facility charge was reduced from 40% to 15%, the resulting rates would be as follows:

Base Facility Charge	1,000 Gallons Commodity Charge	Monthly Bill 5,000 Gallons
$7.50 (Zero Usage)	$8.50	$50.00

This decreased base facility charge rate structure could also be combined with an increasing block rate structure such as:

Base Facility Charge	1,000 Gallons Commodity Charge
$7.50 (Zero Usage)	$7.50 Block 1 – Up to 10,000
	$15.00 Block 2 – All Gallons Above 10,000

The primary beneficiaries of the lower base charges are retired persons on fixed incomes, other single and/or two person households, and customers with discretionary usage that can be reduced.

A consumption or revenue adjustment mechanism with proper constraints and oversight would address most concerns regarding revenue sufficiency and stability as they relate to rate design. Implementation of such a mechanism would, at minimum, need to consider the reduction in risk for the utility, determination of thresholds (allowable variation), customer growth, and application of interest on potential surcredits.

The Public Staff lists the above rate structures as examples of the types to be considered by the Commission. The specific rate structure or structures best suited for a particular utility is dependent on a number of variables and should be determined on a company-by-company basis in future general rate cases.

WHEREFORE, the Public Staff respectfully request that the Commission consider these comments in making its determination in this docket.

This the 22nd day of May, 2019.

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CERTIFICATE OF SERVICE

I certify that a copy of these Comments have been served on all parties of record or their attorneys, or both, by United States mail, first class or better; by hand delivery; or by means of facsimile or electronic delivery upon agreement of the receiving party.

This the 22nd day of May, 2019.

Electronically submitted
/s/ William E. Grantmyre

EXHIBIT 1

FY 2018-19 Wastewater Residential Flat Rate Structures[1]

Utility	Population Served
Aqua North Carolina, Inc.	196,658[2]
Bald Head Island	3,150
Carolina Water Service, Inc. of North Carolina[3]	63,236[2]
Cumberland County – Kelly Hills District	920
Lake Lure	940
Powellsville	643
Proctorville	114

[1] Adapted from EFC Water and Wastewater Rates and Rate Structures in North Carolina as of January 2019. Retrieved from https://efc.sog.unc.edu/sites/default/files/2019/NCLM_EFC_AnnualW%26WWRatesTablesExcel_2019.pdf

[2] EPA SDWIS – Population served by the water systems.

[3] CWSNC has uniform volumetric rates for most of its wastewater systems. CWSNC has flat rates at some systems including Fairfield Harbour, Bradfield Farms, Fairfield Mountains/Apple Valley, Regalwood, White Oak Estates and The Ridges of Mountain Harbour.

EXHIBIT 2

FY 2018-19 Wastewater Rate Schedule Residential[1]

Utility	(000's Served) Population	Rate Schedule	Monthly Gallons at Cap
Metropolitan Sewer Buncombe County	125	Uniform Rate	
Cape Fear Public Utility Authority	173	Uniform Rate with Cap	12,000
Cary	185	Uniform Rate	
Charlotte Water	955	Uniform Rate with Cap	11,968
Concord	99	Uniform Rate	
Durham	263	Uniform Rate	
Fayetteville PWC	204	Uniform Rate	
Greensboro	277	Uniform Rate	
Greenville	96	Uniform Rate with Cap	25,000
High Point	108	Uniform Rate	
ONWASA (Onslow)	125	Uniform Rate	
OWASA (Orange)	83	Uniform Rate	
Raleigh	540	Uniform Rate	
Union County	126	Uniform Rate with Cap	12,000
Winston-Salem	321	Uniform Rate	
Aqua North Carolina	197[2]	Flat Rate	
CWSNC	63[2]	Uniform Rate	

[1] (Adapted from EFC Water and Wastewater Rates and Rate Structures in North Carolina as of January 2019. Retrieved from https://efc.sog.unc.edu/sites/default/files/2019/NCLM_EFC_AnnualW%26WWRatesTablesExcel_2019.pdf)

[2] EPA SDWIS – Population served by the water systems.

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EXHIBIT 3

FY 2018-19 Water Rate Schedule Residential[1]

Utility	(000's Service) Population	Rate Schedule	No. Blocks	Gallons First Block
Asheville	124	Uniform Rate		
Cape Fear Public Utility Authority	173	Uniform Rate		
Cary	185	Increasing Block	4	5,000
Charlotte Water	955	Increasing Block	4	2,992
Concord	99	Increasing Block	3	6,000
Davidson Water	147	Incr./Decr. Block	3	10,000
Durham	263	Increasing Block	5	1,496
Fayetteville PWC	204	Increasing Block	4	2,000
Greensboro	277	Increasing Block	4	2,244
Greenville	96	Uniform Rate		
High Point	108	Uniform Rate		
ONWASA (Onslow)	125	Increasing Block	5	3,000
OWASA (Orange)	83	Increasing Block	5	2,000
Raleigh	540	Increasing Block	3	2,992
Two Rivers (Gastonia)	84	Increasing Block	3	6,000
Union County	124	Increasing Block	5	3,000
Winston-Salem	321	Incr./Decr. Block	4	2,244
Aqua North Carolina	197[2]	Uniform Rate		
CWSNC	63[2]	Uniform Rate		

[1] (Adapted from EFC Water and Wastewater Rates and Rate Structures in North Carolina as of January 2019. Retrieved from https://efc.sog.unc.edu/sites/default/files/2019/NCLM_EFC_AnnualW%26WWRatesTablesExcel_2019.pdf)

[2] EPA SDWIS – Population served by the water systems.

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1. UNC School of Government Environmental Finance Center and North Carolina League of Municipalities. (2018). *2018 North Carolina Water & Wastewater Rates Report*. Retrieved from https://efc.sog.unc.edu/sites/default/files/2018/NCLM_EFC_Annual_Rates_Report_2018.pdf

2. Wyatt Tiger, M., Eskaf, S., & Hughes, J. A. (2011). Implications of Residential Irrigation Metering for Customers' Expenditures and Demand. *Journal AWWA, 103*(12). Retrieved from https://www.academia.edu/1213876/Implications_of_Residential_Irrigation_Metering_for_Customers_Expenditures_and_Demand

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May 22 2019

UNC SCHOOL OF GOVERNMENT Environmental Finance Center

NC Water Infrastructure ENVIRONMENTAL QUALITY

NC LEAGUE OF MUNICIPALITIES

About this Repor

This report is one of a series of resources on water and wastewater rates and rate structures in North Carolina, compiled by the Environmental Finance Center (EFC) at the University of North Carolina's School of Government (SOG) and the North Carolina League of Municipalities (NCLM). These resources are funded and provided to North Carolina local governments by the North Carolina Department of Environmental Quality's Division of Water Infrastructure (DWI).

Between August 2017 and January 2018 the EFC and NCLM conducted a survey of water and wastewater utilities in North Carolina. 520 local governmental and non-governmental utilities across the state were asked to provide their water and/or wastewater rates. 495 utilities (95 percent of rate-charging utilities) from all 100 counties participated in the survey.

The following pages contain the results and analyses of the 2018 North Carolina Water and Wastewater Rates Survey. The purpose of this report is to help utilities in rate setting by providing an up-to-date, detailed survey of current statewide rate structures and trends.

More information on water and wastewater rates in North Carolina can be found here. In addition to this report, there is an accompanying set of tables, and standardized water and wastewater rate sheets for each participating utility. Furthermore, in an online, interactive Rates Dashboard, users can compare utilities against various attributes such as geographic location, system characteristics, and customer demographics, as well as financial indicators and benchmarks.

For advice on rate setting or more information on making appropriate rate comparisons, please contact Annalee Harkins (aharkins@sog.unc.edu) or Shadi Eskaf (eskaf@sog.unc.edu) of the Environmental Finance Center at the University of North Carolina's School of Government, or Chris Nida (cnida@nclm.org) of the North Carolina League of Municipalities.

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Introduction

Water and wastewater rate setting is one of a local government's most important environmental and public health responsibilities. Water and wastewater rates ultimately determine how much revenue a community will have to maintain vital infrastructure. The purpose of this document is to help utilities in rate setting by providing an up-to-date, detailed survey of current statewide rate structures and trends. This report represents a collaborative effort between the NC League of Municipalities (NCLM) and the Environmental Finance Center (EFC) at the UNC School of Government.

Over the course of this survey, 520 water and/or wastewater utilities owned by local governments, not-for-profit associations, and multi-system for-profit companies were contacted by email or phone, and 495 utilities (95 percent) responded by sending in their rate schedules. These utilities serve approximately 8 million North Carolinians and account for 96 percent of the population served by community water and wastewater systems in the state. Table 1 describes the utilities analyzed in this survey. Some utilities use more than one rate structure for different portions of their service areas, raising the total number of "rate structures" in our sample to 550. Many analyses in this report refer to statistics of the 495 rate structures.

Table 1: Number of Participating Utilities with Rates Data

Institutional Arrangement	Provides Water and Wastewater	Provides Water Only	Provides Wastewater Only	Total
Municipality	322	26	18	**366**
County/District	28	29	4	**61**
Sanitary District	7	7	5	**19**
Authority	5	3	1	**9**
Metropolitan District	1	0	2	**3**
Not-For-Profit	1	34	0	**35**
For-Profit Multi-System Utility	2	0	0	**2**
Total Number of Utilities	**366**	**99**	**30**	**495**
Number of Rate Structures	***385***	***125***	***40***	***550***

In addition to this report, **tables of each utility's rates and key components of their rate structures** are available from the EFC and NCLM, as well as **copies of the rate structures of participating utilities**. Those resources are available at http://www.efc.sog.unc.edu/project/north-carolina-water-and-wastewater-rates-and-rate-structures, along with a free, interactive **NC Water and Wastewater Rates Dashboard** that combines a utility's financial, physical, and customer characteristics with the ability to compare rates among similar utilities in various categories.

Four Myths about Pricing

There are many oversimplifications and bits of "conventional wisdom" in the world of water finance and pricing which do not necessarily hold up upon deeper investigation. Some of the myths dispelled by the analysis in this report include:

1. **MYTH: Higher rates are bad.** Higher rates often do not necessarily reflect poor or inefficient management. In fact, data show that some utilities with low rates do not generate sufficient revenue to properly maintain their system's assets, which could ultimately lead to long-term adverse cost and service impacts. Pressure to maintain low rates has the potential to force utilities to run a deficit or avoid making necessary operational and capital expenditures. Some utilities may have low rates because they have not re-examined their rate structures in many years, and their pricing structure may not support key finance and policy goals such as promoting conservation or maintaining affordability.

2. **MYTH: Comparing rates is simple.** An examination of rates and rate structures will only tell part of the story, and there are many different methods of comparing pricing. Ideally, rates should reflect the cost of providing service. Cost of service depends on diverse factors including geographic location, size of treatment facilities, customer base, age of assets, site-specific regulatory requirements, type of water supply, and quality of source water and receiving waters. Two neighboring utilities with similar customer bases may have very different costs that justify very different rate structures and rates. Therefore, policy decisions drawn from the comparative information should also consider the many other factors listed above. Furthermore, figuring out the most pertinent factors to compare can be a challenge. For example, analysis revealed that in some cases, when comparing two utilities, one utility's rate may be higher than the other utility's rate for bills in the 0 to 4,000 gallon range, but lower at 5,000 to 10,000 gallon range, or vice versa. Comparing rates among utilities is really just a starting point for a more in-depth analysis.

3. **MYTH: Pricing is simple.** North Carolina utilities employ a tremendous variety of pricing structures. Utilities show wide variation in how they set base charges and design block structures. Utilities have many design choices and should be thoughtful in customizing their rate structure to serve their specific needs, objectives and priorities as they evolve in time, rather than maintaining outdated rate structures or copying their neighbor's rate structure.

4. **MYTH: Promoting conservation requires increasing block rate structures.** Several utilities are facing water supply challenges and are looking for ways to use pricing structures to promote conservation. Many different types of pricing structures can be adopted to encourage

conservation; some of these are quite complicated and some are very simple. Increasing block (or tiered) rate structures are sometimes heralded as the solution to conservation rate setting. While increasing block rates are sometimes priced in a way to encourage conservation, the analysis shows that some utilities with simpler rate structures – such as uniform rates – sent customers stronger conservation price signals than other utilities with increasing block structures. In fact, a significant minority of the utilities using increasing block rate structures had less effective conservation pricing signals than some utilities employing aggressive uniform rates. Rather than focusing on rate structure designs alone, utilities should consider all aspects of pricing. The rates set at each block are more important than having a block rate structure by itself. Above conservation, utilities must determine if their rates are set to truly reflect their costs, and make sure that rates are not artificially low.

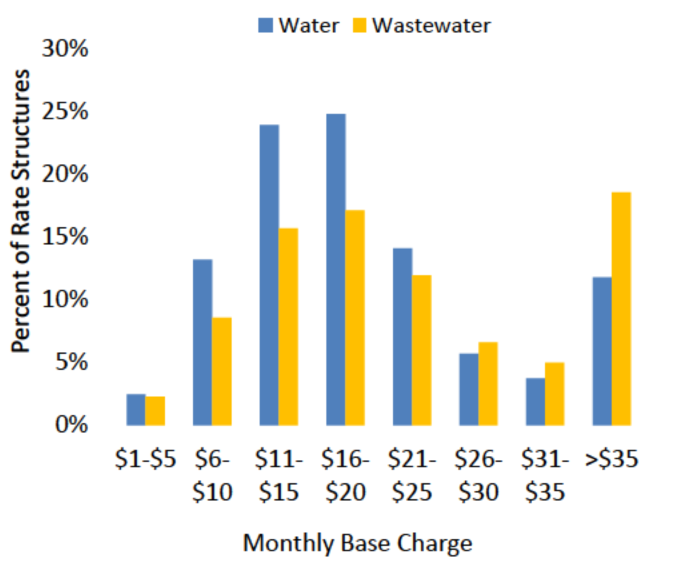
Overview of Rate Structures

Utilities employ a variety of rate structures to determine what their customers pay. Almost all utilities use a combination of base charges and variable charges in their rate structures. There is considerable variation in how these are calculated and how they are charged for different classes of customers.

Base Charges

Base charges contribute to revenue stability because they do not vary from month to month, regardless of consumption. However, high base charges can create affordability concerns and also make it difficult for a utility to encourage conservation for the same reason. The range of residential base charges are shown in Figure 1. The median[1] residential base charge across all rate structures in the state in 2018 is $16.13 per month for water and $18.00 per month for wastewater. For combined utilities, the median combined water and wastewater base charge is $34.00 per month.

Figure 1: Monthly Base Charges for Residential Customers Among 508 Water and 418 Wastewater Rate Structures



[1] Most of the statistics cited in this report refer to *medians*. Exactly half of the rate structures in the sample have a value that is equal to or greater than (or equal to or lower than) the median value. The median is preferred over the average because averages are influenced by exceptionally high or low values whereas medians are not.

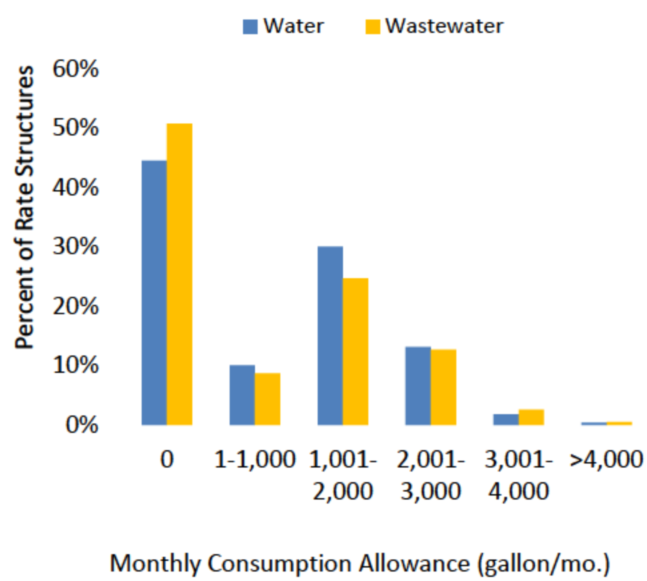
While nearly every rate structure (~100 percent of water and 98 percent of wastewater rate structures) has a base charge, their amounts vary by utility size. The median residential base charges are presented in Table 2 by utility size. The largest utilities have smaller base charges than the smallest utilities. This may be a reflection of the fact that larger utilities have broader customer bases that provide a more stable revenue stream. Smaller utilities may, on average, have less stable customer consumption and therefore decide to shift a greater portion of their operating costs into the base charge.

Table 2: Monthly Residential Base Charges in Water and Wastewater Rate Structures, by Utility Size

	Water Rate Structures			Wastewater Rate Structures		
Size of Utility (Service Population)	**Total Number of Structures**	**Number with Base Charge**	**Median Base Charge**	**Total Number of Structures**	**Number with Base Charge**	**Median Base Charge**
1 - 999	109	109	$19.50	94	94	$21.57
1,000 – 2,499	88	88	$16.88	78	77	$17.00
2,500 – 4,999	80	79	$15.10	74	72	$18.41
5,000 – 9,999	69	69	$17.51	49	49	$16.70
10,000 – 24,999	87	86	$15.00	61	59	$15.00
25,000+	76	76	$12.55	63	61	$14.75
All Rate Structures	***510***	***508***	***$16.13***	***425***	***418***	***$18.00***

A large number of residential rate structures (56 percent of water and 50 percent of wastewater rate structures) include a minimum amount of water consumption or wastewater disposal with their base charges (see Figure 2). For these utilities, the variable charges of the rate structure only take effect when a customer uses more than the consumption allowance included in the base charge. Thus, all customers of these utilities who consume or dispose of an amount up to the minimum allocation would receive the same bill, which is equal to the base charge. For both water and wastewater utilities, the median amount of allowance included with the base charge is 2,000 gallons per month.

