NEW JERSEY 2023 WATER RATE STUDY

Sponsored by New Jersey Infrastructure Bank

Daniel J. Van Abs, PhD, FAICP/PP, Jyoti Venketraman and Will Parker, New Jersey Future

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Purpose

The purpose of this project is to use readily available information to compare the residential drinking water costs of municipal (MUNI), municipal utility authority (MUA) and investor-owned and private company (IOU) public community water systems (PCWS) in New Jersey, with consideration of various utility features that may influence rates, including financial, system characteristics and integrity, and geophysical location. The project uses new (2023) data from the Water Quality Accountability Act (WQAA) reporting requirements of the NJ Department of Environmental Protection (NJDEP) and incorporates information from prior work sponsored by Jersey Water Works on the financial stresses experienced by New Jersey households due to drinking water and sewer utility costs.[1] The comparison uses a combination of standard statistics and multiple linear regression analysis to evaluate the extent to which various utility metrics correlate with higher and lower rates. The results of this project are a spreadsheet, the statistical analysis results, and an overview of the findings as presented in this report.

Acknowledgments

The New Jersey Infrastructure Bank (I-Bank) sponsored this study. Rade Ray Kljajic served as project liaison from American Public Infrastructure, regarding their project work with the I-Bank. Dr. Daniel Van Abs, FAICP/PP, served as the principal investigator under contract to New Jersey Future, with regression analysis provided by Will Parker, graduate intern, working under the direction of Jyoti Venketraman, Director of Collaborations & Organizational Equity and project manager for the Jersey Water Check project.

Summary of Results

The regression model indicates that the residential costs at 50,000 gallons and 80,000 gallons show negative sensitivity to the MUA and MUNI ownership class relative to the IOU ownership class. In other words, MUA and MUNI ownership correlates with a lower residential cost relative to IOU ownership. A second, focused iteration of the regression analysis confirmed that IOU ownership correlates with higher rates. As with all statistical analyses, what is true for a comparison of multiple populations is not always true of individual components of those populations, and so sweeping statements are not supported by the detailed analysis. Rather, there is a general finding that IOUs overall have higher residential costs than MUA and MUNI PCWS overall. Individual PCWS in all three categories may have different characteristics.

To some extent, the geographic extent of PCWS service areas shows that PCWS serving single municipalities correlates with a small decline in total residential cost relative to systems serving more than one municipality. Debt percent and break rate variables were not statistically significant, as is true at the 50,000 gallons threshold for the billing percentage for residential demands, and water source (ground, surface, purchased). However, at 80,000 gallons, both groundwater supply and Coastal Plain location were negatively correlated with residential costs.

[1] Van Abs, D. J., Evans, T., & Irby, K. (2021). A New Jersey Affordability Methodology and Assessment for Drinking Water and Sewer Utility Costs. Rutgers University, https://www.danvanabs.com/uploads/3/8/1/3/38131237/van_abs_et_al_2021.08_nj_affordability_assessment.pdf. Also, Van Abs, D. J., Evans, T., & Irby, K. (2022). Assessing statewide water utility affordability at the census tract scale. AWWA Water Science, e1287. https://doi.org/10.1002/aws2.1287

Most of the IOU PCWS in the dataset (33 of 40) are owned by three companies (Aqua, NJ American Water, Veolia); each uses a common rate schedule for PCWS in their companies (with two exceptions), and so residential customers of both small and large PCWS within each company pay the same rate. To determine whether this factor confounded the regression analysis, a separate analysis focused entirely on the publicly-owned PCWS (MUA and MUNI). The results were similar to those including IOUs but with less robust results. Therefore, the more compelling analysis includes all PCWS in the dataset. One result is that residential rates overall have a bi-modal distribution, with the lowest rates among the medium PCWS (10,000 to 50,000 population) and higher rates among smaller (less than 10,000 people served) and larger (greater than 50,000 people served) systems.

Evaluation of individual metrics may help explain the difference between IOUs and the other two ownership categories. The bulk of the MUNI and MUA PCWS residential rates (75th percentile and lower) have a pattern of lower rates than IOU PCWS, though the outliers for MUNI PCWS are much higher than for the other two categories. However, IOUs pay annual taxes that the MUNI and MUA systems do not, and those taxes may account for much of the difference. Conversely, IOU systems tend to have a much higher median net debt burden relative to annual operating funds (247%, versus 26% for MUAs and 14.5% for MUNI), which may also account for some of the rate differences, as IOUs earn a return on investment (profit) on capital expenditures that are mostly funded through debt. Given the higher relative net debt of IOUs, it is perhaps surprising that the reported breaks per 100 miles of pipeline for IOUs (5.86) are considerably higher than for MUAs (3.99), though somewhat lower than for municipal systems (7.92); it is the MUNI PCWS that have the lowest net debt ratios, which may help explain that higher break rate.

These results are based on statistical evaluations for correlations; they do not provide causative explanations. Given the nature of PCWS and their different histories, management approaches, geophysical conditions, etc., there is considerable variation within the groups and correlations described. As with all statistical analyses, they are not applicable to any individual system, but they can provide a broad understanding of potential issues and relationships affecting PCWS.

Caveats are appropriate. The WQAA dataset is missing some major PCWS, and some of the PCWS within the dataset have missing or clearly incorrect information, resulting in 236 PCWS with sufficient information. In addition, this analysis is based on a good but limited set of metrics and a single year of information.

Additional metrics that could be highly useful for future analysis include: improved pipeline age; real water losses for each PCWS; multiple years of data to assess trends; cash reserves as a hedge against rate increases or capital expenditures; major cost categories that contribute to residential rates (e.g., the percentage of IOU rates dedicated to taxes and ROI for PCWS purchases) and the extent to which rates rely on fixed versus volumetric charges; incorporation of recent and anticipated (e.g., 10-year) capital expenditures that drive recent or future rate changes; and incorporation of household affordability stresses as an indicator of pressures against rate increases.

The analysis can be considered a snapshot in time using a camera of some indeterminate fuzziness. Even so, the results provide a good overview of potential correlations between key metrics and residential costs. The analytical resolution can be improved over time through improved data, inclusion of additional metrics (especially real water losses), and trend analysis.

Description of Data Used

As required by the Water Quality Accountability Act (WQAA), specific public community water systems (PCWS), defined as a public community water system with more than 500 service connections, must develop asset management programs. For those PCWS with entirely residential users, that is roughly 1,500 persons. However, some systems with fewer estimated residential users are also included in the WQAA requirements. Under the WQAA, the New Jersey Department of Environmental Protection (NJDEP) requires annual submittal of data on PCWS attributes, including infrastructure and financial information. The submitted data have been compiled by NJDEP and provided to Jersey Water Works/New Jersey Future for the Jersey WaterCheck dashboard (https://www.njwatercheck.com/). Given the likelihood that PCWS have improved their reporting over the years, this report relies in part on the data provided for 2023, the most recent available.

The two primary metrics are residential water costs at 50,000 gallons and 80,000 gallons per year in 2023, per WQAA submittals.

The factors used for comparison are:

- Percentage of water billed to residential customers in 2023, per WQAA submittals
- Number of pipeline breaks per hundred miles in 2023, per WQAA submittals
- Utility ownership type (previously compiled)
- Utility size class by population served (previously compiled)
- Utility size class by average monthly demand (previously compiled)
- Utility service area type (single municipality or less v. regional) (previously compiled)
- Primary utility water supply source (self-supplied surface water, self-supplied groundwater, purchased surface water) (previously compiled)
- Utility geographic location (Coastal Plain, Piedmont, Highlands/Valley & Ridge) (previously compiled)

These factors and other information used in the spreadsheet are described in more detail below.

PWSID Number (Column A)

This numerical identifier is the Public Water System Identification for each public community water system (PCWS) used in the analysis. The information in this column is provided by NJDEP. In several cases, a single entity owns and operates multiple PCWS, often with non-contiguous service areas, which may or may not use the same rate structure.