Figure 2: Consumption Included with the Base Charge for Residential Customers among 448 Water and 376 Wastewater Rate Structures



Only 2 percent of water and 3 percent of wastewater rate structures include more than 3,000 gallons/month with the base charge. A large number of utilities vary the base charges based on the customer's water meter size in order to distinguish between large commercial and industrial users from residential and small commercial customers. Of the 510 water rate structures applied to commercial and non-residential customers, 123 (24 percent) vary the base charge by meter size. Similarly, of the 425 wastewater rate structures for commercial customers, 85 (20 percent) vary the base charge by the water meter size. The range of meter-based base charges used by this subset of utilities is shown in Table 3. For example, half of the commercial rate structures that vary by meter size charge base charges up to $69.08 per month for water a 2" meter and up to $177.75 for a 4" meter.

Table 3: Maximum Monthly Base Charge Applied to Commercial Customers by Utilities Whose Base Charges Vary by Meter Size

	Percentage of Meter-Based Commercial Rate Structures					
	10%	25%	50%	75%	90%	100%
Water (n = 123)						
5/8"	$7.14	$11.00	$14.35	$20.00	$25.12	$45.40
3/4"	$7.16	$11.01	$14.49	$21.56	$27.38	$45.40
1"	$11.90	$16.00	$24.25	$40.31	$51.26	$92.25
1 1/2"	$15.31	$22.18	$38.00	$63.41	$94.34	$130.00
2"	$20.31	$34.14	$69.08	$106.41	$172.82	$444.43
3"	$27.02	$57.43	$126.53	$205.71	$322.58	$886.93
4"	$40.00	$71.87	$177.75	$329.69	$513.63	$1,594.60
6"	$40.00	$94.50	$289.71	$613.26	$1,013.05	$3,506.25
8"	$40.03	$120.68	$337.30	$757.50	$1,274.29	$3,506.25
10"	$40.03	$120.68	$379.44	$813.00	$1,310.40	$3,506.25
Wastewater (n = 85)						
5/8"	$6.62	$11.45	$15.65	$23.13	$30.44	$52.26
3/4"	$6.76	$11.52	$15.96	$23.48	$30.44	$52.26
1"	$11.32	$19.20	$27.70	$43.50	$62.88	$130.65
1 1/2"	$14.67	$29.44	$43.50	$72.75	$111.31	$261.30
2"	$26.79	$44.14	$73.71	$126.00	$207.18	$418.08
3"	$36.46	$74.35	$135.33	$222.85	$373.01	$842.88
4"	$50.74	$93.80	$200.85	$389.00	$655.21	$1,899.50
6"	$70.03	$133.63	$391.48	$659.82	$1,251.32	$3,371.53
8"	$75.73	$164.24	$510.00	$1,003.20	$1,436.34	$3,371.53
10"	$75.73	$164.64	$538.52	$1,129.59	$1,755.24	$4,025.62

Variable (Volumetric) Charges

When customers consume above the consumption allowance included with the base charge, volumetric rates apply and the customers are charged based on the volume of water or wastewater they use. Figure 3 through 6 present information on the volumetric water and wastewater rate structures for "inside" customers, i.e. those who live within a utility's political jurisdiction or municipal

/ A

boundaries.

The three most common rate structures are uniform, increasing block, and decreasing block. In a uniform rate structure, the volumetric rate at which water/wastewater is charged does not change as the customer uses more water. In an increasing block structure, the volumetric rate increases with greater water consumption. This structure is often employed by utilities that want to encourage conservation. In a decreasing block structure, volumetric rates decrease as consumption rises. This structure might be used to encourage economic development. Other rate structures used in North Carolina include a hybrid of increasing and decreasing blocks where rates increase or decrease for specific targeted blocks of consumption, seasonal rate structures applying different rates at different times of the year, uniform wastewater rates that are capped at a maximum billable consumption amount, tiered flat fees, and a block rate structure that charges all consumption at the rate of the last used block. Seasonal rate structures support conservation, especially for those utilities that experience large seasonal consumption changes (e.g. tourist locations). Wastewater bills are almost always calculated based on the amount of metered water consumption. However, a fraction of wastewater utilities use rate structures with a cap on residential wastewater consumption. For example, if a utility caps its wastewater bill at 20,000 gallons, a customer that uses 25,000 gallons of water will only be charged for 20,000 gallons of wastewater disposal.

Figure 3: Residential Water Rate Structures (n = 510)

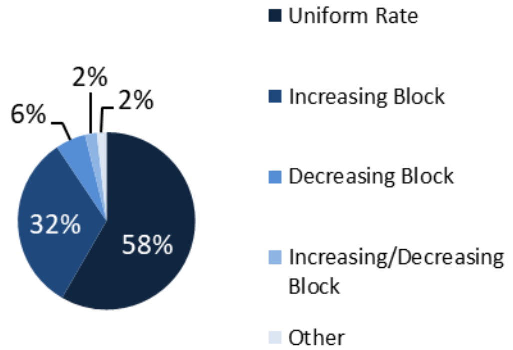


Figure 4: Residential Wastewater Rate Structures (n = 425)

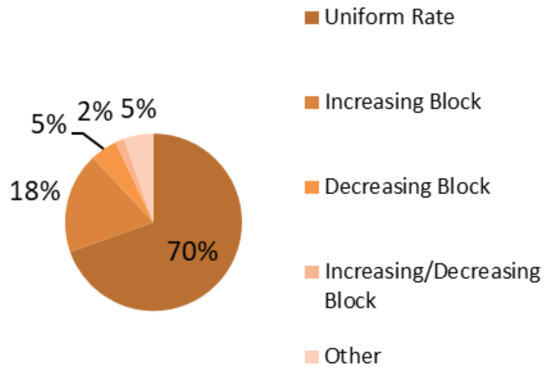


Figure 5: Commercial-Specific Water Rate Structures (n=159)

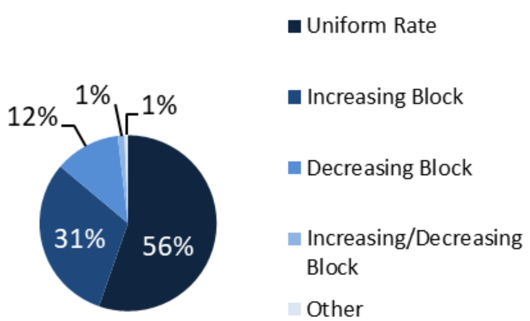
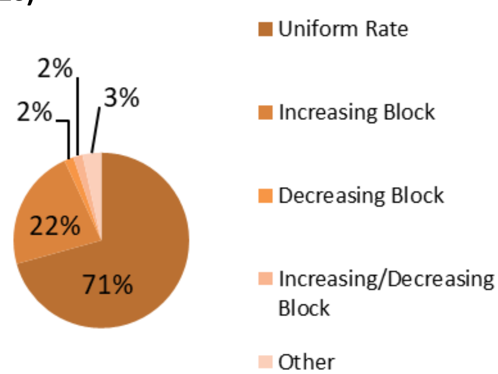


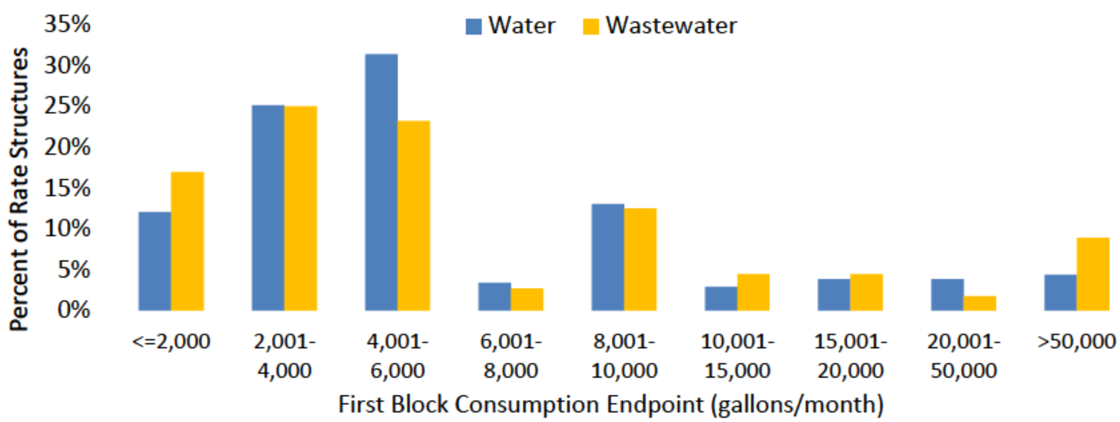
Figure 6: Commercial-Specific Wastewater Rate Structures (n=116)



Most water and wastewater utilities use the same rate structure for residential, commercial, and industrial customers, but some have separate rate structures. In this survey, 31 percent of water rate structures have separate, unique rates for their commercial customers, and a fraction of these also have unique rates that pertain to their industrial (or other types of non-residential) customers. On the wastewater side, 27 percent have separate, unique rates for their commercial customers. The type of rate structures applying specifically to commercial customers (see Figure 5 and Figure 6) are different than those that apply to residential customers.

While some utilities design separate rate structures for commercial users, other utilities use only one rate structure but design the blocks so that they inherently distinguish residential use from that of large non-residential customers. A common practice is to set the first block high enough so that essentially all residential consumption is charged one rate (which is equivalent to a uniform rate for these customers) while most large commercial customers will typically exceed the first block, thus paying an increasing or decreasing block rate. Figure 7 shows how many rate structures include various amounts of consumption and disposal in the first block of their residential block rate structure.

Figure 7: Maximum Quantity in the First Block among 208 Water and 113 Wastewater Residential Block Rate Structure



An examination of rate structures over the range of typical residential consumption reveals that many increasing and decreasing block structures are effectively uniform below 15,000 gallons/month (shown in Figure 8 and Figure 9). For example, whereas 6 percent of residential water rate structures are decreasing block structures (Figure 3), only 3 percent actually apply decreasing rates within the first 15,000 gallons/month of consumption (Figure 8) – the rest have a first block that exceeds the range of typical residential use. Figure 8 and Figure 9 also show the percent of the population served under each rate structure applicable to consumption/disposal levels of up to 15,000 gallons/month. While only 30 percent of the water rate structures are increasing block structures through 15,000 gallons/month, 53 percent of all residential customers are served by these rate structures. Figure 9 shows that the vast majority of residential customers pay uniform rates for wastewater disposal.

Figure 8: Water Rate Structures Applicable to Residential Consumption up to 15,000 gallons/month (n=510)

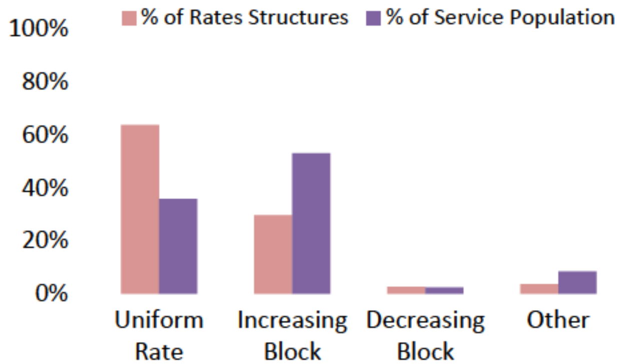
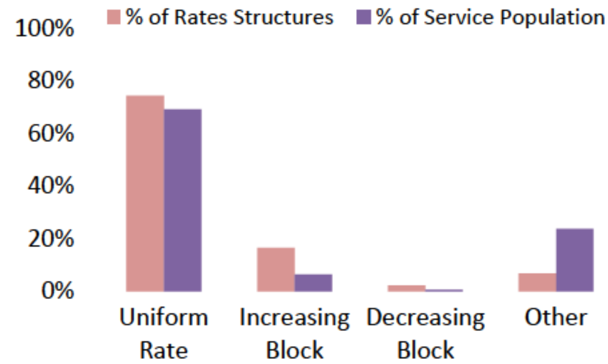


Figure 9: Wastewater Rate Structures Applicable to Residential Disposal up to 15,000 gallons/month (n=425)



The State of North Carolina is now actively discouraging the use of decreasing block rate structures for residential consumption. In 2008, the General Assembly created G.S. 143.355.4 stating:

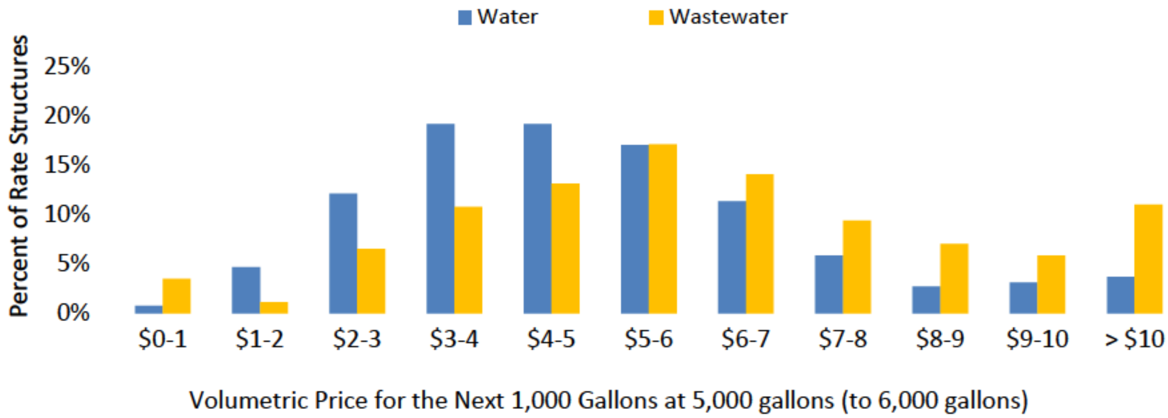
> "To be eligible for State water infrastructure funds from the Drinking Water State Revolving Fund or the Drinking Water Reserve or any other grant or loan of funds allocated by the General Assembly whether the allocation of funds is to a State agency or to a nonprofit organization for the purpose of extending waterlines or expanding water treatment capacity, a local government or large community water system must demonstrate that the system:
> ... (5) Does not use a rate structure that gives residential water customers a lower per-unit water rate as water use increases."

As shown in Figure 8, three percent of the water rate structures analyzed in this study are still designed to charge residential customers using less than 15,000 gallons/month decreasing rates as water use increases. To be eligible for the aforementioned funds, these utilities would need to change their water rate structures.

Residential customers in North Carolina consume an average of 4,000 to 5,000 gallons/month. Among the 510 water rate structures in the sample, the median price for the next 1,000 gallons (not including base charges) at the consumption level of 5,000 gallons/month is $4.90 per 1,000 gallons – 50 percent of the water rate structures have a price that is between $3.35 and $6.25 per 1,000 gallons.

The price for wastewater is higher. Among the 425 wastewater rate structures in the sample, the median wastewater price for the next 1,000 gallons at 5,000 gallons/month is $5.97 per 1,000 gallons – 50 percent of the wastewater rate structures have a price that is between $4.42 and $7.90 per 1,000 gallons. The range of water and wastewater prices for the next 1,000 gallons at the 5,000 gallons/month consumption level is shown on Figure 10. Among the 385 combined water and wastewater rate structures, the median combined price for the next 1,000 gallons is $10.50 per 1,000 gallons – 50 percent of the combined rate structures have a price that is between $7.99 and $13.74 per 1,000 gallons.

Figure 10: Price for the Next 1,000 Gallons at 5,000 gallons/month for 510 Water and 425 Wastewater Rate Structures

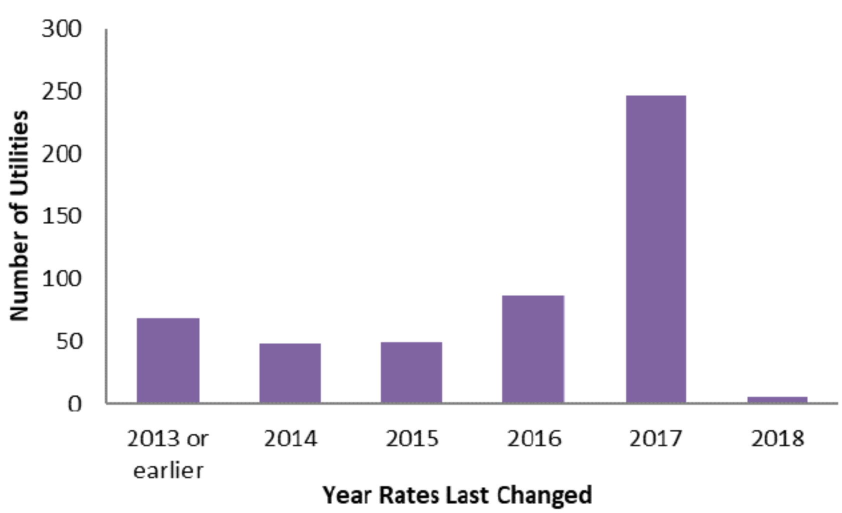


Many utilities provide the option to residential customers to install separate irrigation meters to supply their outdoor water usage. In some cases, the utilities have created a separate, unique rate structure specifically for these irrigation meters. In our sample of 510 water rate structures, only 70 (14 percent) had a unique rate structure for residential irrigation meters. All 70 of these use a uniform or an increasing block rate structure. Read more about irrigation rates, and how they compare to standard rates, on page 15.