Five PCWS have missing, incomplete, or highly unlikely data in the NJDEP dataset, resulting in their exclusion from the analysis. No residential rate information was provided at the 50,000 gallons level by 1432003 RANDOLPH TWP PUBLIC WORKS DEPT, though rate information for 80,000 gallons was provided. Therefore, this PCWS is also excluded. The residential rates provided for 1404001 CHATHAM WATER DEPT ($3,300 and $5,280) are clearly incorrect[2] and therefore this PCWS is excluded also, yielding 235 PCWS with complete rate information. Most of the excluded PCWS are relatively small regarding their total capacity.

[2] The 2021 rate information used in Van Abs, et al., 2021, for Chatham Water Department was $337.29 based on direct analysis of their rate schedule.

Table 1: Excluded PCWS				
PWSID Number	**PCWS Name**	**Capacity (MGM)**	**Rank**	**Cost Data Issue**
1432003	Randolph Twp Public Works Dept	87	124	Missing 50K
1404001	Chatham Water Dept	50	176	Incorrect
1308001	Brielle Water Dept	49.95	178	Missing
1348001	Spring Lake Water Dept	39.61	191	Missing
1344001	Sea Girt Water Dept	18.84	250	Missing

A separate issue involves systems that should have provided information to NJDEP but are not represented in the NJDEP dataset, and so cannot be reflected in this analysis. The reasons for missing data are not known. Of the largest 65 PCWS by total capacity (in MGM, per the NJDEP 2022 Deficit/Surplus Analysis), the following systems lack data.

Table 2: Missing PCWS Among Largest 65			
PWSID Number	**PCWS Name**	**Capacity (MGM)**	**Rank**
1605002	Passaic Valley Water Commission	3645.042	3
0714001	Newark Water Department	3531.210	4
1111001	Trenton Water Works	1350.000	10
2004001	Liberty Water Company	589.000	18
1326004	Suez Water New Jersey - Matchaponix System	224.300	56
0710001	Livingston Township Water Division	213.500	58
0239001	North Arlington Water Department	186.000	61
0233001	Mahwah Water Department	183.450	62
0231001	Lodi Water Department	176.700	64

PWSID Name (Column B)

The name of the PCWS in the NJDEP database.

Activity Number (Column C)

For the most part, this alphanumeric code is CIR240001 for all PCWS. However, a PCWS may have more than one service area, at which point a second code of CIR240002 is provided. The information in this column is provided by NJDEP.

Tot Res Cost 50k Gals (Column D)

This represents the total cost for a household using 50,000 gallons per year. The information in this column is provided by NJDEP. Note that the information provided to NJDEP under the WQAA Capital Improvement Report does not break out these costs. Therefore, there is no method for determining how much of the cost is fixed charges versus volumetric charges for each utility.[3] The following chart shows the relative residential costs by PCWS ownership

[3] A prior analysis for Jersey Water Works did collect information on fixed versus volumetric charges using 2021 residential costs at 45,000 gallons per year.

category (IOU= Investor-Owned or Private Utility; MUA=Municipal Utility Authority); MUNI=Municipal (e.g., water department, public works). The rates are analyzed using standard statistics and box and whisker plots, where the average is denoted by "x", the upper end of the box is the 75th percentile, the middle line is the median (50th percentile) and the lower end of the box is the 25th percentile. Whiskers show variability above and below the box, and individual points are considered outliers.

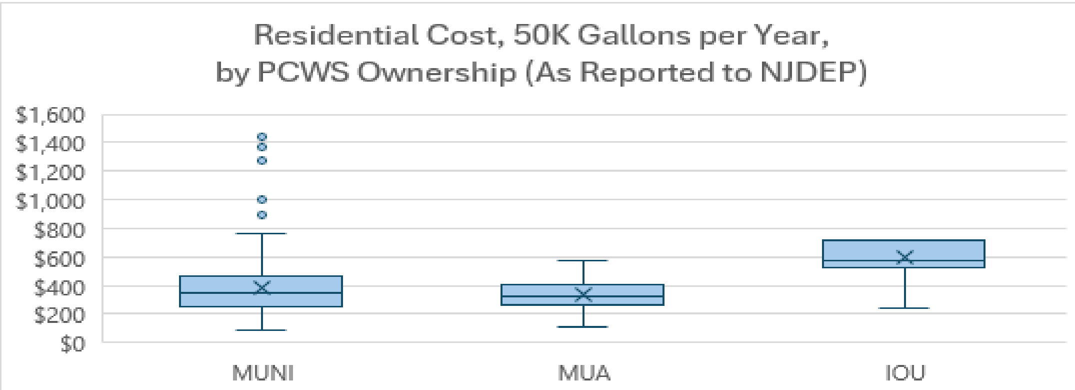

Figure 1: Residential Costs by PCWS (50,000 Gallons per Year)

The rates for local government PCWS (MUNI) show the largest variability by far. The minimum, average, and median costs are not greatly different from those for MUAs, but the maximum costs are nearly three times as high, with seven outliers from roughly $890 to $1439, far above the MUA maximum of $572. All but one of these seven outliers have small capacities of less than 30 MGM (1 MGD). MUA residential costs are more compact, with the average and median nearly equal and no outliers.

The investor-owned (IOU) rates have much higher 25th, median, and 75th percentile results than either local government (MUNI) or MUA PCWS; the 25th percentile for investor-owned PCWS is higher than the 75th percentile for the other categories. These rates are compact also, reflecting a situation where 33 of the 40 PCWS are owned by three investor-owned companies, Aqua (6), NJ American Water (18), and Veolia (9). Each of these companies uses consolidated rate schedules (with one exception each reported for NJ American and Veolia) so that residential customers of both large and small PCWS owned by each corporation pay the same amount. These consolidated rate schedules have implications for the analysis of costs across PCWS system size and population served, as they may mask trends that otherwise would exist.

Cost per 1000 Gals (50K base) (Column E)

This column divides the prior column by 50 to determine the cost per 1,000 gallons.

Tot Res Cost 80k Gals (Column F)

This represents the total cost for a household using 50,000 gallons per year. The information in this column is provided by NJDEP.

Cost per 1000 Gals (80K base) (Column G)

This column divides the prior column by 80 to determine the cost per 1,000 gallons. The overall results for Columns D through G are as follows.

Table 3: Residential Water Costs (Total and Per 1,000 Gallons)				
	Tot Res Cost 50,000 Gals	Cost per 1000 Gals (50,000 base)	Tot Res Cost 80,000 Gals	Cost per 1000 Gals (80,000 base)
MAXIMUM	$1,439.20	$28.78	$2,142.40	$26.78
MINIMUM	$91.75	$1.84	$161.13	$2.01
AVERAGE	$419.98	$8.40	$612.46	$7.66
MEDIAN	$384.00	$7.68	$553.60	$6.92

Cost Diff 50K v 80K (percent) (Column H)

This column divides the cost per thousand gallons for 50,000 gallons per year by the same metric for 80,000 gallons. A value of 100 indicates that the rate schedule is flat; the cost per 1,000 gallons has not changed. Greater values indicate that the first rate is higher than the second, due most likely to a portion of the rate being a fixed charge; as user demands increase, the fixed charge becomes a smaller portion of the rate. The higher the number, the more dominant the fixed charge in the rate.[4] Values lower than 100 indicate that the cost of water per thousand gallons increases as usage increases, likely reflecting inclining rate schedules and potentially a relatively small portion of the rate being fixed charges. Of the 235 PCWS with complete rate information, the results are:

Table 4: Ratio of Cost per 1,000 Gallons for 50,000 Gallons Relative to 80,000 Gallons	
Ratio	**Number of PCWS**
Above 130%	20
Above 100%	163
At 100%	13
Below 100%	59

% Water Billed Res (Column I)

PCWS differ greatly regarding their user base. Many of the smallest are entirely or mostly residential, while the largest may have extensive commercial and even industrial user demands. This column provides the percentage of all water billing that is residential. This metric was used to test whether PCWS with large non-residential customer billing have lower residential costs. The average for 235 PCWS is 77.55% and the median is 85%. One PCWS, 1712001 SALEM WATER DEPARTMENT, shows a result of zero residential billing, which is not correct, but the correct amount is not available. The information in this column is provided by NJDEP.

Table 5: Percentage of Water Billings to Residential Customers			
	Percentage		**Percentage**
MAXIMUM	99.90	**AVERAGE**	79.11
MINIMUM	6.50	**MEDIAN**	85.00

[4] For example, if a residential rate is entirely a fixed charge, the ratio of cost per thousand gallons would be at the maximum of 1.6 or 160%, reflecting the fact that 80,000 gallons is 160% of 50,000 gallons. Several PCWS used 100% fixed charges. One PCWS reported a higher cost at 80,000 gallons than at 50,000, a probable error.

Net Debt as % Revenue (Column J)

The information in this column is provided by NJDEP. PCWS with a high net debt relative to annual revenue will have a harder time using either customer revenue or new debt to address system operation, maintenance, and capital improvements, as more operating revenue must be expended on debt service. Conversely, PCWS with very low or no net debt relative to revenue have the capacity for additional expenditures. There may be situations where insufficient asset management is occurring so as to avoid debt, but in other cases, a PCWS with high rates may avoid debt by funding capital projects using cash flow or accumulated reserves.

Reported levels ranged from zero (indicating no net debt, which can include cases where reserves are equal to or higher than any debt) to over 600%. Of 235 PCWS, 144 reported values of less than 50% (including 74 at zero), while 58 reported values above 200%. The breakdown by ownership is as follows, with the median for IOUs being far higher.

Table 6: Net Debt as Percentage of Annual Operating Revenue

	ALL	MUNI	MUA	IOU
MAXIMUM	662.60	662.60	403.90	345.80
MINIMUM	0.00	0.00	0.00	0.00
AVERAGE	98.22	88.53	94.95	141.94
MEDIAN	20.00	14.50	26.00	247.00

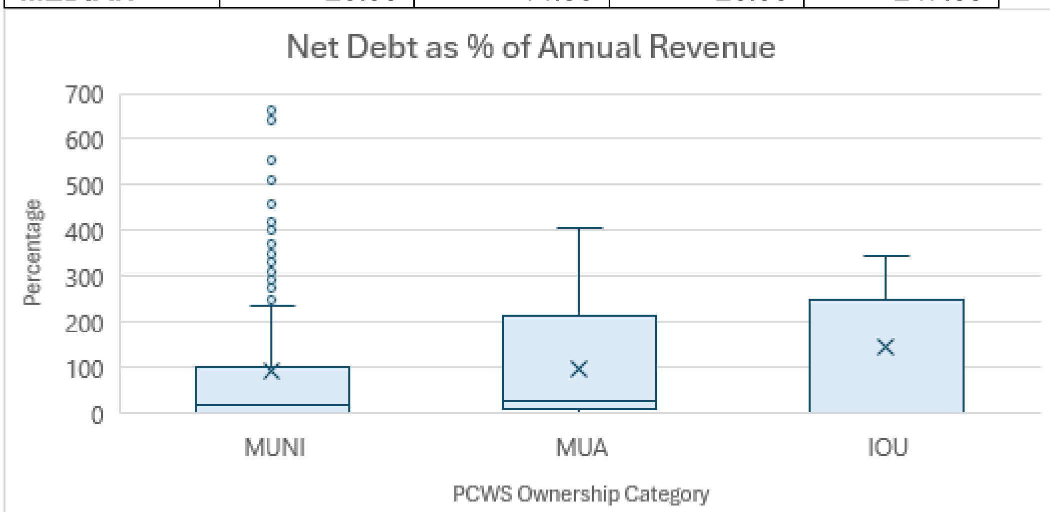

Figure 2: Net Debt as Percentage of Annual Operating Revenue (Whisker Plot)

As shown in the chart above, MUNI PCWS tends to have a lower net debt relative to revenue, which may indicate a reluctance to fund capital projects. However, the highest MUNI outliers are far above those for IOU and MUA systems, potentially indicating MUNI systems that may be struggling financially to address capital costs.

Another method for assessing this metric is by comparison to annual residential costs. The following chart shows the results at 50,000 gallons per year. As shown, many PCWS across all cost ranges have low debt percentages. Those with high debt percentages are spread across most cost levels except for the very highest.

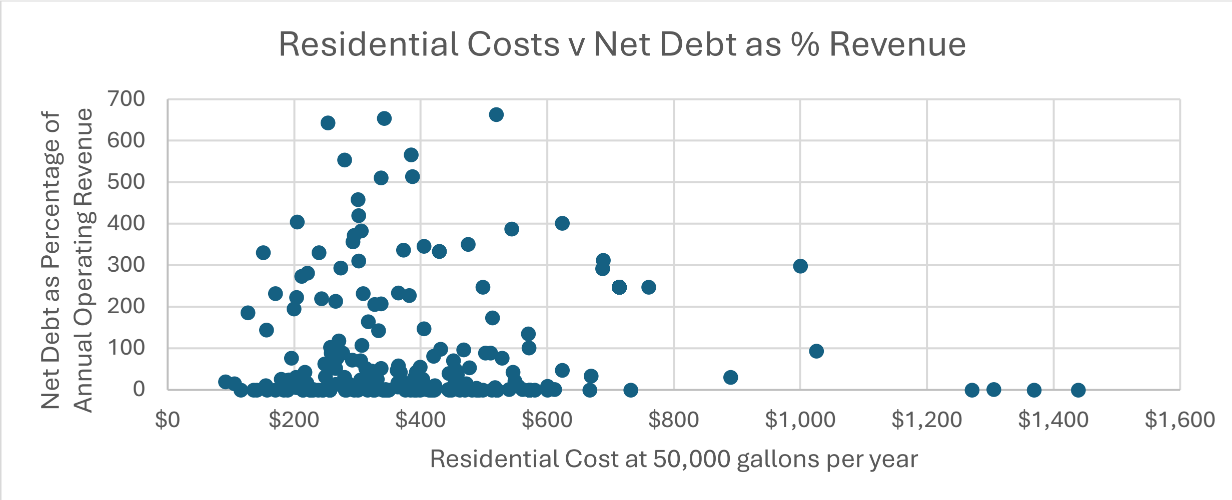

Figure 3: Net Debt as Percentage of Annual Operating Revenue (Scattergram)

Breaks per 100 mi 2023 (Column K)

Each PCWS reports the number of breaks per year for each type and size of water main and distribution main. The information in this column is derived from that information provided by NJDEP. This column provides the total number of line breaks for 2023, normalized to a "per 100 miles of pipeline" metric to allow comparison among PCWS. Of the three ownership categories, MUAs showed lower median results. Ideally, this metric would be compared to the average age of pipelines, but many PCWS either reported large percentages of pipelines with an unknown age or distributed their pipelines equally over several decades. Therefore, the average pipeline age information is not sufficiently robust for use in this analysis.