Changes in Residential Rate Structures in the Last Year

Most North Carolina utilities actively evaluate and modify their rate structures every one to two years. The calendar year in which each of the 507 rate structures active as of January 2017 were first put into effect is shown in Figure 11. Only approximately 14 percent of the rate structures were instated in 2013 or earlier (at least five years ago).

Figure 11: In What Calendar Year Were the Current Rate Structures First Instated? (n=507)



The figure shows that about 50 percent of the current rate structures were made effective since January 2017, and 67 percent have changed their rates in the last two years.

The trend among North Carolina utilities for many years has been to move away from decreasing block rate structures to either uniform or increasing block structures. This trend is largely driven by an interest in preserving water supplies by promoting water conservation and discouraging excessive or wasteful consumption. The trend is in keeping with the state's encouragement of using conservation-oriented rates and rate structures as mentioned previously.

This year's survey included 434 water rate structures and 365 wastewater rate structures that were also included in the 2016 survey. Out of the 443 water rate structures included in last year's rates survey, 11 changed in the last year, shown in Table 4. Most of the changes were from uniform rates to increasing block rates. Overall, one decreasing block rate structure was changed in the last year, and five increasing block structures were gained. There are four wastewater rate structures that were changed between 2017 and 2018, out of the 364 surveyed in both years. An analysis of how much rates have increased in the past year is shown on page 17.

Table 4: Changes to Water Rate Structures from January 2017 to January 2018

		Changed To				
		Increasing Block	Uniform Rate	Decreasing Block	Other	***Total Lost***
Changed From	Increasing Block		0	0	1	***1***
	Uniform Rate	4		0	0	***4***
	Decreasing Block	1	5		0	***6***
	Other	0	0	0		***0***
	Total Gained	***5***	***5***	***0***	***1***	***11***

What Utilities Charge their Customers

The following sections present information on the water and wastewater bills charged to "inside" customers, i.e. those who live within a utility's political jurisdiction or municipal boundaries. For rates and bills charged to "outside" customers, go to page 21.

Residential Water and Wastewater Bills

Figure 12 and Figure 13 show the median amount that utilities bill their residential water and wastewater customers, respectively, for a range of consumption/disposal amounts on a monthly basis[2]. These calculations include base charges, consumption allowances, and volumetric rates. The colored bars highlight what the middle 80 percent of utilities charge (between the 10th and 90th percentile) across the consumption spectrum.

Figure 12: Monthly-Equivalent Residential Water Bills by Consumption (n=510)

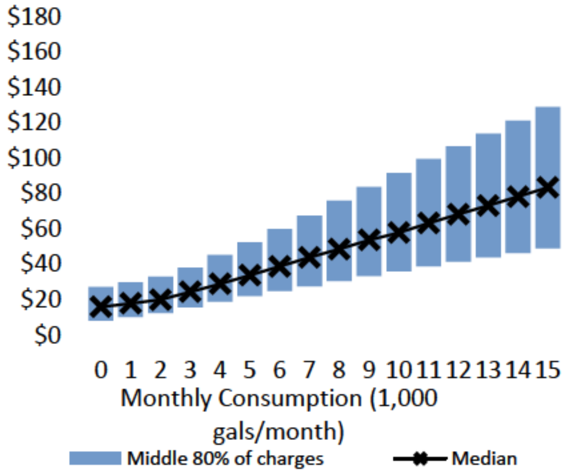
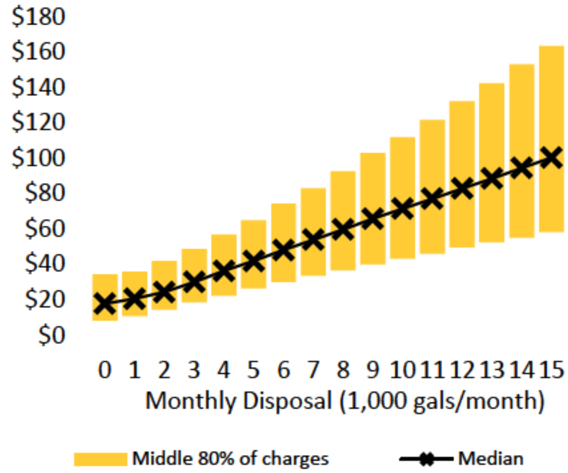
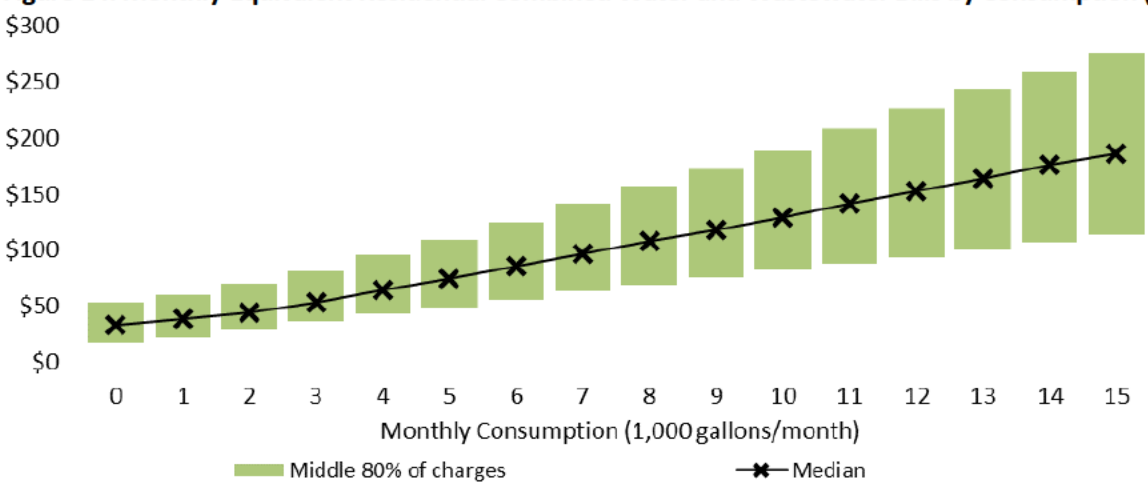


Figure 13: Monthly-Equivalent Residential Wastewater Bills by Disposal (n=425)



The median monthly amount charged for zero gallons of water is $16.05, $34.00 for 5,000 gallons and $58.00 for 10,000 gallons. As a point of comparison, a gallon of potable water at a major grocery retailer is approximately $1.00 while the median bill for 5,000 gallons of tap water is approximately $0.0068 per gallon, or 147 times cheaper. Wastewater bills are generally higher than water bills. The median monthly wastewater bill for customers disposing zero gallons is $17.87, $42.00 for 5,000 gallons and $71.55 for 10,000 gallons.

Figure 14: Monthly-Equivalent Residential Combined Water and Wastewater Bills by Consumption (n=385)



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[2] For utilities that bill on a non-monthly basis (bi-monthly or quarterly), charges have been calculated and presented on a monthly basis to allow for accurate comparison.

The range of combined water and wastewater bills for various usage levels is shown above in Figure 14. The median monthly combined bill for zero gallons is $33.60, $74.37 for 5,000 gallons and $129.65 for 10,000 gallons.

Residential Bills By Utility Size

Table 5 shows that water and wastewater bills are generally higher among the smallest utilities. This is probably because large utilities are able to spread their fixed costs among a greater customer base.

Table 5: Median Residential Water and Wastewater Monthly Bills at 5,000 gallons/month, by Utility Size

	Water Rate Structures		Wastewater Rate Structures	
Utility Size (Service Population)	**Number of Rate Structures**	**Median 5,000 gallons/month Monthly Bill**	**Number of Rate Structures**	**Median 5,000 gallons/month Monthly Bill**
1 - 999	109	$36.20	94	$45.21
1,000 – 2,499	88	$38.00	78	$41.83
2,500 – 4,999	80	$31.98	74	$38.48
5,000 – 9,999	69	$34.00	49	$44.15
10,000 – 24,999	87	$31.81	61	$38.92
25,000+	76	$30.89	63	$39.87
All Rate Structures	***510***	***$34.00***	***425***	***$42.00***

Residential Bills By Type of Utility Ownership

Table 6 shows that municipal utilities generally have lower water and wastewater bills than other service providers, possibly because the population density is highest for municipal utilities, which translates into lower per customer costs (and therefore bills) for distribution and collection. Conversely, County utilities, which are typically more spread out, have the highest water bills.

Table 6: Median Residential Water and Wastewater Monthly Bills at 5,000 gallons/month, by Utility Type

	Water Rate Structures		Wastewater Rate Structures	
Utility Type	**Number of Rate Structures**	**Median 5,000 gallons/month Monthly Bill**	**Number of Rate Structures**	**Median 5,000 gallons/month Monthly Bill**
Municipality	356	$31.88	346	$40.95
County/District	76	$42.85	44	$47.96
Sanitary District	19	$37.04	12	$49.29
Authority/Metropolitan District	10	$40.82	10	$44.83
Not-For-Profit	35	$35.00	1	$48.00
For Profit	14	$40.24	12	$56.37
All Rate Structures	***510***	***$34.00***	***425***	***$42.00***

Residential Bills By Water Source Type

Table 7 shows the median water charge for 5,000 gallons/month based on the water supply source. The water rates set by purchase water systems (those that buy at least a portion of their water from another water system), are on average higher than those of groundwater or surface water systems. Purchase water systems must account for their own operational costs in addition to the costs of the supplier treating the water. Water systems treating their own water face costs that are dependent on the source of water. Generally, treating surface water is more expensive than treating groundwater. In North Carolina, water rates for water systems that withdraw surface water are lower at the median than water rates for water systems withdrawing groundwater, but this could be due to the fact that surface water systems in North Carolina tend to be much larger than groundwater systems.

Table 7: Median Residential Water Monthly Bills at 5,000 gallons/month, by Type of Water Supply

	Water Rate Structures		
Water Supply Type (as determined for regulatory purpose)	**Total Number of Rate Structures**	**Median Monthly Water Bill at 5,000 gallons/month**	**Median Service Population**
Groundwater	159	$34.00	1,445
Surface Water	114	$29.10	13,875
Purchase*	233	$38.60	4,201
All Water Rate Structures	***506***	***$34.21***	

* “Purchase” water systems are those that buy at least a portion of their water from another water system, which could be either surface water or groundwater.

Residential Bills By River Basin

It is important to consider the operating environment when comparing rates among utilities. Source water quality and quantity can have a significant impact on the cost to produce water. Likewise, receiving water quality can have a major impact on the cost of wastewater treatment. In an attempt to consider these impacts, median water and wastewater bills for 5,000 gallons/month were calculated for each of North Carolina’s major river basins, shown in Figure 15.

The highest median water charges in river basins with a sample of more than 10 rate structures can be found in the Tar-Pamlico river basin, in the northeast of the state. The lowest median water charges, by contrast, are found in the Lumber River basin situated in the south-central of the state. The highest median wastewater charges can be found in the Pasquotank river basin in the northeast. Wastewater charges in the Neuse and the Tar-Pamlico river basins are higher than average for the state, and both river basins are under stringent discharge regulations. The lowest median wastewater charges can be found in the French Broad river basin in the west of the state.

Figure 15: Median Residential Water and Wastewater Monthly Bills at 5,000 gallons/month, by River Basin

Underlying river basin map is from the NC Wildlife Resources Commission's website.

Commercial Water and Wastewater Bills

Figure 16 and Figure 17 show the median monthly water and wastewater bills, respectively, for commercial customers at different levels of consumption and disposal[3]. The middle 80 percent of charges also are indicated. The variation in commercial bills across rate structures increases significantly as the consumption/disposal amount increases.

Figure 16: Monthly-Equivalent Commercial Water (n=510) and Commercial Wastewater Bills (n=425) at Low Consumption Levels

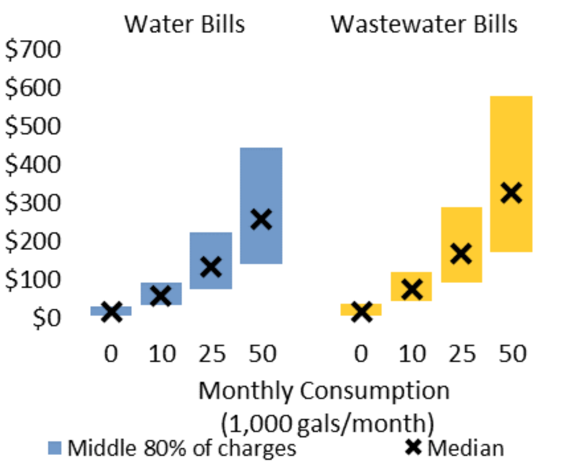
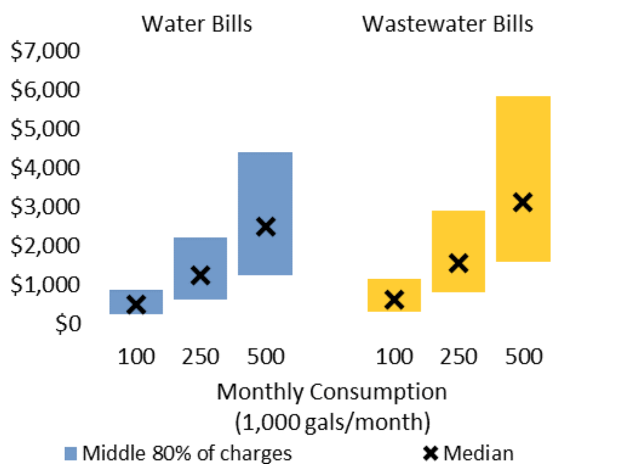
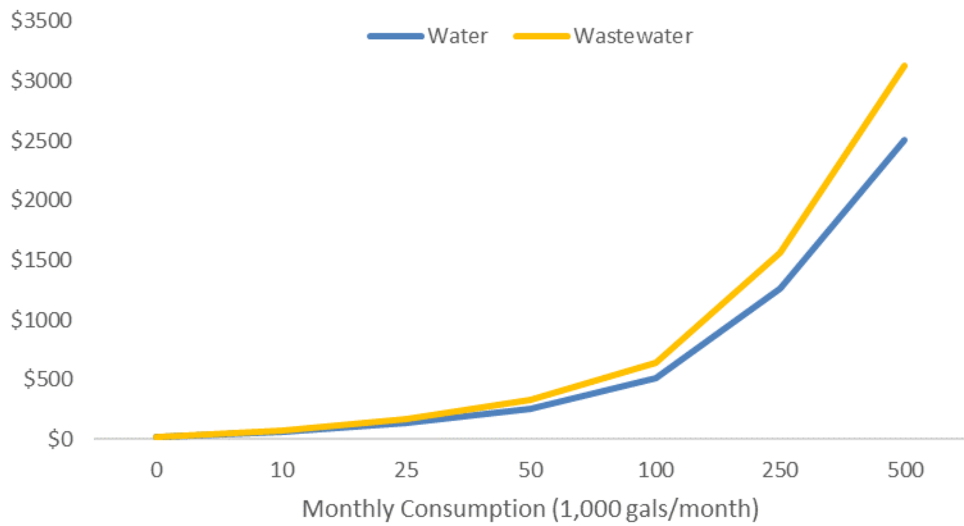


Figure 17: Monthly-Equivalent Commercial Water (n=510) and Commercial Wastewater Bills (n=425) at High Consumption Levels



[3] The residential rate structure is used to calculate the billings for commercial customers except for the utilities that specify different rates and rate structures for commercial or non-residential customers.

Figure 18: Median Monthly-Equivalent Commercial Water and Wastewater Bills



As shown above in Figure 18, the median monthly bill for commercial customers consuming zero gallons (on a 3/4" meter[4]) is $17.00 for water and $19.00 for wastewater. The median monthly bill for 50,000 gallons/month is $258.36 for water and $326.35 for wastewater. The median bill for those consuming 500,000 gallons/month (on a 1½" or 2" meter) is $2,509.00 for water and $3,125.00 for wastewater.

Irrigation Bills for Residential Customers

Residential customers that water their lawns, wash their cars, or otherwise use water outdoors frequently use much more water outdoors than they do indoors. An EFC study of customers in five cities in North Carolina shows that residents with irrigation meters tend to use, on average, two to seven times as much water outdoors in the summer months as they do indoors[5]. With such large volumes of water used outdoors, particularly in the summer months, and with G.S. 143.355.4 clearly encouraging the use of rates to support conservation, some utilities have taken the opportunity to charge for water used through irrigation meters at a unique rate structure. In our survey, 70 rate structures included such unique rates. As seen in Figure 19, irrigation rates are usually higher than the standard water rates.