Table 7: Breaks per 100 miles of Pipeline

	ALL	MUNI	MUA	IOU
MAXIMUM	114.78	114.78	17.19	66.22
MINIMUM	0.00	0.00	0.00	0.00
AVERAGE	10.01	10.81	4.92	9.31
MEDIAN	6.02	7.92	3.99	5.86

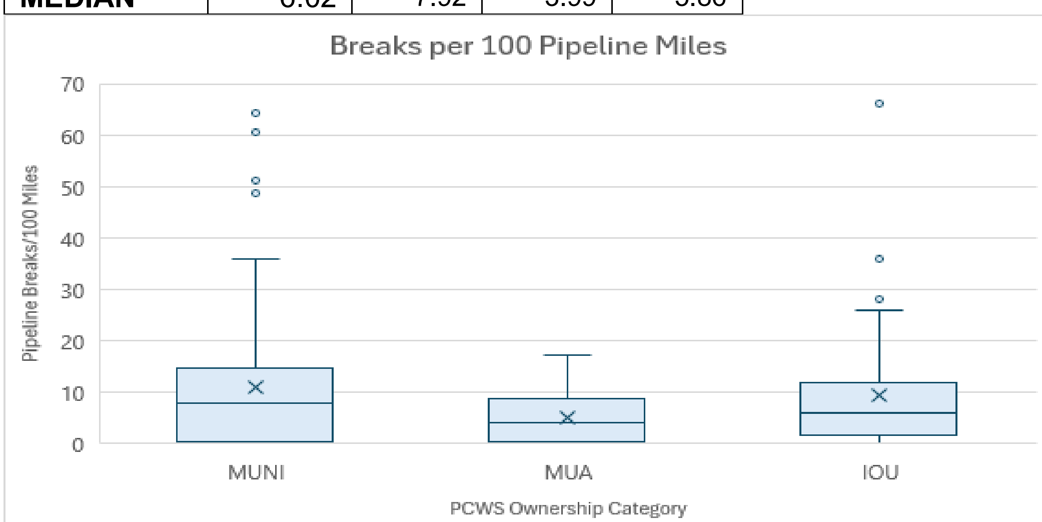

Figure 4: Breaks per 100 miles of Pipeline

PCWS Ownership (Column L)

One potential factor in residential rates is PCWS ownership. This column provides a simple analysis of ownership.

Table 8: PCWS Ownership Categories		
Code	**Description**	**#PCWS**
MUNI	Municipal Department (e.g., Public Works)	**173**
MUA	Municipal Utility Authority	**22**
IOU	Private or Investor-Owned Utility	**40**

Type of Water Source (Column M)

This column provides the primary source of water, either surface water or groundwater that is self-supplied, or purchased water from another source. While there are exceptions (especially where groundwater supplies require extensive treatment), in general, surface water and purchased water will have higher costs, therefore affecting rates. There are many PCWS that have their own supplies but augment them with purchased water; the PCWS is only deemed reliant on purchased water if that is the dominant supply. Information on purchased water is from NJDEP's Deficit/Surplus Analysis spreadsheet for 2022. Information on self-supplied water is based primarily on PCWS consumer confidence reports.

Table 9: Primary Water Source	
	#PCWS
Surface Water (Self-Supplied)	18
Ground Water (Self-Supplied)	136
Purchased Water	81

Geology (Column N)

Each PCWS was assigned a designation as Coastal Plain (C) or Bedrock (BR) based on the primary location of their service area. NJDEP has noted that PCWS in bedrock areas are more likely to have significant topographic changes, potentially requiring multiple pressure zones. This factor can then affect operation, maintenance and replacement costs, and therefore rates. Of the 235 PCWS, 130 primarily serve Coastal Plain areas and 105 primarily serve Bedrock areas.

Capacity (MGM) (Column O)

This column provides the PCWS capacity in millions of gallons per month (MGM), including self-supplied and purchased water minus any water contracted for provision to other PCWS. The information in this column is provided by NJDEP from the 2022 Deficit/Surplus Analysis spreadsheet. In this case, there are 234 PCWS, as one PCWS lacks information on capacity.

Table 10: Total PCWS System Capacity				
	ALL PCWS	**MUNI**	**MUA**	**IOU**
MAXIMUM	6762	664	2635	6762
MEDIAN	74	62	156	81
MINIMUM	3	3	11	3
AVERAGE	227			

The median capacity of local government PCWS is smaller than MUAs, but nearly the same as for investor-owned systems. However, the maximum capacity for local government PCWS is far lower than that of the other two categories.

PCWS Size Category by Population (Column P)

Larger utilities are assumed to have opportunities for economies of scale, sequencing of capital projects to avoid rate shocks and debt peaks, and increased internalization of expertise. Population estimates from a Rutgers report for NJDEP's new Statewide Water Supply (as described in Appendix D) are used in this column to categorize PCWS by ranges of population served.

Table 11: PCWS Populations Served	
PCWS Size Category	**#PCWS**
Very Small <0.5K	2
Small 0.5-3.3K	47
Medium 3.3-10K	64
Medium 10-50K	100
Large 50-100K	12
Very Large >100K	10

PCWS Size Category by MGM (Column Q)

Information from Column O is used to assign PCWS size categories by total capacity in MGM.

Table 12: PCWS Size by Total Capacity		
Size Category	**Capacity Range**	**#PCWS**
VS	<5MGM	2
S	5-30MGM	66
M	>30MGM	133
L	>300MGM	33

Service Area Type (Column R)

Finally, each PCWS was assigned either R for regional systems (e.g., including more than one municipality in part or in whole) or S for single municipal systems (e.g., including part or all of one municipality). Of the 235 PCWS, 38 are designated R and 197 are designated S. Most of those with a municipal or smaller service area are municipal utilities, with the remainder split between MUAs and private utilities. The regional PCWS includes only three MUAs, with the rest evenly split between municipal and private utilities.

Table 13: PCWS With Regional and Non-Regional Service Areas				
SERVICE AREA	**TOTAL**	**IOU**	**MUA**	**MUNI**
MUNICIPAL OR LESS (S)	197	23	19	155
REGIONAL (R)	38	17	3	18

Implications of Taxation Policies for Residential Water Costs

As discussed previously, the reported residential costs for investor-owned systems have much higher 25th, median, and 75th percentile results than either local government (MUNI) or MUA

PCWS; the 25th percentile for investor-owned PCWS is higher than the 75th percentile for the other categories. Several potential explanations exist for this disparity. First, investor-owned utilities (IOUs) have a natural profit motive to invest in capital improvement projects; operational costs and routine maintenance are on a "cost recovery" basis, but capital costs receive a "return on investment" (ROI) that provides a profit. As noted in the Net Debt as % Revenue discussion, IOUs have much higher debts relative to operating revenue than MUNI and MUA systems. Second, IOUs (unlike publicly-owned PCWS) periodically purchase other privately-owned or publicly-owned PCWS; the purchase cost of these purchases is considered a capital cost subject to ROI provisions, and the purchased systems often require infusions of capital expenditures (again raising the first point). Third, these systems are subject to taxes that publicly-owned systems do not pay. The first two concepts require data that are not available for this study and would require extensive forensic accounting.

The taxation issue is open to inquiry, however. The NJ Board of Public Utilities staff provided information on limits to taxes and fees paid by investor-owned utilities subject to the rate approval rules of the Board.[5] They are:

Table 14: IOU Federal/State Taxation Rates (per NJBPU)	
Taxation Category	**Percentage**
Federal Income Taxes (statutory rate, of gross operating profits)	21.00%
Gross Receipts and Franchise Taxes (GRFT)*	14.00%

*NJBPU Note: GRFT Taxes vary by utility because franchise taxes are based on the percentage of mains on the public right of way.

However, information was not readily available regarding the actual taxes paid relative to operating revenue for all IOUs in the database. As detailed information was not available from each utility on the applicability of each tax, a simplified analysis was performed using two percentages, 20% and 30% of operating revenue; the actual rates for each utility may be higher or lower. As shown in Table 15 and Figure 5 below, a 30% adjustment of the rate for investor-owned PCWS makes the box plot for investor-owned PCWS more similar to the other two categories; the median cost for investor-owned PCWS is less than the 75th percentile costs for MUNI PCWS, and almost exactly the same as the 75th percentile for MUA systems. At a 20% rate adjustment (Figure 6), the effects are less notable, but still enough to bring the IOU median to nearly the same as the 75th percentile for MUNI systems, but the 25th percentile rate for IOUs is above the 75th percentile for MUA systems.