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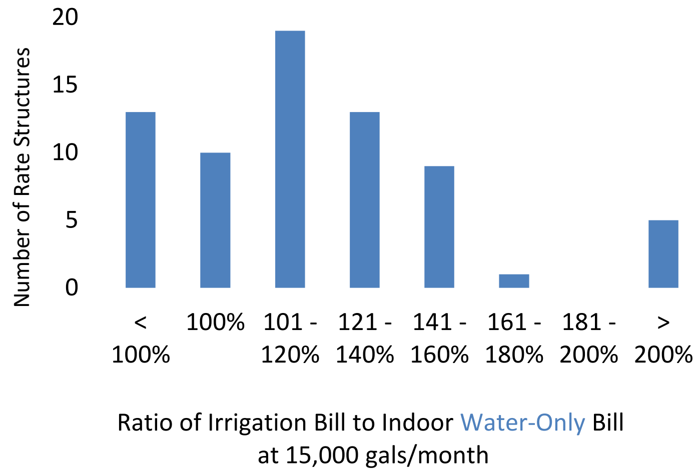
[4] Some utilities use different base charges for different meter sizes for customers. Bills for consumption or disposal of up to 100,000 gallons/month was computed assuming a 5/8" or 3/4" meter size, 250,000 gallons/month assuming a 1" meter size, and 500,000 gallons/month assuming a 1½" or 2" meter size. When applicable, the "next largest" meter size is used in calculating the bills when a utility does not utilize a specific meter size.

[5] Tiger, M.W., Eskaf, S. & Hughes, J. (2011) "Implications of Residential Irrigation Metering for Customers' Expenditures and Demand." *Journal AWWA*, 103:12, 30-41.

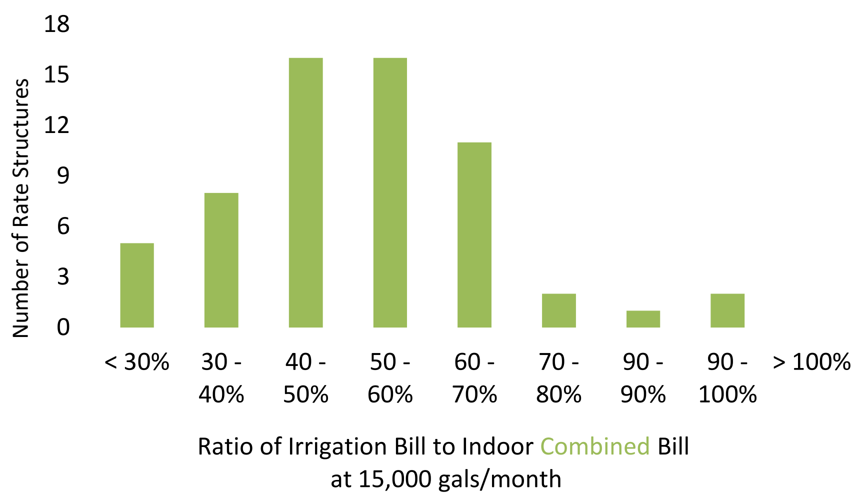
Typically, irrigation rates are higher than the standard water rates, but less than the combined water and wastewater rates. The ratio of the irrigation water bill at 15,000 gallons/month to the residential (indoor) water-only or combined bill is shown in Figure 19 and Figure 20. The irrigation bill for 15,000 gallons/month is higher than what the customer would have been charged under the standard water rate structure for that consumption amount in 47 out of the 70 rate structures (67 percent). However, 13 of the irrigation rate structures actually provide a price discount to customers to customers for their outdoor water usage, which essentially discourages water conservation.

Figure 19: Comparing the Irrigation Bill to the Water Bills for Residential Customers at 15,000 gallons/month among the 70 Unique Irrigation Rate Structures (n = 70)



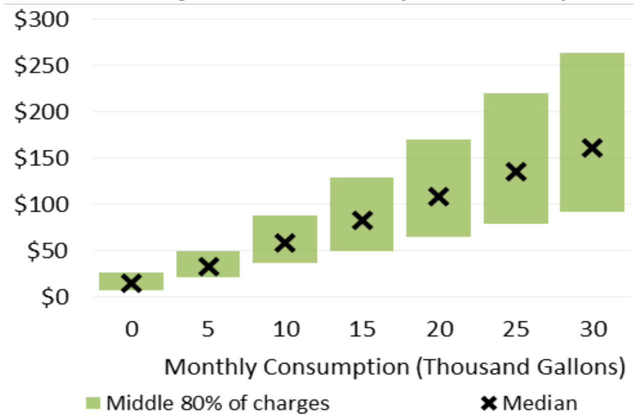
Nearly all of the irrigation rate structures provide residential customers with a price break compared to the combined water and wastewater charge for 15,000 gallons/month. This is logical, since outdoor water usually does not enter the sewer system after use, and therefore the utility does not encounter wastewater treatment costs for the water that flows through the irrigation meters.

Figure 20: Comparing the Irrigation Bill to the Combined Water and Wastewater Bills for Residential Customers at 15,000 gallons/month among the 70 Unique Irrigation Rate Structures (n = 61)



Whether or not a utility has a unique rate structure for irrigation water, all utilities must evaluate carefully what they are charging for large consumption of water through their residential rate structures. The monthly-equivalent bills for all 510 rate structures in our sample are shown below in Figure 21 for a consumption range that is typical of residential irrigation usage.

Figure 21: Monthly-Equivalent Bills for Irrigation Water Use by Residents, by Consumption (n=510)



Changes in Residential Rates Over Time

Out of the 434 water and 365 wastewater rate structures included in last year's rates survey, residential rates were increased from last year for 40 percent of the water rate structures and 43 percent of wastewater rate structures, as shown in Figure 22.

Figure 22: Percent of Rate Structures that Increased Residential Rates in the Last Year

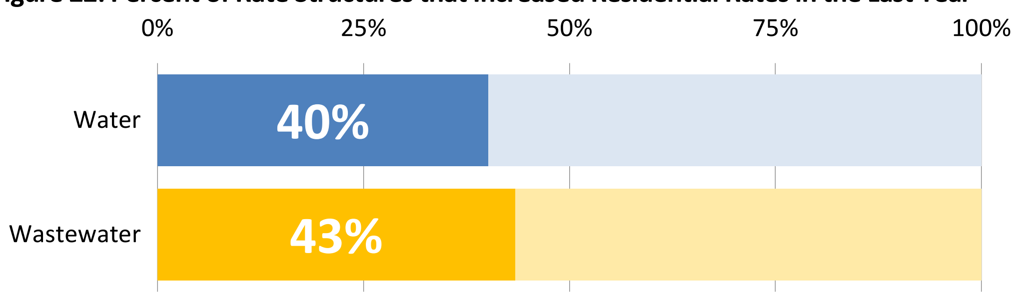


Figure 23 and Figure 24 show the residential monthly bill increase for customers that use 5,000 gallons/month among the 174 water and 158 wastewater rate structures that have raised rates in the last year. The median increase was $1.32/month for water and $1.50/month for wastewater. For both water and wastewater the median increase amounts to a 4.0 percent increase.

Among 179 water rate structures that were collected in the survey every single year since 2006, usually more than half raised rates from one year to the next, as shown in Figure 25. Between 207 and 2011 a larger proportion of water rates were raised, possibly in reaction to reduced water demands from customers during and after a significant drought that affected the majority of the state in 2007 and

2008. As water customers cut demand, utilities were forced to raise rates in order to balance their budgets since declining demands do not reduce utilities' expenses at the same rate.

Figure 23: Percent Increase in Residential Monthly Bills Since 2017 for 5,000 gallons/month among 174 Water and 158 Wastewater Rate Structures that Raised Rates

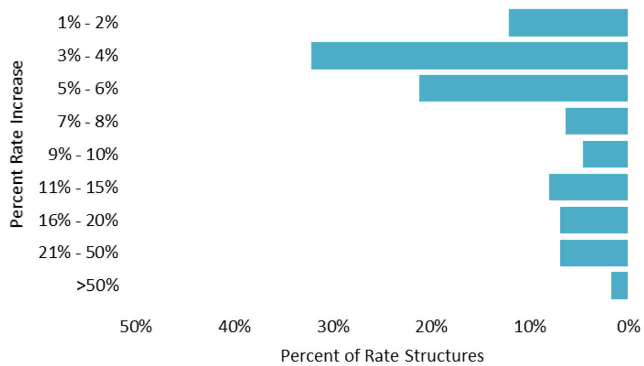


Figure 24: Increase in Residential Monthly Bill Amount Since 2017 for 5,000 gallons/month among 174 Water and 158 Wastewater Rate Structures that Raised Rates

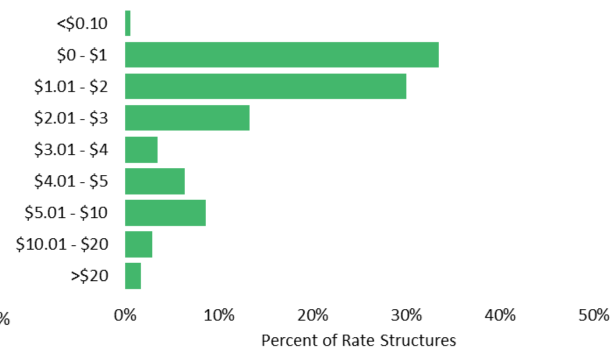
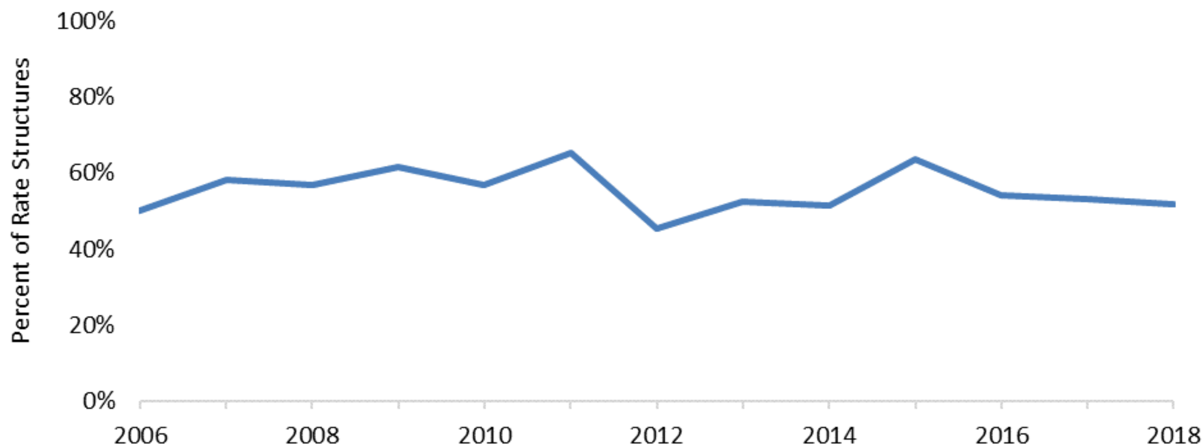


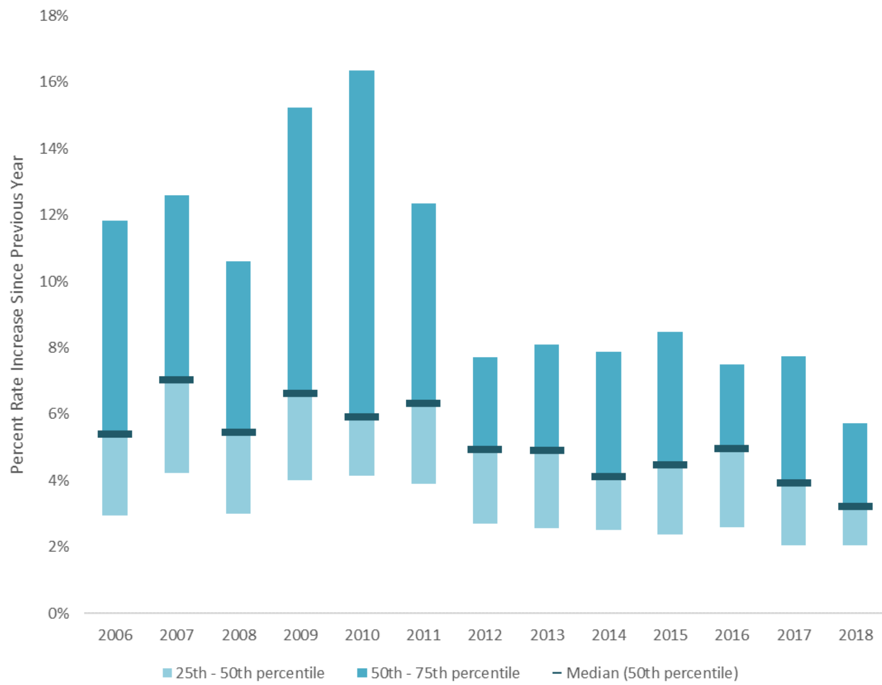
Figure 25: Water Rate Structures Changing Among the Same 179 Water Rate Structures Since 2006



The cohort of rate structures is consistent across all years.

The effects of declining demands during and after the drought are also evident in the magnitude of the rate increases adopted by these 179 water rate structures, as shown in Figure 26. The median rate increases implemented prior to 2012 was around 6 - 7 percent, and a quarter of the utilities that raised rates had rate increases greater than 15 percent in 2009 and 2010. By comparison, since 2012, fewer utilities have raised rates (as shown in Figure 25). Water utilities that did raise rates more consistent and the increases typically ranged between 2.5 percent and 8 percent. The median rate increase was also consistent among these 179 rate structures since 2012, at around 4 - 5 percent per year.

Figure 26: Percent Increase to the Water Bill for 5,000 Gallons/Month in Rate Structures that Raised Rates among the Same 179 Water Rate Structures Since 2006



The cohort of rate structures is consistent across all years. Only rate structures that raised rates are analyzed in each year.

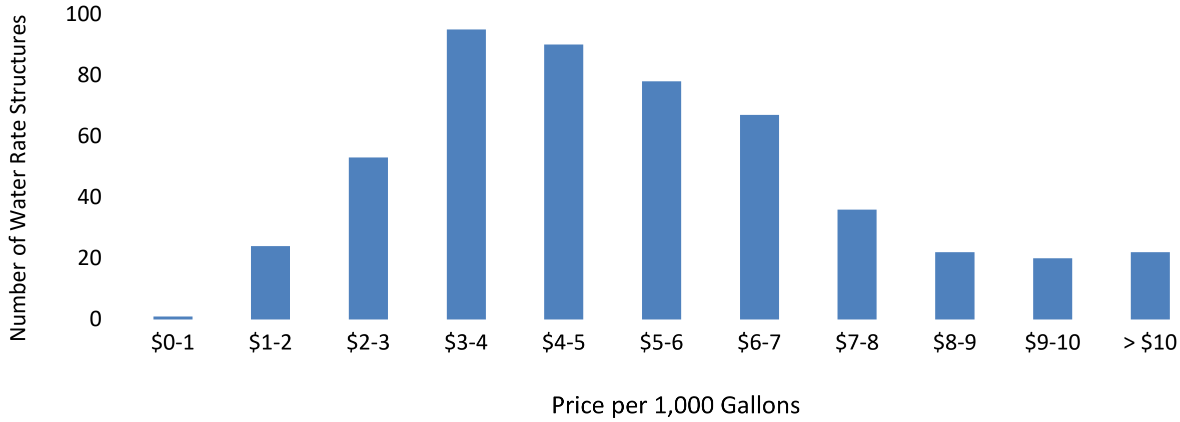
Pricing to Incentivize Water Conservation

Many North Carolinian residents are currently paying water bills under increasing block rate structures (see Figure 8), which increases the volumetric rate as the customer consumes more. If designed well, increasing block rate structures can incentivize customers to be efficient in their water use in order to avoid reaching the higher tiered water rates. In addition, some utilities are charging customers higher irrigation water rates than the standard water rates, which specifically targets incentivizing outdoor water use (see Figure 19). However, there are other methods utilities could use when designing their water rate structures to incentivize efficiency and conservation.

One of the water rate structure components that utilities can manipulate to send a strong pricing signal to encourage water conservation is the rate that customers pay at higher levels of consumption. The annual average residential consumption for most utilities is usually below 5,000 gallons/month. Seasonal use of water can raise consumption levels for some residential customers to two or three times this amount, or more, in peak usage months, which drives up the capital costs of constructing water systems to be able to deliver peak demands. Utilities can discourage excessive discretionary water use by setting high prices for the next 1,000 gallons of water at those high levels of consumption.

The median water volumetric rate at 14,000 gallons is $5.00/1,000 gallons, meaning that a customer would pay another $5.00 in their water bill if they increase their water use from an already-high 14,000 gallons to an even-higher 15,000 gallons. Half of the residential water rate structures charge between $3.50/1000 gallons and $6.63/1000 gallons for the next 1,000 gallons at 14,000 gallons/month (see Figure 27). These rates are only slightly higher than the volumetric rates residential customers are paying near the average level of consumption at 5,000 gallons/month (see Figure 10). One utility is charging $20.00/1,000 gallons for water at 14,000 gallons, strongly incentivizing residential customers to keep their consumption below 15,000 gallons.