Table 15: Residential Water Costs by PCWS Ownership With IOU Tax Adjustment Scenarios					
	MUNI	**MUA**	**IOU (Original)**	**IOU (Adjusted 20%)**	**IOU (Adjusted 30%)**
Maximum Cost	$1,439.20	$571.65	$713.96	$571.17	$499.77
Median Cost	$342.50	$326.81	$572.12	$457.70	$400.48
Average Cost	$389.53	$330.62	$600.86	$480.68	$420.60
Minimum Cost	$91.75	$116.00	$239.28	$191.42	$167.50
Max Capacity (MGM)	664	2635	6762		
Median Capacity (MGM)	62	156	81		
Minimum Capacity (MGM)	3	11	3		

[5] Personal communication, Jack Streppone, NJBPU, to Kevin Drennan, Ameri-Pi, 22 October 2024

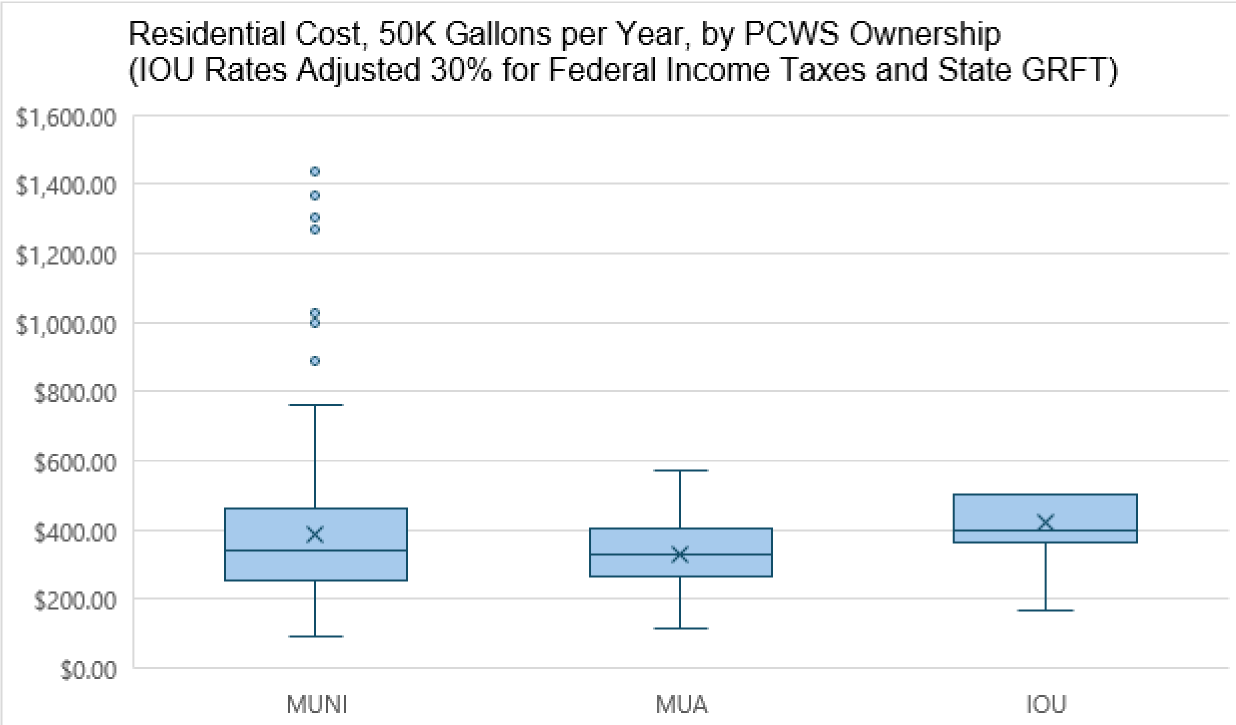

Figure 5: Residential Water Costs by PCWS Ownership With IOU 30% Tax Adjustment

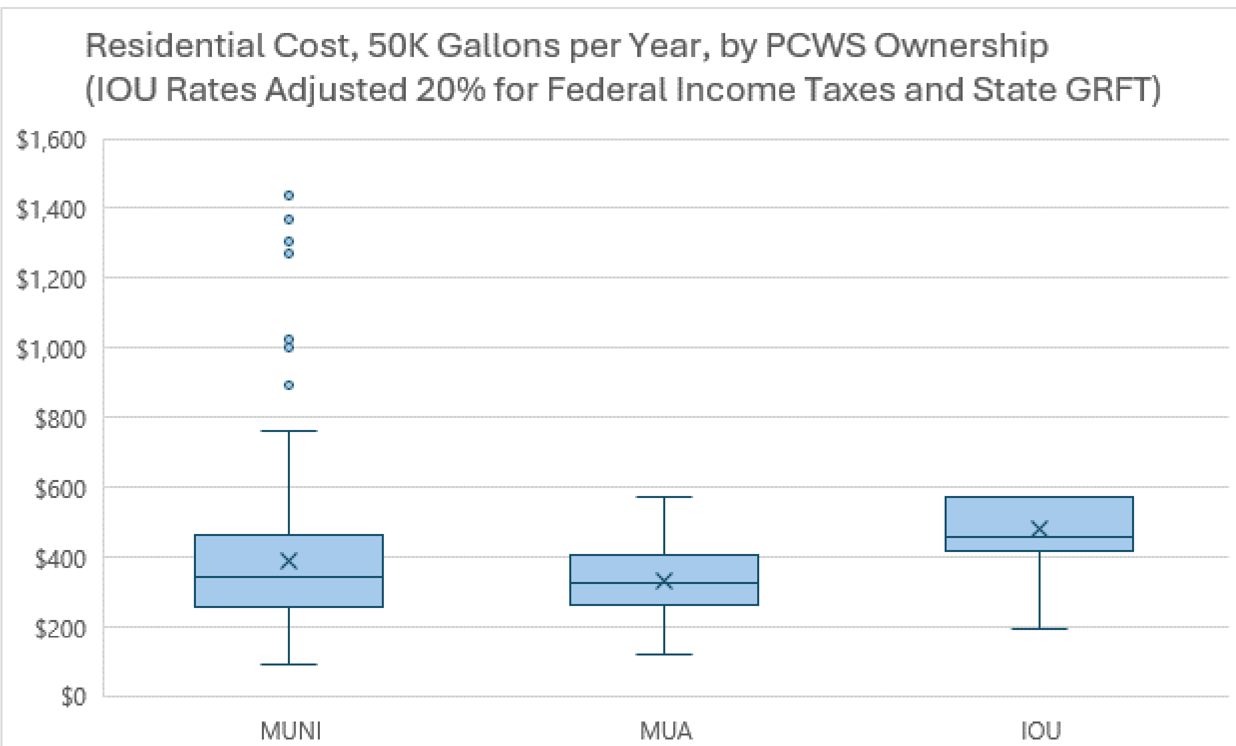

Figure 6: Residential Water Costs by PCWS Ownership With IOU 20% Tax Adjustment

Regression Analysis Methodology and Results

New Jersey Future used a multiple linear regression analysis to examine the dependent variables (residential costs at 50,000 and 80,000 gallons per year) against the remaining factors as independent variables, to assess the extent to which each independent variable correlated positively (an increase in the independent variable correlated with an increase in cost) or negatively (an increase in the independent variable correlated with a decrease in cost), using the software program R. Both water demand scenarios were used to determine whether changes in cost affected the level of correlation for any independent variables (reflecting differences in the costs per 1,000 gallons).

In the first step, categorical (i.e., non-numerical) values were converted to dummy variables, with one group serving as a reference for the others (e.g., IOU PCWS as the reference for analysis against MUNI and MUA PCWS). Then, correlation and multiple regression analyses were conducted to examine the relationship between each independent variable and the dependent variable.

Population served was assessed in two ways; by category using dummy categories, and by numerical population. However, the latter approach did not provide significant results. As the following chart shows, both small and large PCWS (cut off at 100,000 for the purposes of this chart) tend to have higher costs, resulting in a non-linear relationship.