Figure 27: Volumetric Rate for Water at 14,000 gallons/month in 510 Water Rate Structures

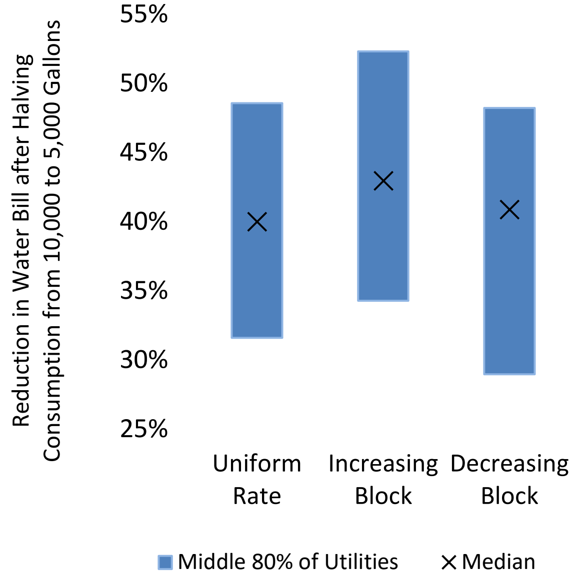


Keeping in mind that most residential customers do not ever use 14,000 gallons in a single month, many customers will never be charged the volumetric rates set at these high volumes. Those customers are likely not irrigating their lawns or using excessive amounts of water to begin with. However, utilities that are interested in incentivizing all of their customers to conserve in order to prevent water shortages or delay expensive expansion projects could do so by charging high volumetric rates at lower levels of consumption, such as the volumetric rate set at near the average consumption levels (see Figure 10). Increasing the volumetric rate at 5,000 gallons/month rather than at 14,000 gallons/month is an effective method to encourage all customers to cut back, rather than just large users or peakers.

Another way to measure the strength of the conservation pricing signal of water rates is to determine how much of a financial reward (decrease in water bill) a customer will receive by lowering their water consumption from a high volume (10,000 gallons) to an average level (5,000 gallons). The reduction in the water bill acts as a price incentive to encourage conservation for large users, and is measured both in terms of absolute bill savings and as a percentage of bill reduction. Figure 28 shows that there are some utilities that reward customers substantially in terms of bill reduction percentage for cutting back (e.g. nearly halving the bill when customers halve their consumption), whereas other utilities provide relatively little incentive (e.g. only a 30 percent reduction in bill).

Interestingly, while some increasing block rate structures clearly send very high conservation pricing signals, there are many increasing block rate structures that send a weaker pricing signal (less than a 40 percent reduction in bill) than some uniform rate structures that achieve 45 percent or higher reductions in bill. Put another way, a utility with a uniform rate structure that charges a high price for water, say $7.00 per thousand gallons, sends a significantly higher pricing signal than a utility that charges $3.00 per thousand gallons even if the utility has an increasing block rate structure. It is possible to design a simple, uniform rate structure to incentivize water conservation as well as, or sometimes better than, many increasing block rate structures currently in use.

Figure 28: Reduction in Monthly Water Bill from 10,000 gallons/month to 5,000 gallons/month



What Utilities Charge Outside their Political Boundaries (i.e. "Outside Rates")

All of the charges presented above refer to what utilities charge customers that live within their political boundaries. Municipal utilities often serve customers who live outside of city limits, and a handful of other utilities specify geographical boundaries within their service areas and identify their customers as residing "inside" and "outside" those boundaries. In many cases, utilities charge different rates for customers living inside or outside the boundary. Overall, 60 percent of water rate structures and 62 percent of wastewater rate structures specified different rates for customers living outside, and the vast majority were for municipal utilities. In fact, 82 percent of the municipal rate structures charged more for outside customers than for inside customers. At 5,000 gallons/month, water rate structures that charge outside customers a different rate are, at the median, charging a water bill that is 1.84 times more than inside customers. For wastewater, the median ratio is 1.93. Most utilities with different outside rates charged less than double the inside charges, as shown in Figure 29. Figure 30 shows median charges for combined residential water and wastewater service for all utilities that have a separate rate schedule for outside customers for both water and wastewater service. For utilities that charge for both water and wastewater and have outside rates, the median combined bill charged to inside customers for 5,000 gallons/month is $80.34, compared to $141.81 for outside customers.

Figure 29: Outside Residential Bills as a Ratio of Inside Bills at 5,000 gallons/month (n=510 water, n=425 wastewater)

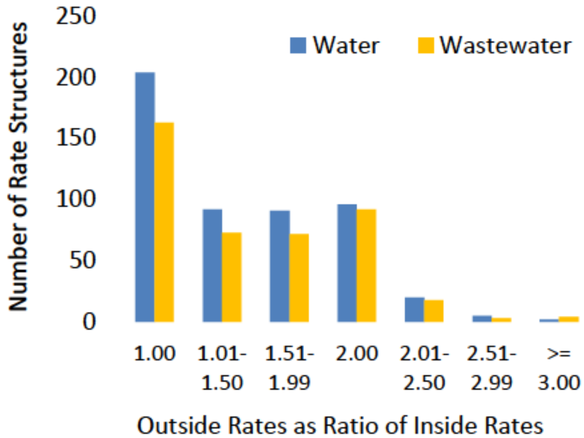
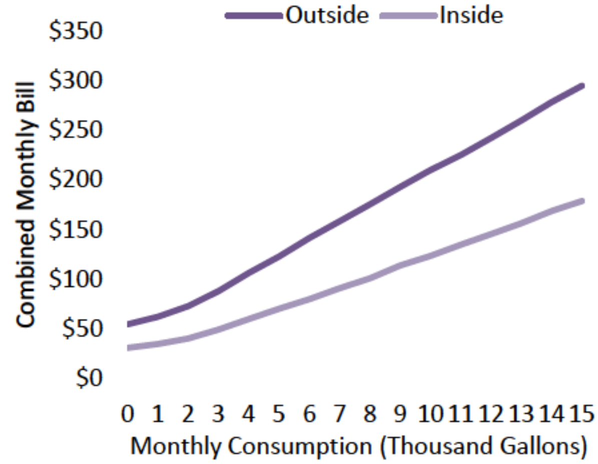


Figure 30: Median Combined Residential Water and Wastewater Bills for Rate Structures with Different Inside/Outside Rates (n=249)



There are at least three reasons why utilities might charge more for outside customers. Inside customers, as citizens of the local government that provides the utility service, bear more of the investment risks of owning and operating a utility. They also bear more of the burden of financing and facilitating its operations through their local government unit[6]. In the case of municipalities, higher outside charges might be part of managing growth and annexation, or to make contributions alongside the property tax base that secures certain types of bonds and loans serving the entire water or wastewater system. For all utilities, outside customers are often more expensive to serve because of lower densities and the fact they reside farther, on average, from the water or wastewater treatment plant than inside customers, increasing costs for distribution and collection.

Affordability of Residential Rates

What the Average North Carolinian Pays for 5,000 Gallons

As mentioned above, the median price for 5,000 gallons/month across all the rate structures is $34.00 for water and $42.00 for wastewater, using "inside" residential rates. This indicates that half of the 510 water rate structures in this sample charge more than $34.00 for water for 5,000 gallons/month, and half of 425 wastewater rate structures charge more than $42.00 for wastewater. However, as shown in Table 5, larger utilities may be charging lower rates because they are able to spread their costs across a large customer base. The utilities in this study serve about 8 million North Carolinians. If we assume that everyone in this sample pays "inside" rates only, the average North Carolinian in this sample would be paying a weighted average[7] of $29.17 for water and $40.26 for wastewater, or

[6] AWWA (2012). *Principles of Water Rates, Fees, and Charges*. Manual of Water Supply Practices: M1. 6th Ed.

[7] The "weighted average bill" is the average bill being paid by customers, taking into account the different utility's rates and service populations, assuming that all of the customers are paying their utility's bill for 5,000 gallons/month.

$78.13 for combined services at 5,000 gallons/month. These numbers represent a good estimate of average bills across the population of the state. The actual average bill for a North Carolinian for 5,000 gallons is likely to be higher, however, since a substantial portion of the citizens are paying “outside” rates that are greater than “inside” rates as shown in Figure 29. Furthermore, some citizens may be paying a portion of their water bill through irrigation rates, making it impossible to accurately estimate what the average North Carolinian actually pays for 5,000 gallons.

Annual Bills as a Percent of Household Income

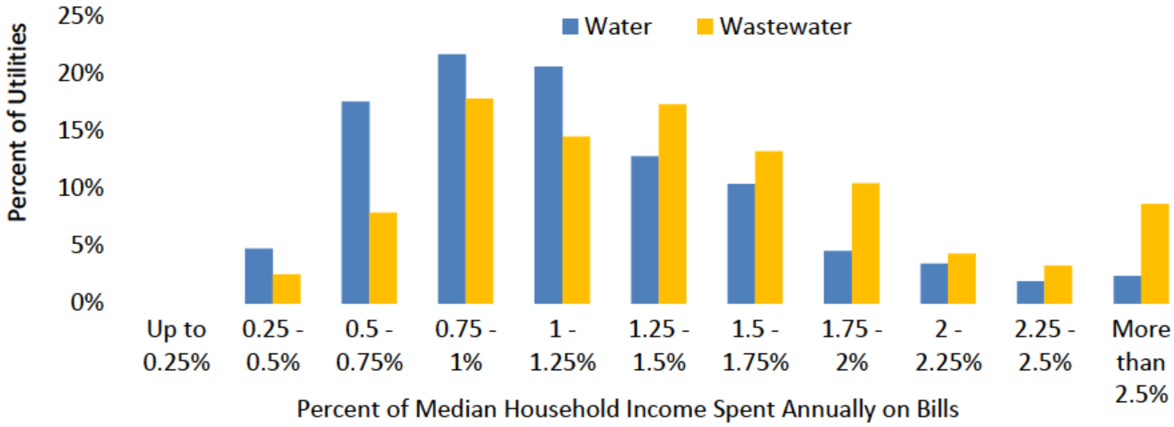
Is the weighted average bill of $78.13 per month for combined water and wastewater for 5,000 gallons too high for most North Carolinians? Compared to monthly electric bills, grocery bills, and even discretionary bills such as cable TV bills or high-speed internet bills, water and wastewater bills usually make up a smaller portion of a household budget. Nevertheless, because citizens may not have an alternative to the water service they are currently receiving, and water service is necessary for public health, and because water and wastewater rates continue to rise faster than inflation, the issue of affordability of rates remains vital.

Affordability is very difficult to assess, and there is no one true, accurate measure for affordability. The most commonly used and most cited measure in the water industry is “percent MHI” – that is, calculating what a year’s worth of water and wastewater bills for an average level of consumption (e.g.: 5,000 gallons/month) is compared to the median household income (MHI) in the community served by the utility. This indicator is easy to calculate by simply using the calculated bill amount and the U.S. Census Bureau’s median household income data from their latest 5-year American Community Survey estimates, available at http://factfinder.census.gov. Each year, the US Census Bureau publishes a new estimate of MHI for each Census Place in the country.

Compared to the 2016 median household incomes of the communities served by the 510 water and 425 wastewater utilities in this survey, annual bills for 5,000 gallons/month range from 0.3 percent MHI to over 4.2 percent MHI for each service, as shown in Figure 31. The majority of water rates fall between 0.5 percent and 1.25 percent MHI, with a median of 1.07 percent MHI across all utilities. Wastewater rates are higher, with the majority of wastewater rates falling between 0.75 percent and 1.5 percent MHI, and a median of 1.36 percent MHI across the utilities. For combined water and wastewater bills at 5,000 gallons/month, half of the utilities charge more than 2.79 percent MHI.

There is no single target for affordability, even in terms of percent MHI. Currently, 57 percent of utilities in North Carolina charge more than 2.5 percent MHI for combined water and wastewater at 5,000 gallons/month.

Figure 31: Annual Bills for 5,000 gallons/month as a Percent of the Serviced Community's 2016 Median Household Income (n=462 water, n=393 wastewater)



While half of a local government's residents make less than the median household income of the community, often utility managers are more concerned with a smaller number of residents—those in the lowest income brackets. Customers who have an annual household income below $25,000 will be paying much higher proportions of their income on basic water and wastewater service than what the percent of median household income numbers reveal. Thus, whereas a utility might have combined rates that amount to 2.5 percent median household income, that same utility might have more than 15 percent of its customers paying 5 percent or more of their annual income for water and wastewater service at 5,000 gallons/month. Furthermore, larger low-income families, or families that live in substandard housing stock with older appliances that are less water efficient, may end up using more water and thereby paying an even higher percentage of their income for essential water service. To comprehensively assess the affordability of a utility's water and wastewater rates using a variety of metrics, utilities are encouraged to download and use the Water and Wastewater Residential Rates Affordability Assessment Tool at www.efc.sog.unc.edu/reslib/item/water-wastewater-residential-rates-affordability-assessment-tool

Do Prices Reflect the True Cost of Water Services in North Carolina?

Comparing rates across the state or among specific utilities is further complicated by the variation in the extent to which utilities charge the full cost of providing service. In FY2016-17, 21 percent of local government water and/or wastewater utilities in North Carolina did not generate enough operating revenues during the year to pay for their day-to-day operations and maintenance expenses and debt service, let alone enough funds to pay for future capital expenses. While these utilities are geographically dispersed, as shown in Figure 32, nearly all were utilities that serve fewer than 10,000 accounts, and 60 percent serve fewer than 1,000 accounts. This reflects the difficulties that small utilities face in generating sufficient revenue from their small customer base to pay for the high fixed costs of operating a utility.

Figure 32: Local Government-Owned Water and Wastewater Utilities' Cost Recovery in FY 2017 (n=341)

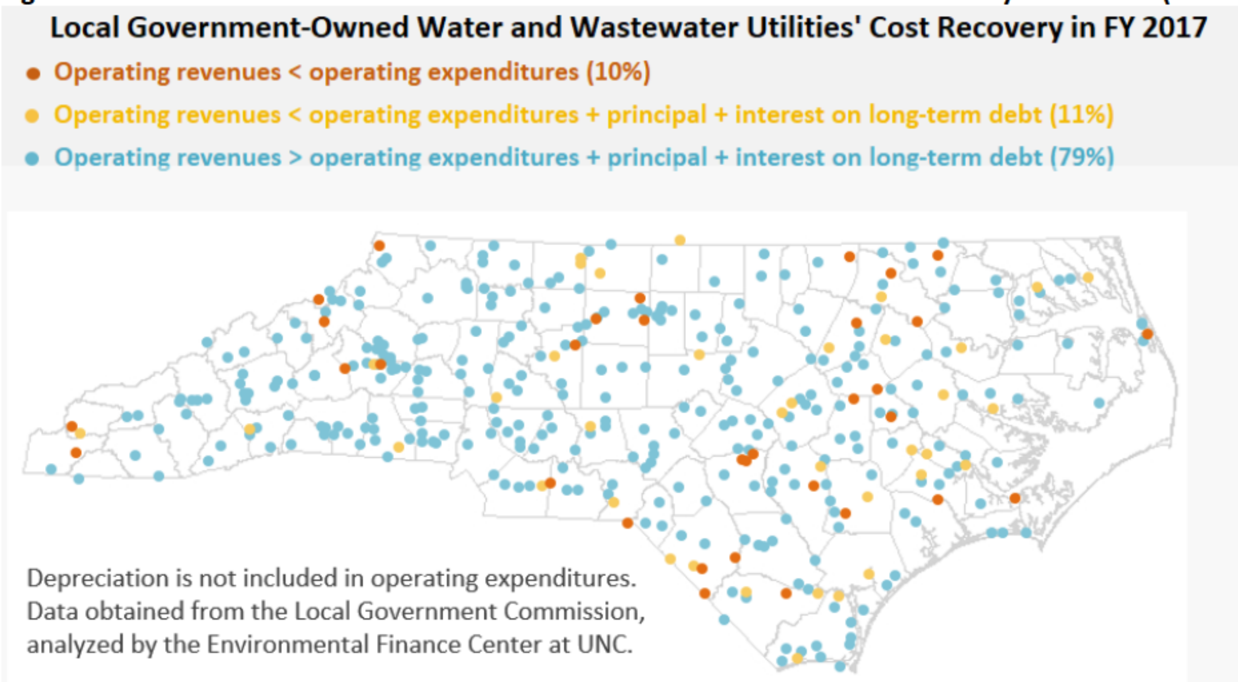
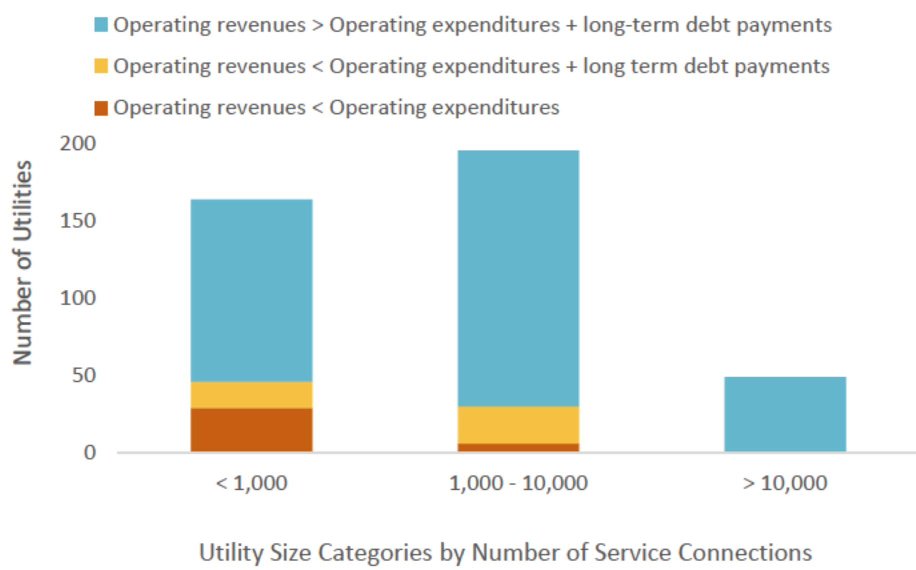