The R regression analysis provided a slope estimate, Standard Error, t-value, and the Pr(>|t|) (the p-value associated with the value in the t-value column). Results are considered significant when the Pr(>|t|) is 0.05 or less, with additional levels of significance at 0.01 or less, 0.001 or less, and zero. The regression analysis was developed in two phases, first with all independent variables, and then with only those independent variables found to be significant in the first run. Table 16 shows the code key for the results discussed below.

Table 16: Key for Regression Analysis Variable Codes

Variable Code	Variable Full Name
PWSID	PWSID Number
PopNew	Population Served (not in original analysis - used in second analysis as substitute for categorical dummy variables of population
FiftyCost	Tot Res Cost 50k Gals
EightyCost	Tot Res Cost 80k Gals
ResPercent	% Water Billed Res
DebtPercent	Net Debt as % Revenue
BreakRate	Breaks per 100 mi 2023
MUA	PCWS Ownership MUA
MUNI	PCWS Ownership MUNI (municipal)
IOU	PCWS Ownership IOU (investor-owned/private)
Surface	Type of Water Source Surface
Ground	Type of Water Source Ground
Purchase	Type of Water Source Purchase
GeologyC	Geology C
Capacity	Capacity (MGM)

Table 16: Key for Regression Analysis Variable Codes	
Variable Code	**Variable Full Name**
XLPop	PCWS Size Category by Population Very Large >100K
MPop	PCWS Size Category by Population Medium 3.3-10K
MLPop	PCWS Size Category by Population Medium 10-50K
Spop	PCWS Size Category by Population Small 0.5-3.3K
Lpop	PCWS Size Category by Population Large 50-100K
LCapacity	PCWS Size Category by MGM L
MCapacity	PCWS Size Category by MGM M
SCapacity	PCWS Size Category by MGM S
VSCapacity	PCWS Size Category by MGM VS
Type	Service Area Type S

Results for All PCWS

Tables 17 and 18 summarize the descriptive statistics and analysis results from the first round of regression analysis. Overall, the models based on the F test are significant. The adjusted R Squared of between 0.20 and 0.35 shows a significant correlation between the input variables and output in the range of 0.45 to 0.6 (square root of R Square). The model indicates that the Total residential cost at 50,000 gallons and 80,000 gallons shows negative sensitivity to the MUA and MUNI ownership class relative to the IOU ownership class. This implies that MUA and/or MUNI ownership results in a reduction in total residential cost relative to IOU ownership. To some extent, systems serving single municipalities result in a small decline in total residential cost relative to systems serving more than one municipality. Debt percent and break rate variables are not statistically significant.

Table 17: Regression Analysis Round 1 Results, 50,000 Gallons per Year (Population Served in Dummy Categories)					
	Estimate	**Std. Error**	**t-value**	**Individual P-value**	**Significance**
(Intercept)	1172.0	193.8	6.0		***
ResPercent	-0.9	0.6	-1.5	0.0608	
DebtPercent	0.1	0.1	0.7	0.3088	
BreakRate	0.2	0.9	0.2	0.5818	
MUA	-157.9	52.5	-3.0	0.0365	**
MUNI	-166.2	35.6	-4.7	0.0002	***
IOU	NA	NA	NA	0.0000	
Surface	2.9	60.1	0.0	0.0550	
Ground	-40.3	27.9	-1.4	0.4751	
Purchase	NA	NA	NA	0.7704	
GeologyC	-21.2	25.8	-0.8	0.2030	
Capacity	0.0	0.0	-0.2	0.0802	
XLPop	-398.5	172.1	-2.3	0.0050	*
Lpop	-429.8	150.5	-2.9	0.4894	**
MLPop	-490.6	136.2	-3.6	0.0000	***
MPop	-381.7	132.8	-2.9	0.2743	**
Spop	-281.3	131.1	-2.1	0.0000	*

Table 17: Regression Analysis Round 1 Results, 50,000 Gallons per Year (Population Served in Dummy Categories)					
	Estimate	**Std. Error**	**t-value**	**Individual P-value**	**Significance**
LCapacity	-47.2	138.8	-0.3	0.6042	
MCapacity	-42.0	131.2	-0.3	0.0000	
SCapacity	-23.2	131.0	-0.2	0.0001	
VSCapacity	NA	NA	NA	0.4538	
Type	-87.2	36.0	-2.4	0.0015	*
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.1 ' ' 1	
Residual standard error: 177.9 on 215 degrees of freedom					
(3 observations deleted due to missingness)					
Multiple R-squared: 0.3445		Adjusted R-squared: 0.2896			
F-statistic: 6.277 on 18 and 215 DF, p-value: 2.696e-12					

Table 18: Regression Analysis Round 1 Results, 80,000 Gallons per Year (Population Served in Dummy Categories)					
	Estimate	**Std. Error**	**t-value**	**Individual P-value**	**Significance**
(Intercept)	1381.6	286.9	4.8		***
ResPercent	-1.0	0.9	-1.1	0.1266	
DebtPercent	0.1	0.1	0.9	0.3245	
BreakRate	0.0	1.3	0.0	0.6119	
MUA	-212.0	77.6	-2.7	0.0271	**
MUNI	-202.5	52.7	-3.8	0.0040	***
IOU	NA	NA	NA	0.0000	
Surface	4.0	88.9	0.0	0.0545	
Ground	-73.6	41.3	-1.8	0.1528	.
Purchase	NA	NA	NA	0.6729	
GeologyC	-65.9	38.2	-1.7	0.0290	.
Capacity	0.0	0.0	-0.3	0.1422	
XLPop	-478.1	254.7	-1.9	0.0224	.
LPop	-494.0	222.8	-2.2	0.9238	*
MLPop	-602.2	201.7	-3.0	0.0000	**
MPop	-436.2	196.6	-2.2	0.1108	*
SPop	-321.3	194.0	-1.7	0.0014	.
LCapacity	91.7	205.5	0.4	0.5855	
MCapacity	94.7	194.3	0.5	0.0005	
SCapacity	93.4	193.9	0.5	0.0009	
VSCapacity	NA	NA	NA	0.9244	
Type	-75.8	53.3	-1.4	0.0167	
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.1 ' ' 1	
Residual standard error: 263.3 on 215 degrees of freedom					
(3 observations deleted due to missingness)					
Multiple R-squared: 0.2748,		Adjusted R-squared: 0.2141			
F-statistic: 4.526 on 18 and 215 DF, p-value: 2.453e-08					

As a next step, the project team conducted another regression by switching reference categories for dummy variables to test whether it had any impact and took a step-by-step approach to dropping non-significant variables and running a regression to test significance.

First, MUA, MUNI, and IOU, as well as the Surface, Ground, and Purchase categories of water source, were all incorporated. For the latter group, all had weak significance or low coefficients, so these were deleted. In the former (ownership categories), IOU was by far the most significant. Categories MUA and MUNI were deleted, and regression showed that the reallocation when deleted for each of these variables was not notable—their value went mostly to the Intercept.

Next, all PCWS by capacity metrics, categorical or numeric, were deleted due to low significance. The reallocation here from regression was similarly not notable.

Finally, ResPercent, DebtPercent, and BreakRate were deleted for weak significance / low coefficient. The reallocation was not notable, except for ResPercent. When ResPercent was deleted, the change was reallocated to the Population Served variables. This points to possible multicollinearity between these two variables - ResPercent (% water billed to residential customers) and the population served variable. Multicollinearity means the two variables are highly correlated. This means it is hard to isolate the distinct impact of each variable on the dependent variable.

Tables 19 and 20 summarize the results from this next round of regression analysis. Similar to the earlier regression model, the Total residential costs at 50,000 gallons and 80,000 gallons show positive sensitivity to the IOU ownership class relative to the MUA and MUNI ownership. Changing reference categories here had no impact. The analysis also indicated differences in results between the two dependent variables. Total residential costs at 80,000 gallons show negative sensitivity to Groundwater and negative sensitivity to Geology C.

Table 19: Significant Regression Analysis Results: 50,000 Gallons Per Year Demand (All PCWS)

	Estimate	Std. Error	t-value	Pr(>|t|)	Significance
(Intercept)	856.7	129.5	6.6	0.0000	***
P	180.1	33.9	5.3	0.0000	***
XLPop	-380.3	140.8	-2.7	0.0074	**
LPop	-401.5	134.8	-3.0	0.0032	**
MLPop	-473.7	126.1	-3.8	0.0002	***
MPop	-361.5	126.8	-2.9	0.0048	**
SPop	-269.4	127.5	-2.1	0.0356	*
Type	-91.6	35.1	-2.6	0.0096	**
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' ' 1
Residual standard error: 176.4 on 227 degrees of freedom					
(2 observations deleted due to missingness)					
Multiple R-squared: 0.3213			Adjusted R-squared: 0.3004		
F-statistic: 15.35 on 7 and 227 DF; p-value: < 2.2e-16					

Table 20: Significant Regression Analysis Results: 80,000 Gallons Per Year Demand (All PCWS)					
	Estimate	**Std. Error**	**t-value**	**Pr(>|t|)**	**Significance**
(Intercept)	1174.3	192.9	6.1	0.0000	***
P	213.7	49.9	4.3	0.0000	***
Ground	-78.0	38.4	-2.0	0.0435	*
GeologyC	-59.7	35.7	-1.7	0.0954	.
XLPop	-463.0	207.1	-2.2	0.0263	*
LPop	-471.1	199.5	-2.4	0.0191	*
MLPop	-570.4	185.6	-3.1	0.0024	**
MPop	-405.1	187.1	-2.2	0.0315	*
SPop	-292.53	188.41	-1.553	0.12192	
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	
Residual standard error: 258.8 on 225 degrees of freedom					
(2 observations deleted due to missingness)					
Multiple R-squared: 0.2669,			Adjusted R-squared: 0.2376		
F-statistic: 9.103 on 9 and 225 DF; p-value: 1.005e-11					

Results for Publicly-Owned PCWS

To test the influence of investor-owned PCWS, which for the most part apply the same rate schedule to both large and small PCWS under their ownership, a second analysis focused entirely on the publicly-owned PCWS, municipal (MUNI) and municipal utility authority (MUA). The models showed a lower adjusted R-squared value compared to earlier results. Total residential costs at 80,000 show negative sensitivity to groundwater and geology C (i.e., PCWS using groundwater and PCWS in the Coastal Plain exhibit lower rates).

Table 21: Significant Regression Analysis Results: 50,000 Gallons Per Year Demand (RESULTS FOR PUBLIC SYSTEMS ONLY)					
	Estimate	**Std. Error**	**t-value**	**Pr(>|t|)**	**Significance**
(Intercept)	836.1	138.6	6.0	0.0000	***
XLPop	-454.9	186.0	-2.4	0.0154	*
LPop	-398.0	142.3	-2.8	0.0057	**
MLPop	-476.9	133.2	-3.6	0.0004	***
MPop	-361.2	134.1	-2.7	0.0077	**
SPop	-248.8	134.9	-1.8	0.0667	.
Type	-71.0	43.5	-1.6	0.1044	
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' ' 1
Residual standard error: 186 on 188 degrees of freedom					
Multiple R-squared: 0.2148,			Adjusted R-squared: 0.1898		
F-statistic: 8.573 on 6 and 188 DF, p-value: 3.043e-08					

Table 22: Significant Regression Analysis Results: 80,000 Gallons Per Year Demand (RESULTS FOR PUBLIC SYSTEMS ONLY)					
	Estimate	**Std. Error**	**t-value**	**Pr(>|t|)**	**Significance**
(Intercept)	1126.5	197.3	5.7	0.0000	***
Ground	-75.6	44.5	-1.7	0.0914	.
GeologyC	-90.3	42.3	-2.1	0.0340	*
XLPop	-662.3	273.9	-2.4	0.0166	*
LPop	-480.5	210.4	-2.3	0.0235	*
MLPop	-580.1	195.7	-3.0	0.0034	**
MPop	-411.8	198.0	-2.1	0.0389	*
SPop	-274.9	199.2	-1.4	0.1691	
Signif. Codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	
Residual standard error: 272.6 on 187 degrees of freedom					
Multiple R-squared: 0.1989,			Adjusted R-squared: 0.1689		
F-statistic: 6.633 on 7 and 187 DF, p-value: 5.163e-07					

Discussion

Regression Analysis

Regression analysis testing the relationship between dependent variables (Total residential cost at 50,000 gallons and at 80,000 gallons) and multiple independent variables indicates a relationship between the dependent variables and the independent variable of system ownership. The model shows that the sensitivity of the total residential cost at 50,000 gallons and at 80,000 gallons was positive to IOU ownership while it was negative to MUA and MUNI ownership. Basically, the model shows that MUA and MUNI ownership have a lower cost per gallon relative to private ownership of about 14 percent.

The model does not include variables that can explain structural reasons within different types of ownership that may account for the cost differences. For example, structural factors can include but are not limited to low political will to increase rates that are often seen within public water systems or the ease of recovery of capital investment cost via rates that are noticed in IOU systems. The model does not account for various factors that affect the integrity of the systems, though it does indicate that the breaks per 100 pipeline miles, debt as a percentage of annual operating revenue, and percentage of billing to residential customers do not have a significant correlation with residential costs. As previously discussed, quality information on the median age of pipelines is not available; however, even that metric could mask major variability in pipeline composition, size, and integrity.

The large drop in costs based on population size categories relative to the very small population served category should be carefully understood. The "Very Small" population served category is the reference category. This reference category has only two water systems, one of which has an extremely high cost of $1305 at 50,000 gallons. As a result, all other categories show a large negative drop in comparison. However, an analysis using actual populations served (rather than population groupings) as an independent variable yielded no significance in regression, indicating there is no linear relationship. That raised the question about the potential for a non-linear relationship that helps explain rate distributions.

The chart below of the distribution of rates to the population served demonstrates such a non-linear relationship between rates. Based on these charts and the regression results, which generally show the strongest statistical relationship for Medium, Medium-Large, and Large categories, it appears that rates decline in a statistically significant way as the population increases, up until around 30,000 people. At that point, rates begin to increase again but lose a clear trend in the extra-large category due to the small number of data points. When the reference category is switched, this trend remains clear, with the ML category (10,000 to 50,000 population) showing the lowest rates and with strong significance for the rate increase in Medium and Large categories. A non-linear regression (6-order polynomial) is shown as a trendline on the charts and indicates a fairly high R-squared of 0.18 for 50,000 gallons. While not shown, as the results are very similar, the R-square is 0.14 for 80,000 gallons.

The chart datapoints are color coded to show which systems are owned by municipal (MUNI), municipal utility authority (MUA) and investor-owned/private (IOU) systems. As previously discussed in the data description, the IOU rates are concentrated in a narrow band regardless of PCWS size, and they are generally greater than the rates for MUA and MUNI PCWS in the

VS to ML range of population served. However, some MUNI PCWS greatly exceed the IOU costs in the VS and S population ranges.

Individual Metrics

Evaluation of the individual metrics adds some nuances to the regression analyses. The bulk of the MUNI and MUA PCWS rates (75^{th} percentile and lower) have a pattern of lower rates than IOU PCWS, but the outliers for MUNI PCWS are much higher than the other two categories. However, IOUs pay annual taxes that the MUNI and MUA systems do not, and those taxes may account for much of the difference. On the other hand, IOU systems tend to have a much higher median net debt burden relative to annual operating funds (247%, versus 26% for MUAs and 14.5% for MUNI), which may also account for some of the rate differences, as IOUs earn a rate of return (profit) on capital expenditures that are mostly funded through debt. Given the higher net debt of IOUs, it is perhaps surprising that the reported breaks per 100 miles of pipeline for IOUs (5.86) are considerably higher than for MUAs (3.99), though somewhat lower than for municipal systems (7.92); it is the MUNI PCWS that have the lowest net debt ratios, which may help explain that higher break rate.