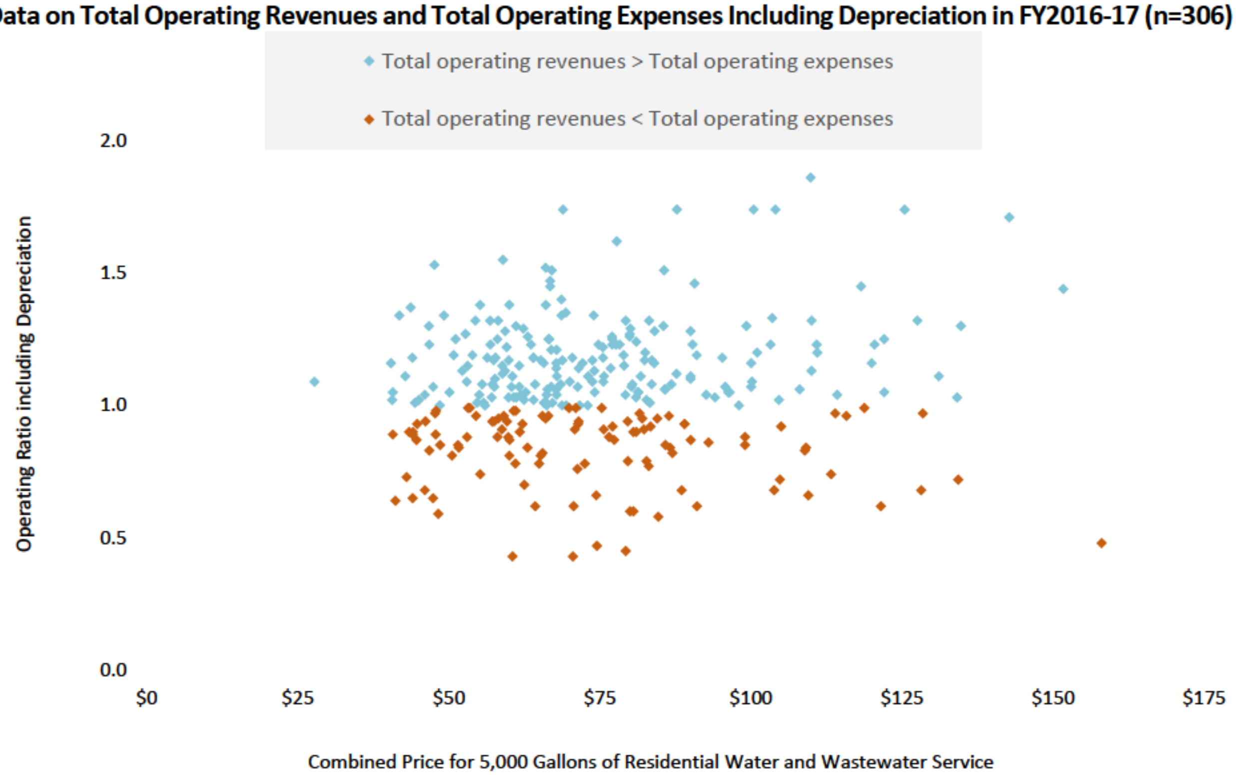
Figure 33: Local Government-Owned Water and Wastewater Utilities' Cost Recovery in FY 2017 by Utility Size (n=409)



Rates that provide enough revenue to balance an annual budget do not necessarily provide enough revenue to cover long term capital and maintenance needs and many utilities charge much less than the full cost of service provision. Figure 34 shows rates from FY 2016-17 in terms of combined water and wastewater charges for customers using 5,000 gallons/month plotted against the ratio of total operating revenues over total operating expenses (including depreciation) from the same fiscal year.

This measure, often referred to as an operating ratio, helps identify if an entity is operating at a financial loss, financial gain, or is breaking even. Financial data were provided by the Local Government Commission (LGC) in the Department of the State Treasurer. The figure shows that many utilities are not covering their total operating expenses, making it difficult or impossible to rehabilitate aging infrastructure, save for operating emergencies, finance system improvements and expansion, and engage in proactive asset management. It is interesting to note that the utilities that did not recover their operating expenses (operating at a financial loss) are not always charging low rates – even some utilities with high rates can be operating at a financial loss. Nevertheless, there are several utilities that charged low rates (to the left of the graph), which resulted in operating at a financial loss (below the horizontal line on the graph) in that fiscal year.

Figure 34: Combined Residential Bill in FY2016-17 for 5,000 gallons/month for Utilities with Reported LGC Data on Total Operating Revenues and Total Operating Expenses Including Depreciation in FY2016-17 (n=306)



In FY 2017, 90 percent of water and wastewater utilities that reported financial data to the Local Government Commission were able to cover operating expenses, and 79 percent had a healthy operating ratio of over 1.2, meaning they could account for depreciation of current assets, as well as save for future capital improvements, emergencies, or other needs. 10 percent of utilities were not able to cover operating expenses including depreciation. As noted in Figure 33, all utilities surveyed this year with operating ratios below 1.0 have fewer than 10,000 service connections.

Operating ratio as calculated here may be a flawed measure, however, due to the distorting effects of book value depreciation. Due to inflation, older systems' assets that were purchased long ago have nominally cheaper prices than assets of plants that are newer. This makes older systems' depreciation expense smaller in comparison to the depreciation of a newer system with the same types of assets. In turn, this means that the operating ratio seems higher (better) for older plants than for newer plants, due to the effect of inflation. Despite this, the measure maintains a level of intuitive power which makes it a useful tool for examining the ongoing capacity for the utility to bring in enough revenue to cover its operating costs. The performance of each utility on several financial indicators and benchmarks can be viewed in the North Carolina Water and Wastewater Rates Dashboard at www.efc.sog.unc.edu/reslib/item/north-carolina-water-and-wastewater-rates-dashboard.

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MARY WYATT TIGER, SHADI ESKAF, AND JEFFREY A. HUGHES

Implications of residential irrigation metering for customers' expenditures and demand

UNLESS THEY CONSIDER THE EFFECTS OF PRICING AND POLICY ON CUSTOMER ACTIONS, UTILITIES PROMOTING INSTALLATION OF IRRIGATION METERS TO ENCOURAGE CONSERVATION MAY INADVERTENTLY PROVIDE INCENTIVES TO INCREASE IRRIGATION WATER USE.

Municipal water utilities across the United States are serving clean drinking water to residential customers to apply to lawns and plants via inground (sprinkler) irrigation systems. This nonagricultural outdoor water demand (defined in this article as municipal irrigation) presents many challenges for water providers. The seasonal nature of the demand drives significant peaks in summertime water use for many US utilities. These peaks require water suppliers to invest in costly source, treatment, and distribution capacity expansions to continue to meet the peak demands of their customers. It is somewhat paradoxical that even as municipal irrigation water demand helps to drive increases in capital costs for water systems, such use is usually considered discretionary for many residential customers during times of water shortage and is more price-sensitive than other end uses of water.

To accommodate the larger volume and flow rate of water desired for residential irrigation systems and to relieve irrigators of unfounded wastewater charges, some utilities offer their customers the option of installing a second water meter (defined here as an irrigation meter) to meter outdoor water use. A backflow prevention device usually is installed with the irrigation meter to prevent accidental contamination of the distribution water system. The residential customer is billed for water use through the two meters, i.e., the irrigation meter for outdoor water use and the standard meter for water flow into the home. Although utilities offer similar services to their nonresidential customers, the focus of this article is residential irrigation metering.

A water provider offering customers the option of installing irrigation meters faces strategic decisions about how to market and incentivize this installation, how to manage separately irrigated water during times of drought, and, most germane to this article, how to charge for the installation of and water flowing through the meter. Optimally these decisions will be shaped by utility goals and objectives. For instance, a utility intent on promoting water conservation may decide to charge higher rates for separately metered irrigation water than for standard-metered water. However, unless the water supplier has considered the possible outcomes of its policies and pricing for irrigation meters, it may find that irrigation customers react counter to utility objectives.

This article describes some of the paradoxes observed among residential irrigation metering strategies and practices and examines their potential consequences, particularly with regard to the relationship between irrigation pricing and irrigation demand. The authors also detail results of irrigation metering at 12 North Carolina utilities, which provide lessons learned for other water providers to consider before implementing their own dedicated irrigation metering initiatives.

IRRIGATION METERING INITIATIVES TAKE DIFFERENT FORMS, TARGET VARIOUS AIMS

Authorities differ on irrigation meter guidance. Some states and regions provide guidance to water providers on whether to encourage the installation of irrigation meters; these recommendations and/or requirements are driven by a variety of motivations. California Assembly Bill 1881, the Water Conservation in Landscaping Act of 2006, requires local entities to install irrigation meters to better measure the volume of water used exclusively for landscaping at properties with more than 5,000 square feet of irrigated landscape (California Assembly, 2006). In 2008, the North Carolina General Assembly passed Session Law 2008-143, commonly referred to as the 2008 Drought Bill, which mandated that starting in July 2009, water systems operated by local governments and all other large community water systems "require separate meters for new inground irrigation systems that are connected to their systems" (NCGA, 2008). According to Bill Holman, chair of the North Carolina State Water Infrastructure Commission (NCSWIC), this requirement was motivated not only by a need to conserve water but also with the aim of more accurately measuring outdoor water use to provide the information necessary to improve water use efficiency (Holman, 2011). With additional and better data on outdoor water use, utilities could design tiered water rate structures and target discretionary water use during water shortages. Furthermore, by separately metering and then disclosing outdoor water use data to their customers, water suppliers might encourage customers to adjust their irrigation practices to achieve greater efficiency in use (Holman, 2011).

In a nearby state, the Metropolitan North Georgia Water Planning District (MNGWPD) took the opposite approach and requested that utilities in its region discourage the installation of irrigation meters by implementing "high fees for irrigation meters purchase and/or installation" (MNGWPD, 2006). The specific reasons behind this suggestion are detailed later in this article, but the MNGWPD's tack alludes to some of the policy decisions embedded in irrigation rate-setting. Not only must a utility decide the most appropriate method to allocate system development charges (often called impact fees) to irrigation meters, it must also set appropriate rates for the water measured through that meter. Water providers typically do not apply wastewater rates to irrigation-metered water because almost all of that water is applied outdoors and is not returned to the wastewater system. Of course, installation of irrigation meters does not result automatically in decreased wastewater flows and operating costs; all the irrigation meter does is measure the volume of water that would have been applied outdoors regardless of a separate meter. The decision not to apply wastewater rates simply recognizes that because the irrigation water is consumed, irrigators are not placing demands on the wastewater treatment system. Another rate-setting approach that recognizes this fact is a "sewer cap," i.e., an upper limit on the amount of standard-metered water use to which wastewater rates are applied. A few of the utilities in the current study have sewer caps on their customers' standard-metered water.

Current study set out to investigate unexplored implications of irrigation metering. Although metering residential irrigation helps utilities monitor and measure outdoor water use, the resource management and financial implications of this initiative have yet to be fully explored. The current research delves into these implications by comparing the irrigation metering practices and pricing of the North Carolina Urban Water Consortium (NCUWC), which comprises 12 large utilities: Cape Fear Public Utility Authority (CFPUA), Charlotte-Mecklenburg Utilities (CMU), Fayetteville Public Works Commission (FPWC), Greenville Utilities Commission (GUC), Orange Water and Sewer Authority (OWASA), Winston-Salem/Forsyth County Utilities Division, and the water divisions for the cities or towns of Burlington, Cary, Durham, Greensboro, High Point, and Raleigh (Figure 1).

Irrigation practices and pricing differed significantly among these 12 utilities, and these differences serve to highlight the implications of various strategies. The authors looked at the extent of residential irrigation metering at the different utilities, the connection and system development fees charged, and both the inherent incentives and the ultimate residential financial consequences of irrigation pricing. The experiences of these water providers can benefit other US utilities that are now requiring, offering, or considering offering dedicated residential irrigation meters.

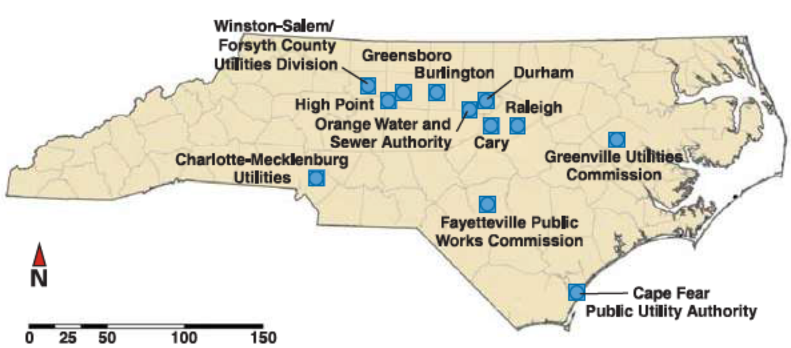
Irrigation restrictions, policies, and practices provide context for the study. Before the passage of North Carolina's Drought Bill, all 12 water suppliers participating in the current research offered and installed dedicated residential irrigation meters for potable water. Most of the utilities gave their residential customers a choice about whether to install a dedicated irrigation meter, but FPWC and High Point customers with inground irrigation systems were required to install irrigation meters, even before the Drought Bill's provisions came into effect.

In 2007 and 2008, when North Carolina experienced one of its most severe droughts on record and water resources became scarce, many water suppliers imposed mandatory outdoor watering restrictions to curtail use. For most utilities, however, the majority of water being applied to outdoor landscapes in their service area flowed through standard household meters rather than dedicated irrigation meters. Therefore, utilities had no accurate method for determining how much of their treated water was being used for irrigation and could only estimate the amount of water potentially being saved by irrigation restrictions. Moreover, for those customers without dedicated irrigation meters, water providers were unable to systematically enforce irrigation restrictions. Instead, they relied on staff to physically observe restriction violations.

During the drought, a few utilities tried enacting more stringent restrictions on their customers with dedicated irrigation meters. For example, CMU issued watering citations to customers with irrigation meters that used more than 2,000 cubic feet of water in one month, under the assumption that any use above this amount would be in violation of the utility's watering restrictions. In a more drastic move, OWASA cut off all 220 of its system's irrigation meters for six months during the drought. Although systematic, these measures could be considered inequitable given that those customers who did not have an irrigation meter were able to continue to irrigate through their standard household meters and bypass both the restrictions and any accompanying penalties.

In 2009, researchers at the Environmental Finance Center (EFC) at the University of North Carolina's School of Government in Chapel Hill analyzed billing records from five NCUWC utilities and used an original algorithm to estimate the number of households using their standard household meters to irrigate through an inground irrigation system and the amount of water being applied (Boyle et al, 2011). This was performed by profiling water use patterns for those households with irrigation meters and identifying households without irrigation meters that had similar use patterns. The analysis indicated that significant numbers of households appeared to be irrigating using inground irrigation systems via their standard meter (Table 1). It became clear that the five utilities had two types of residential irrigators: those irrigating through a standard meter and those irrigating through an irrigation meter.

FIGURE 1 Map of the 12 North Carolina water utilities studied



METHODOLOGY DESIGN ELUCIDATED IRRIGATION USE, PRICING, AND POLICIES

In 2010, the authors of the current study collected data on irrigation pricing, policies, and practices from the 12 NCUWC members and compared them against one another to draw observations about the financial and resource management implications of increased irrigation meter installation. The analysis focused on the economic incentives (and disincentives) for customers to retroactively install an irrigation meter. With this intention, the authors collected and confirmed information about each utility's impact fees and/or connection fees for irrigation meters, backflow prevention policies and operation, and irrigation water use and rates and then analyzed the effect of these practices. In addition, the research integrated findings on residential irrigation watering trends from a recent EFC study that analyzed customer consumption and billing records of five of the twelve utilities for 30 months (Boyle et al, 2011).

The current research focused specifically on the residential customer class because it accounts for the largest proportion of customers at these utilities. In addition, for most utilities, the majority of irrigation meters belong to residential customers. Furthermore, whereas commercial, industrial, or institutional customers vary greatly in their rate classes and demand patterns, residential customers are easier to compare based on common assumptions.

Study ascertained the extent of residential irrigation metering. To determine the level of irrigation metering coverage at each facility, utility staff provided the total numbers of all meters, residential meters, and irrigation meters at the end of the 2009 calendar year. Utility staff also supplied the total gallons used for irrigation measured through irrigation meters in the 2009 calendar year. The authors supplemented this information with the results of the previous billing record analysis conducted at five of the utilities in order to gain insight into irrigation watering trends and the prevalence of dedicated irrigation meters (Boyle et al, 2011).