Caveats and Research Approaches

This research project used readily available information from NJDEP's Water Quality Accountability Act reporting system and from prior studies. In some ways, this is a wealth of information, but in other ways there are significant concerns.

- Some major systems are absent from the dataset. While their absence likely does not greatly skew the results, they do serve a considerable population (more than 1.1 for Newark. Passaic Valley Water Commission and the Trenton system alone).

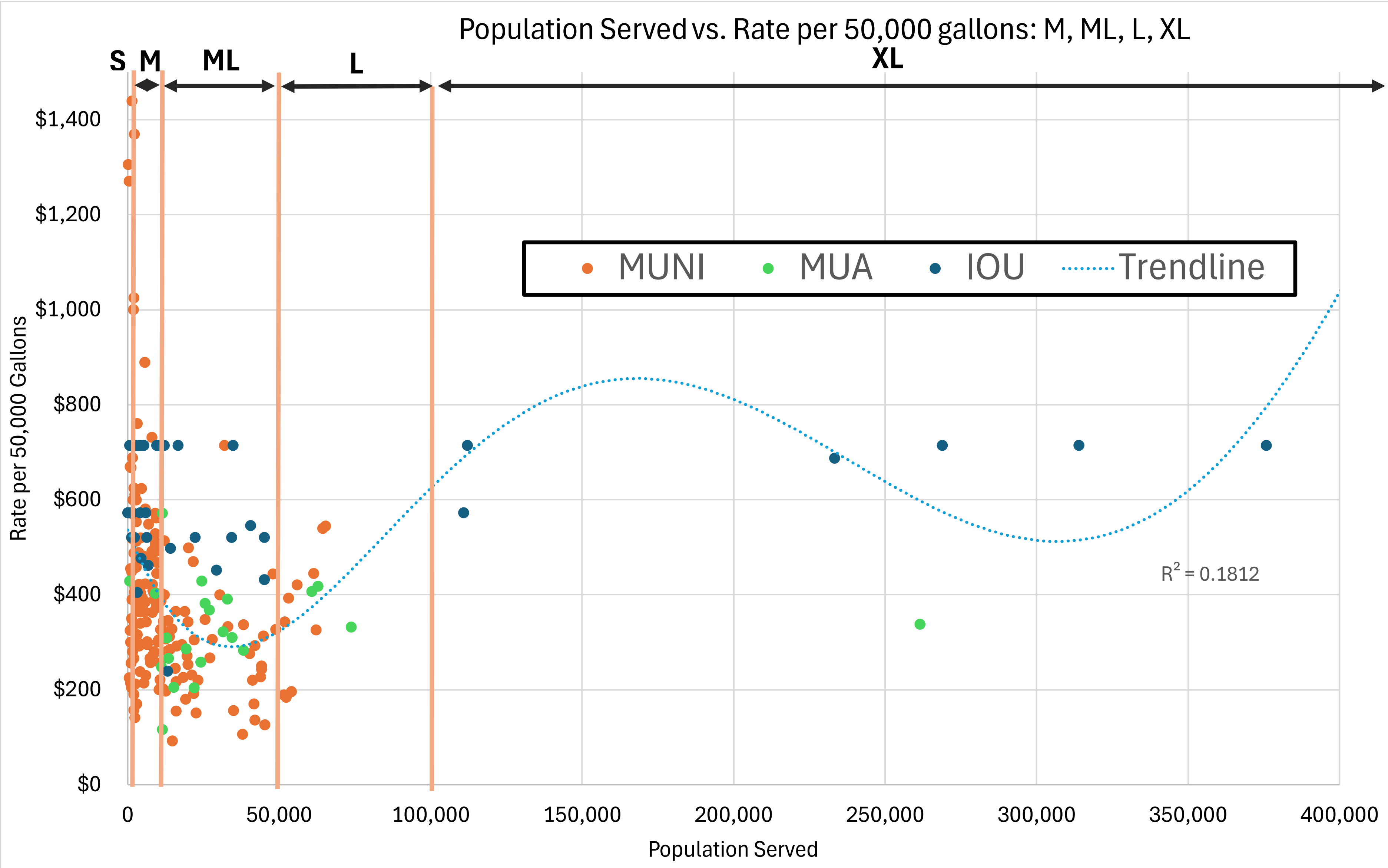

Figure 7: Population Served Versus Residential Water Rate per 50,000 Gallons

- The analysis relies entirely on the 2023 dataset for many metrics. It is not possible to know where in a rate-setting cycle any specific PCWS may be. Some systems make routine, gradual changes while others hold rates steady for a considerable amount of time and then adopt a major increase.
- Reported information on pipeline age was questionable for enough PCWS that the data was not used to calculate a median age as a basis for correlation to residential costs. It may not be feasible for some PCWS to assign ages to their pipelines for lack of data, but it complicates the potential for analysis.
- Without information on non-residential rates, it is not possible to assess the extent to which non-residential revenues (e.g., commercial, industrial, connection fees) are subsidizing residential rates, or vice versa.
- There is no information regarding the extent to which different categories of operating expenses and debt result in residential rates, including whether a PCWS operates a treatment plant and the relative expense of doing so, the costs of purchased water, MUA and MUNI PCWS contributions to municipal government revenues beyond direct payment for services (e.g., payment services, shared motor pool costs), and the relative cost of debt.
- There is no information on real water losses for PCWS in the dataset, which could augment understanding of system integrity beyond pipeline age and breaks per 100 miles.
- There is no available information on the extent to which residential rates rely on fixed versus volumetric charges, which will affect the difference between costs at 50,000 and 80,000 gallons per year.
- The WQAA reporting requirements are relatively new, and therefore the potential for reporting errors exists as PCWS become used to the protocols. It is to be expected that future years will yield better data.

For this reason, the analysis can be considered a snapshot in time using a camera of some indeterminate fuzziness. Even so, the results provide a good overview of potential correlations between key metrics and residential costs. The analytical resolution can be improved over time through improved data, inclusion of additional metrics (especially real water losses), and trend analysis.

Three major additions to the analysis are recommended. First, consideration of recent and planned capital expenditures (CapEx) will help explain rate trends that either respond to recent expenditures or anticipate the fiscal demands of upcoming expenditures. Second, information on existing cash reserves will provide new insights regarding potential pressures for increased rates. Third, pressure on rates due to recent or anticipated CapEx and operating cost increases are countered by concerns about affordability. The New Jersey affordability study for Jersey Water Works used slightly different water demands than this study (45,000 and 60,000 gallons per year, rather than NJDEP's 50,000 and 80,000 gallons per year), rates from 2021 rather than 2023, and both drinking water and wastewater utility costs. Therefore, the affordability study was not used as a point of comparison here, but an updated approach could be useful in assessing where increasing rates may result in a major increase in affordability pressures on households.

Conclusions

This report provides the first detailed analysis of residential water rates relative to a variety of factors related to PCWS ownership, status, finances, and geophysical location. The results indicate that publicly-owned PCWS as a group have lower residential rates than investor-owned utilities (with a handful of the smallest systems having much higher rates). However, most of the financial, system integrity, and geophysical metrics assessed do not provide support for why those IOU rates are often higher. Net debt as a percentage of annual operating revenue and annual pipeline breaks per 100 miles may provide part of the answer based on simple statistics, but they were not found statistically significant in the regression analysis. Overall, residential rates are bi-modal, with the lowest rates among the medium PCWS (10,000 to 50,000 population) and the highest rates among small systems (less than 10,000 people served) and larger systems (greater than 50,000 people served).

The report results are useful for a general overview of relationships, but as with any statistical analysis, they are not applicable to any one PCWS. The report also should be considered a snapshot of 2023 conditions, which may change over time with additional pressures on PCWS to deal with expensive capital projects for asset management, new treatment technology and requirements, and lead service line removal.