Connection and system development fees varied among utilities. The authors of the current study collected and compared the tap and system development fees charged to residential customers for standard household and irrigation meters. System development charges, or impact fees, are associated with developing system capacity to accommodate the extra demand placed on the system by the new customer. In North Carolina, as in many states, utilities have great flexibility in setting tap and impact fees as long as these fees do not exceed the costs the utility incurs in labor and materials to install the water line and meter and in capital costs required to size the water system to meet the peak demands at the new connection. Given this article's focus on customer expenditures rather than actual utility costs, the up-front fees charged to customers for irrigation meter installation were assessed.

Because the terminology and methodology for calculating the up-front charges of meter installation varied extensively among the 12 utilities, the analysis in the current study was limited to tap (i.e., connection), impact, system development, facilities investment, and acreage fees; ancillary charges such as application fees and deposits were not included in the comparison. In order to compare a consistent price, the authors made three basic assumptions.

- The tap and meter were installed by the utility. (This was the case for all utilities except Greensboro, which did not install the meters.)
- Fees included the cost of running a water line to the meter.
- The connection required no water main extensions.

Comparisons were made for four scenarios. In the first scenario, a new residential customer installs a ¾- or ⅝-in. water meter and a 4-in. sewer line for all indoor and outdoor purposes. The second scenario called for a new residential customer to install a ¾-in. water meter and a 4-in. sewer line for indoor purposes, as well as a 1-in. irrigation meter for outdoor water use on a split line. In the third scenario, an existing residential customer installs a new 1-in. irrigation meter off a split line between the main and the nonirrigation meter. In the fourth scenario, an existing residential customer installs a new 1-in. irrigation meter off a new line that directly taps into the main.

Irrigation pricing and its effects were assessed. The authors analyzed the rates that the 12 utilities charged for water used for irrigation and compared rates for customers using dedicated irrigation meters versus those who did not. Specifically, the analysis addressed the following questions.

- Is there a financial incentive (or disincentive) for existing residential customers to install an irrigation meter retroactively? Do customers with irrigation meters pay more or less for their irrigation water than customers without irrigation meters?
- Will a household's savings achieved from not paying wastewater rates eventually pay off the up-front meter installation costs plus irrigation rates? If so, how long will it take for a household to break even and begin to accumulate a

TABLE 1 Comparison of known and estimated irrigating households between July 2007 and June 2008

Utility	Known		Estimated		
	Percent of Households With Irrigation Meters	Percent of Total Residential Water Volume Measured by Irrigation Meters	Percent of All Households That Irrigate With Inground Systems	Percent of Households That Irrigate Through Standard Meter	Percent of Total Residential Volume Used for Irrigation But Not Metered Separately
Utility 1	8	9.5	12	4	5.1
Utility 2	3	4.9	4	1	1.7
Utility 3	3	4.8	4	1	2.6
Utility 4	2	2.6	12	10	8.2
Utility 5	0.2	0.4	6	4.8	8.3

Adapted from Boyle et al, 2011.

These data reflect trends and analysis by Boyle et al (2011) of five of the twelve North Carolina utilities participating in the current study.

financial net benefit for choosing to install an irrigation meter?

In order to answer these questions, monthly charges were calculated over the course of a year for irrigation water that flowed through an irrigation meter and through a standard household meter, using each utility's rates as of May 2010 (EFC, 2010). This calculation was made for households both inside and outside city limits, where applicable. North Carolina state law does not prohibit municipalities from adopting different user-fee rate schedules for services provided extraterritorially (Millonzi, 2006). Most municipalities (84%) charge higher rates for customers outside the municipal boundary, with these rates usually close to double the rates for customers within the municipality (Eskaf & Nida, 2011). Depending on the utility, each type of irrigator (inside city limits with irrigation meter, inside city limits without irrigation meter, outside city limits with irrigation meter, and outside city limits without irrigation meter) could be receiving a completely different pricing signal for irrigation water use.

For modeling purposes, the hypothetical irrigator used as much as four times as much water in the summer as in the winter and two and three times as much in the shoulder months (spring and fall), following the pattern shown in Table 2. This pattern was based on use patterns of known irrigators served by the five NCUWC members previously studied by Boyle and co-workers (2011).

> Economics and, to some degree, utility communications influence a household's decision to connect or not connect to an irrigation meter.

Using these calculations, the authors conducted a household expense analysis, modeling the cumulative up-front meter installation costs, rates including annual adjustments, and backflow inspection fees over several years in order to compare the price each utility charged to the customer for residential irrigation with and without an irrigation meter. The customer's break-even point was then determined for each water provider. The following assumptions were included in the customer expenditure model:

- Residential water use, both indoors and outdoors, followed the monthly consumption pattern that is shown in Table 2.
- Irrigation rates and combined water and wastewater rates were increased from their May 2010 starting points by 5% per year.
- Average up-front costs for installing backflow prevention equipment and the on-going backflow-prevention-equipment inspection fees (as surveyed by EFC) were applied to the irrigation meter.
- The present value of costs was calculated using an annual discount rate of 5%.

FINDINGS REVEALED UNEXPECTED RESULTS OF IRRIGATION METERING EFFORTS

Billing data helped define extent of residential irrigation metering. In 2009 the percentage of all meters that were irrigation meters varied among the 12 utilities from a low of 1.1% at OWASA to a high of 14.3% at Cary, which included reclaimed water irrigation meters (Table 3). By comparison, the percentage of residential meters at the 12 water providers varied between 72 and 97%, indicating that the prevalence of irrigation meters was low. As noted previously, irrigation meters were required only on residential irrigation systems served by FPWC and the city of High Point; dedicated irrigation meters were optional for customers served by the other utilities. As shown in Table 1, however, no utility (in the

TABLE 2 Typical monthly water use for a North Carolina residential household with summertime irrigation

Meter	Use Measured	Typical Water Use by Month—*gal*											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No irrigation meter	Indoor and outdoor use combined	4,000	4,000	4,000	12,000	12,000	16,000	16,000	16,000	12,000	12,000	8,000	8,000
With irrigation meter	Indoor	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
	Outdoor	0	0	0	8,000	8,000	12,000	12,000	12,000	8,000	8,000	4,000	4,000

Adapted from Boyle et al, 2011.

These data reflect trends and analysis by Boyle et al (2011) of five of the twelve North Carolina utilities participating in the current study.

Boyle et al, 2011, study) was able to achieve 100% coverage of all residential irrigation systems with irrigation meters, whether or not the meters were mandated.

Regardless of whether the customer had an irrigation meter, the quality of service water was virtually the same except for Cary reclaimed water customers. For customers with or without an irrigation meter, potable water came out when the irrigation system came on. However, these two types of customers were charged significantly different rates for the same service and affected the utility's revenue stream in different ways. Additionally, from a public health perspective, these two types of customers presented varying degrees of risk to water quality. If a utility does not have a reliable method of identifying customers who have inground irrigation systems but no irrigation meter, it cannot determine whether those customers pose a threat to public health by not complying with backflow-prevention requirements.

More than likely, economics and, to some degree, utility communications influence a household's decision to connect or not to connect to an irrigation meter. Mandating installation of irrigation meters for inground irrigation systems may increase irrigation metering but will not achieve total compliance because many customers will already have sprinkler systems connected through their standard meter. Utilities that want to maximize the use of irrigation metering in order to monitor outdoor water use or for other enforcement reasons should carefully consider their up-front fees and irrigation water pricing as well as the marketing strategy they use to encourage irrigation metering. One approach would be to replicate the billing data analysis performed by Boyle and co-workers (2011) to identify customers who may have an irrigation system but are not connected to an irrigation meter and then strongly market installation of irrigation meters to this targeted group.

Table 3 also shows the level of irrigation-metered water use at the utilities. Annual irrigation-metered water use per meter ranged from 24,000 (OWASA) to 166,000 gallons (CMU), with an average of 119,000 gallons per year. A severe drought in 2007–08 and varying utility watering restrictions post-drought influenced some of these results. For example, irrigation meter data for OWASA were not available for 2009, and the utility's 2008 water use data indicated that it had the lowest per-meter irrigation water use. However, this low use can be attributed in part to the fact that the utility turned off service to all irrigation meters from Jan. 1, 2008, through Apr. 11, 2008.

The supplemental billing-data analysis uncovered information on the amount of water used for residential irrigation (Boyle et al, 2011). Analyzing only the residential customers with irrigation meters over a 30-month period, the authors compared the volume of water flowing through dedicated irrigation meters

TABLE 3 Use of irrigation meters in 2009

Utility	Total Number of Meters	Residential Meters %	Number of Residential and Nonresidential Irrigation Meters	Residential and Nonresidential Irrigation Meters %	Annual Total Irrigation-Metered Water Use *mil gal*	Annual Irrigation-Metered Water Use Per Meter *gal*
Burlington	21,000	93	800	3.8	Does not track	Does not track
Cary*	50,537	79	6,627 potable, 630 reclaimed	13.1 potable, 1.2 reclaimed	468.813 potable, 67.485 reclaimed	70,743 potable, 107,119 reclaimed
CFPUA	67,023	97	1,780	2.7	222.273	124,872
CMU	242,745	89	7,477	3.1	1,242.507	166,177
Durham	81,935	87	2,372	2.9	390.237	164,518
FPWC	87,679	85	6,844	7.8	911.591	133,196
Greensboro	100,997	72	3,556	3.5	222.925	62,690
GUC	33,524	87	1,439	4.3	232.898	161,847
High Point	41,196	86	1,329	3.2	217.239	163,460
OWASA†	19,387	93	220	1.1	6.730	24,364‡
Raleigh	165,353	89	6,862	4.1	944.948	137,707
Winston-Salem	125,701	NA	4,865	3.9	495.692	101,889

CFPUA—Cape Fear Public Utility Authority, CMU—Charlotte-Mecklenburg Utilities, FPWC—Fayetteville Public Works Commission, GUC—Greenville Utilities Commission, NA—not available, OWASA—Orange Water and Sewer Authority

*As of July 1, 2009
†As of Dec. 31, 2008
‡Total is low because irrigation meters were turned off Jan. 1, 2008, through Apr. 11, 2008, and restrictions were in place for the rest of the year.

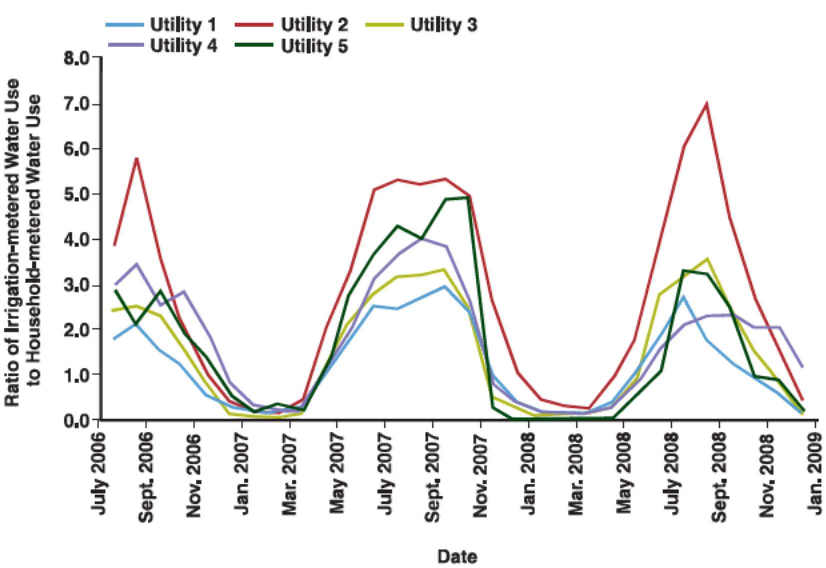
with the volume flowing through standard meters. The monthly ratios for five of the utilities are shown in Figure 2. These residential customers usually used their irrigation meters between April and November, using two to seven times as much water outdoors as they did indoors at the peak month. This peaking ratio varied significantly among the five utilities but revealed the extent to which residential irrigation drives utility peak demand, which explains the desire of water suppliers to meter irrigation use for monitoring and enforcement purposes.

Connection and system development fees help utilities recover costs. Most utilities charge up-front fees for all meter installations, including irrigation meters. Connection (tap) fees are usually assessed to compensate the utility for the time and materials involved in installing the meter. Some utilities also assess system development fees, or impact fees, as a way for customers to compensate the water provider for their contribution to the utility's peak demand that drives up system capital costs. As shown in Figure 2, irrigation demand peaked at much higher levels than indoor water demand for the five utilities studied. Utilities may use this peaking behavior as justification for charging higher impact fees to irrigation meters than to standard meters.

Unless there is a mandate to install irrigation meters for inground irrigation systems, a new residential customer connecting to the water system for the first time could decide to pay only the fees associated with installing a standard household meter and choose to connect the irrigation system to the home's plumbing, drawing irrigation water from the standard meter (scenario 1 in Figure 3). However, under North Carolina's recent mandate requiring installation of irrigation meters for new inground irrigation systems (NCGA, 2008), this customer now must pay the additional up-front costs for a second meter (scenario 2 in Figure 3). In scenario 1, a new residential customer hooking up to standard water and sewer service pays $1,990 in High Point or $8,481 in OWASA. In scenario 2, the same customer must also install an irrigation meter, paying an additional $350 (for a total of $2,340) in High Point or $6,479 (for a total of $14,960) in OWASA's territory. On average across the 12 utilities, it will cost a residential customer an additional $1,371 in up-front costs to install an irrigation meter. These high costs may help explain why some residential customers with irrigation systems chose not to install irrigation meters, regardless of the relief from wastewater rates. High up-front costs may be difficult for the average customer to pay in a lump sum, and utilities that allow customers to pay the up-front costs over time may help increase irrigation metering. The difference in the total up-front costs between a standard and irrigation meter is the cost levied to residential customers for mandated irrigation metering; that difference constitutes additional revenue for the utility. However, as explained in the subsequent section, in some cases those costs to the customer (and revenue to the utility) are counterbalanced by the cost savings a customer achieves by not paying wastewater rates.

Utilities must consider the inherent incentives and residential financial effect of irrigation pricing. Table 4 summarizes which of the 12 participating water providers applied a separate rate structure for irrigation-metered water, i.e., one that differs from the rate structure applied to standard-metered water in May 2010. In this study, nine utilities (plus Cary's reclaimed irrigation rate structure) had separate rates for irrigation-metered usage; in comparison, only 11% of the utilities in North Carolina (including the nine from this study) had separate irrigation rates in 2011 (Eskaf & Nida, 2011). This suggests that North Carolina's larger utilities were more likely to have separate irrigation rates than were the smaller utilities in the state.

FIGURE 2 Ratio of irrigation-metered (outdoor) water use over standard household-metered (indoor) water use among households that had both meters installed



Adapted from Boyle et al, 2011

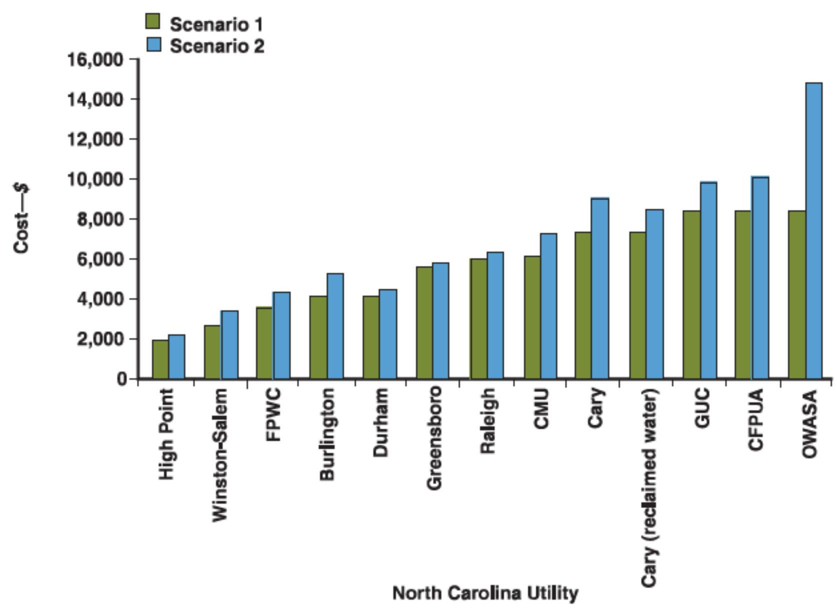
Of the utilities with separate irrigation rates, many set those rates relative to their residential water rate structure. For those with increasing block-rate structures for residential water rates, irrigation rates were set at the higher-tier levels. For example, CFPUA charges all irrigation at rates equivalent to the third tier (their highest tier) of water consumption metered through a standard meter. The rates for reclaimed water in the town of Cary are an exception. Cary's reclaimed water rates are the same as its lowest tier rate for residential water, regardless of volume, thus providing a discount for using reclaimed water rather than potable water to irrigate.

In 2009, EFC researchers conducted a study for the NCSWIC on the relationship between utility rates and water use in North Carolina and found that the marginal price (the price of purchasing an additional 1,000 gallons) for water and wastewater combined were influential on the average water use of residential customers (Hughes et al, 2009). The higher the combined marginal price, the lower the average residential water use. This relationship was not as evident when water rates alone were considered and wastewater rates were excluded from price. In other words, residential customers' water use seemed to be affected by the total combined water and wastewater rates, not just the water portion. Accordingly, Figure 4 compares the May 2010 price of an additional 1,000 gallons through an irrigation meter (being charged just the irrigation rates or the water-only rates) with the marginal price of water and wastewater combined through a standard meter (water plus wastewater rates). The figure compares the marginal irrigation price at 10,000 gallons per month through an irrigation meter with the marginal combined price at 14,000 gallons per month through an irrigation meter. The two consumption points were chosen to best reflect the marginal price for the same amount of irrigation water (10,000 gallons), assuming that the first 4,000 gallons metered through the standard meter are for nondiscretionary indoor purposes only. Results for all 12 utilities showed that the marginal price for 1,000 gallons of irrigation water was cheaper when metered through an irrigation meter than when metered through a standard meter. Even though nine of the utilities charged higher irrigation rates than water rates, the elimination of the wastewater rates provided a net decrease in the rates applied to irrigation-metered water.

This effect seems counter to the utilities' intention of charging more for a discretionary use of water that drives peak seasonal demands and requires costly capital investments. Although water providers purposefully set irrigation rates higher than the standard water rates both to recover the additional costs of meeting this demand and to encourage the efficient use of irrigation water, the utilities in this study actually set a pricing incentive to use more water when they removed wastewater rates. This poses a conundrum for utilities that promote the installation of irrigation meters for purposes of monitoring, controlling, or encouraging conservation of discretionary uses of high-volume water: the installation of the irrigation meter provides a net price break to the customer, which encourages customers to use more irrigation water, not less.

This finding clarifies why the MNGWPD made its suggestion that utilities discourage the use of irrigation meters as a water conservation strategy. Yet, as NCSWIC Chair Bill Holman pointed out, there are conservation benefits to promoting the installation of irrigation meters. By measuring and monitoring outdoor water use and providing customers with data on that use, utilities may encourage some of their customers to use outdoor water more efficiently.

FIGURE 3 Up-front costs of installing a standard meter (scenario 1) versus installing both a standard meter and an irrigation meter (scenario 2)



CFPUA—Cape Fear Public Utility Authority, CMU—Charlotte-Mecklenburg Utilities, FPWC—Fayetteville Public Works Commission, GUC—Greenville Utilities Commission, OWASA—Orange Water and Sewer Authority

There are at least two scenarios in which irrigation rates may exceed water and wastewater combined rates. One is if the irrigation rates are set at a level that is greater than the sum of water and wastewater rates. The other scenario is if the utility applies a cap on wastewater rates, i.e., an upper limit on the amount of standard-metered water use to which wastewater rates are applied. CFPUA, CMU, GUC, and OWASA charge wastewater rates for all water flowing through the standard meter up to 2,400 cubic feet and 30,000, 25,000, and 15,000 gallons per month, respectively. Only water rates, and not wastewater rates, are applied to water flow that surpasses the cap. Sewer caps typically are adopted under the assumption that residential water use beyond a certain high-level point is most likely consumptive (i.e., applied outdoors) and will not be flushed into the sewer, requiring wastewater treatment, and therefore, should not be charged for wastewater treatment. Relative to their standard-metered irrigating counterparts, customers of utilities with sewer caps who irrigate through an irrigation meter are paying as much or more for their irrigation water. In this case, these irrigation-metered customers are incentivized to use less water than their standard-metered counterparts. When applied, sewer caps decrease the financial incentive for conservation of outdoor water use among standard-metered irrigators. Sewer caps also reduce the incentive for a residential customer to install an irrigation meter because the customer is already receiving a break on wastewater rates for some or most of his or her outdoor water use.

Given that for all the utilities in the current study, the irrigation rates were less expensive for the customer than combined water and sewer rates, the authors decided to calculate the length of time it would take for an irrigation customer to recoup the up-front costs of installing an irrigation meter. To summarize the differences in customer expenditures for irrigating through a standard meter versus irrigating through an irrigation meter, a payback point was calculated for residential customers both inside and outside city limits, where applicable. The payback point is the break-even point at which the up-front costs of installing an irrigation meter and backflow-prevention device plus the ongoing irrigation rates and routine backflow-inspection costs equal the savings gained from not paying the standard combined water and wastewater rates (after adjusting for inflation and incrementally increasing rates each year). After this payback point, the residential customer begins to accumulate a net financial savings for having installed an irrigation meter.

As shown in Table 5, the payback point for the 12 utilities in this study varied widely, ranging from 1.9 years for Cary's customers using reclaimed water to more than 42 years for OWASA residential customers, to not within the customer's lifetime at CFPUA. At the majority of the utilities, prices were set at rates such that payback occurs within five to 10 years, under the modeling assumptions described in this methodology. For example, an irrigation customer in Burlington would recover the up-front costs of $1,100 to install an irrigation meter in year seven. At the other end of the spectrum, however, OWASA's high

TABLE 4 Summary of irrigation rates in May 2010

Utility	Separate Irrigation Rates	Structure	Relation to Residential Water Rates
Burlington	No	Decreasing block	Same as residential water rates
CPFUA	Yes	Uniform	At tier 3 rates residential water rates
Cary (potable)	Yes	Increasing block	At tier 3 and tier 4 residential water rates (break at 15,000 gallons)
Cary (reclaimed)	Yes	Uniform	At tier 1 residential water rates
CMU	Yes	Increasing block	At tier 3 and tier 4 residential water rates (break at 1,600 cubic feet)
Durham	Yes	Uniform	At tier 4 residential water rates
FPWC	Yes	Increasing block	Starting higher than tier 4 residential water rates
Greensboro	Yes	Uniform	At tier 4 of residential water rates
GUC	No	Uniform	Same as residential water rates
High Point	Yes	Uniform	Higher than residential water rates
OWASA	Yes	Uniform	Higher than tier 3 of residential water rates
Raleigh	No	Uniform	Same as residential water rates
Winston-Salem	Yes	Increasing block	Same as residential water rates until tier 5, then higher

CFPUA—Cape Fear Public Utility Authority, CMU—Charlotte-Mecklenburg Utilities, FPWC—Fayetteville Public Works Commission, GUC—Greenville Utilities Commission, OWASA—Orange Water and Sewer Authority up-front meter installation costs make choosing to install an irrigation meter financially unattractive. For CFPUA customers, the high-tier 3 rate applied to all irrigation-metered water is almost as high as the utility's tier 1 and tier 2 combined water and wastewater rates. Water providers face a balancing act of pricing their up-front and irrigation water rates relative to their standard water and wastewater rates so as to shorten the payback period and encourage the installation of irrigation meters while maintaining high enough irrigation rates to encourage water conservation and efficiency of water use outdoors.

In addition, the payback point may vary significantly for residential customers in different parts of a utility's service area. Residents living inside and outside the city limits may be charged different rates by the same municipal utility and potentially receive very different price signals. An example of this discrepancy is shown in Figure 5, which compares the payback points of a residential irrigation customer outside of the Cary town limits with that of a residential irrigation customer who is inside the town limits. The figure shows that a Cary irrigation customer outside of town limits recovers the up-front costs of an irrigation meter more quickly (by about four years) than an irrigation customer inside the town limits. The irrigation-connection fees are the same for both types of customers; it is the difference in water and wastewater rates applied outside the town limits that drives the change in the payback point. Specifically, Cary residential customers outside the town limits are charged triple the water, wastewater, and irrigation rates that customers inside the town limits are charged. Therefore, the money saved by not paying the wastewater charges accelerated the payback for a residential customer irrigating through an irrigation meter outside the town limits.

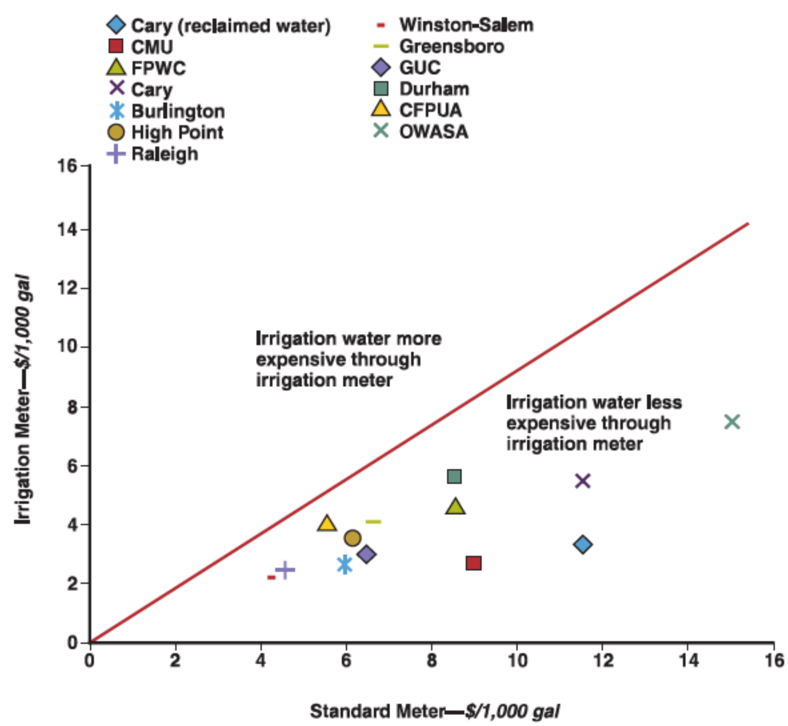
UTILITIES MUST CONSIDER ALL RAMIFICATIONS OF IRRIGATION METERING

Significant benefits are associated with dedicated irrigation metering. Separately metering residential irrigation helps water suppliers monitor outdoor water use and provides options for enforcing watering restrictions that can be used to better manage peak flows of discretionary water use during periods of water shortage. A utility can use data on irrigation water use to set fairer rates and system development charges for both standard and irrigation meters. In addition, it is easier for a utility to install and monitor backflow-prevention devices when a dedicated meter is installed for the irrigation system. For these reasons, utilities, state regulators, and others such as conservationists and public health groups promote the installation of dedicated residential irrigation meters.

Additionally, this metering approach has the potential benefit of increasing revenue for the utility from tap and system development charges (although in some cases connection fees alone may cover only the utility's costs in installing the meter). With an increase in irrigation metering, utilities should also expect an increase in backflow-prevention activities. If the utility provides backflow inspections, it can expect an increase in revenues from these services as well.

Separately metering and billing residential irrigation water may have unintended effects on water use and pricing. Any water provider implementing an irrigation-metering initiative should carefully consider the implications and unanticipated consequences of irrigation metering and

FIGURE 4 Marginal price of irrigation water through an irrigation meter versus through a standard meter



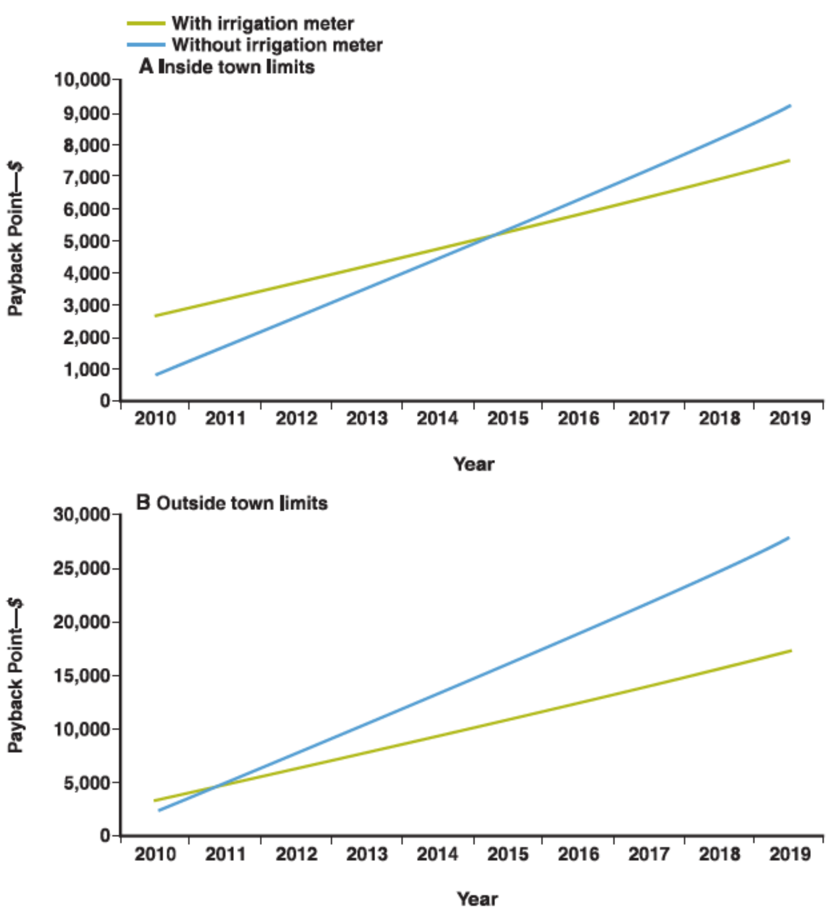
CFPUA—Cape Fear Public Utility Authority, CMU—Charlotte-Mecklenburg Utilities, FPWC—Fayetteville Public Works Commission, GUC—Greenville Utilities Commission, OWASA—Orange Water and Sewer Authority

TABLE 5 Number of years before payback point, i.e., point at which an irrigating household installing an irrigation meter breaks even and begins to accumulate a net financial savings

Utility	Payback Point—*years*
Cary (reclaimed)	1.9
CMU	4.9
FPWC	5.4
Cary (potable)	6.1
High Point	6.5
Burlington	7.0
Raleigh	8.2
Greensboro	9.1
Winston-Salem	10.7
GUC	11.6
Durham	18.9
OWASA	42.4
CFPUA	Not within a lifetime

CFPUA—Cape Fear Public Utility Authority, CMU—Charlotte-Mecklenburg Utilities, FPWC—Fayetteville Public Works Commission, GUC—Greenville Utilities Commission, OWASA—Orange Water and Sewer Authority

FIGURE 5 Comparison of irrigation payback points for residential customers inside and outside Cary, N.C., town limits



billing policies on actual and calculated water demands, as well as the revenues collected from variable usage. A utility that installs more irrigation meters might calculate a decrease in average household water use by dividing total standard-meter residential use by the number of residential accounts. However, this perceived decrease could be false. Because residential customers installing irrigation meters will be running their irrigation systems through the dedicated meter, their standard meter will measure less flow. If water suppliers want to measure and report a true average for household water demand, they must calculate the water demand from both the residential irrigation meters and the residential standard meters. Unfortunately, utility billing systems are not designed to easily provide this type of analysis.

When a water provider does conduct a careful analysis and calculates a true household water demand for indoor and outdoor purposes, it may find that average household water use has in fact increased following installation of irrigation meters. This increase will likely be a result of the utility providing a net reduction to the charges applied to the irrigation-metered water use, compared with the combined water and wastewater rates that would otherwise be applied. By not charging irrigation water rates high enough to completely compensate for the elimination of wastewater rates applied to the irrigation-metered water use, water providers inadvertently weaken the financial incentive to conserve water use for this peaking, discretionary water demand. (Utilities with sewer caps may be an exception because irrigation use above the cap is not charged wastewater rates in any case.)

If water providers want to send a conservation signal to irrigation customers, they may need to consider setting irrigation rates higher than the combined water and wastewater rates (rather than simply setting them higher than water rates) and also give special consideration to the differences in price signals sent to customers outside city limits. If a utility wants to adopt this kind of rate schedule while simultaneously encouraging dedicated irrigation-meter installation, it may want to provide alternative incentives to reduce the up-front costs of installing an irrigation meter.

Setting costs of irrigation-meter installation and ongoing rates is a balancing act. The up-front costs of irrigation-meter installation are associated with the costs of installing a meter and developing system capacity to accommodate the extra demand placed on the system and by irrigation customers who place a high, peaking demand on system capacity during the summer months that is two to seven times their indoor water use. Irrigation metering provides an opportunity to target higher system development charges to those customers contributing to the peak demand of the system while possibly lowering the impact fees for other customers. However, when up-front costs of irrigation-meter installation are high, providers create a financial disincentive for customers installing irrigation meters; the higher the up-front cost to install irrigation meters, the lower the demand will be for these meters (as was observed with OWASA customers in the current study). Water providers promoting the installation of irrigation meters should consider targeting marketing strategies and offering financing options for up-front installation costs. Prices must be strategically set to provide financial incentives for customers to install irrigation meters.

Water suppliers are operationalizing their policies through their rates, and in doing so, must balance sometimes-competing objectives. In setting initial and ongoing costs associated with dedicated irrigation meters, utilities must weigh the value of metering and monitoring irrigation water use against the use of pricing to encourage water efficiency. They must also recognize the costs of building a water supply infrastructure to meet peak demands while at the same time acknowledging that consumptive water demand places little to no demands on the wastewater infrastructure. Only by doing their homework before they set irrigation meter policies and pricing will utilities avoid the unintended and counterproductive outcomes that can occur with separately metering and billing residential irrigation water.

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