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Water Needs through 2040 for New Jersey Public Community Water Supply Systems

Prepared for the New Jersey Department of Environmental Protection
Division of Water Supply & Geoscience

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Daniel J. Van Abs, PhD, PP/AICP
Principal Investigator
Rutgers – The State University of New Jersey
School of Environmental and Biological Sciences
Department of Human Ecology
55 Dudley Road, New Brunswick, NJ 08903

e: vanabs@sebs.rutgers.edu

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Disclaimer

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New Jersey Water Needs through 2040:
Evaluation of Population and Water Use Rate Scenarios

Executive Summary

The New Jersey Department of Environmental Protection (NJDEP) contracted with Rutgers-The State University of New Jersey (Rutgers) to estimate water demands for each Public Community Water Supply (PCWS) system in New Jersey to the year 2040. The project results will support future water supply planning by NJDEP, including the Statewide Water Supply Plan. This project made several important advances regarding our understanding of water supply demands and demand forecasting. This report provides a detailed technical discussion of the methodology, data collection, data analyses, model development and assumptions, and results for the project. It is not written or intended for general public use.

Residential Demand Data

Multi-year residential water demand data were collected and analyzed representing over 40 percent of the state's population and over 45 percent of those served by PCWS systems. Data were provided by Mount Laurel MUA, Newark Water & Sewer, New Jersey American Water (28 systems), Passaic Valley Water Commission (PVWC), Ridgewood Water Department, Roxbury Township Water, and Suez-New Jersey (Hackensack and Franklin Lakes systems). The results provide a detailed view of per capita demands and how they vary by housing density and geographic area of the state. Additional factors were assessed, including housing age, average slope and precipitation intensity, but the available data did not support differentiation of residential demands by these factors. The weighted average values for all systems are as shown in **Table ES-1**, which clearly shows that rates differ dramatically between low density and high density housing.

Table ES-1. Residential Per Capita Demands by Housing Density and Season

Residential Demands Metric	Housing Density	Weighted Average (gallons)
Average Annual Per Capita Per Day	high	49.89
	medium	60.79
	low	87.10
Total Summer Use Per Capita Per Day	high	52.96
	medium	78.23
	low	128.51
Average Non-Summer Use Per Capita Per Day	high	46.23
	medium	52.09
	low	62.93
Ratio of Summer Use to Non-Summer Use (Per Capita Per Day)	high	1.15
	medium	1.50
	low	2.04

In addition to per capita demands, the residential data provide an understanding of how residential demands differ between the summer and non-summer periods, and perhaps more importantly, how the ratio of summer to non-summer demands differs regionally and between different housing densities. In general, high-density residential development shows minimal differences between the seasons, while low-density residential development shows great differences, and especially in the coastal zone. As can be seen in the table above, for all systems, Non-Summer demands for low density development are roughly 36 percent greater than high density development, while Summer demands differ by over 140%. For high density development, Summer demands are little higher than Non-Summer, while for low density development, Summer demands are double, on average.

PCWS System Population Estimates

These analyses required a detailed understanding of populations within PCWS service areas **(see Figure ES-1)**. Following an approach used by the Highlands Water Protection and Planning Council, a technique called dasymetric analysis was employed using Geographic Information System (GIS) software. This approach provided estimates of population associated with high, medium and low density residential development for each Census block group, the smallest Census area available. Using this technique and NJDEP draft mapping of PCWS service areas (see map on next page), the total population served by PCWS systems is roughly 90 percent of the total population (a total of 7,884,569, compared to the 2010 Census of 8,791,894). Comparison of the computed populations with actual 2010 populations, for PCWS systems serving entire municipalities where comparisons are easiest, indicates that the dasymetric analysis provides a good estimate at that scale. The use of this technique for very small PCWS systems is less robust.

Population projections from the three Metropolitan Planning Organizations (MPOs) – North Jersey Transportation Planning Authority (NJTPA), the Delaware Valley Regional Planning Commission (DVRPC), and the South Jersey Transportation Planning Organization (SJTPO) – were used as the only source of municipal population projections. In aggregate, they project an 18 percent increase in population from 2010 to 2040, to roughly 10.4 million. This value exceeds an extrapolation of the 2030 statewide projections from the NJ Department of Labor and Workforce Development (NJDOL), which would result in a statewide population of 10.1 to 10.2 million. The differences can be ascribed to the different methods used by the MPOs and NJDOL. The MPO municipal population projections for 2040 were distributed to the PCWS service areas in the same manner as for the 2010 populations.

The project team evaluated how population projections may vary if rates of fertility, mortality and net migration change from assumed levels. The population profile of New Jersey is significantly different from the national profile, as are the fertility, mortality and migration rates. The sensitivity of statewide population projections to changes in these rates (using national rates or other recent historical trends) indicates that mortality rates are less likely to cause a significant difference in 2040 population (+0.54% to -1.09%) than fertility rates (+3.36% to -0.22%). Net migration (i.e., influx from other states and other nations minus outflux to other states and nations) is most subject to major changes, from year to year and over time. Net migration is calculated in various ways by various entities, and is not easy to confirm. However, based on available information, the 1990s were a period of relatively high net immigration, with the period from the year 2003 through 2014 being a period of either significant net outmigration or a rough equilibrium. As has been reported, New Jersey's recent population increases are due to more births than deaths, which have resulted in a net gain despite net outmigration. Variations in net migration within recent averages yield the greatest potential variation in 2040 population (+5.27% to -3.90%). Similar analyses were performed for the county populations, showing that counties are more variable based on changes in these three rates, as would be expected. All projections are subject to error, as economic shifts and regulatory changes (such as to national immigration policies) cannot be predicted that could alter trends. Two major examples are Atlantic City's changing casino industry, and Camden City's redevelopment efforts.

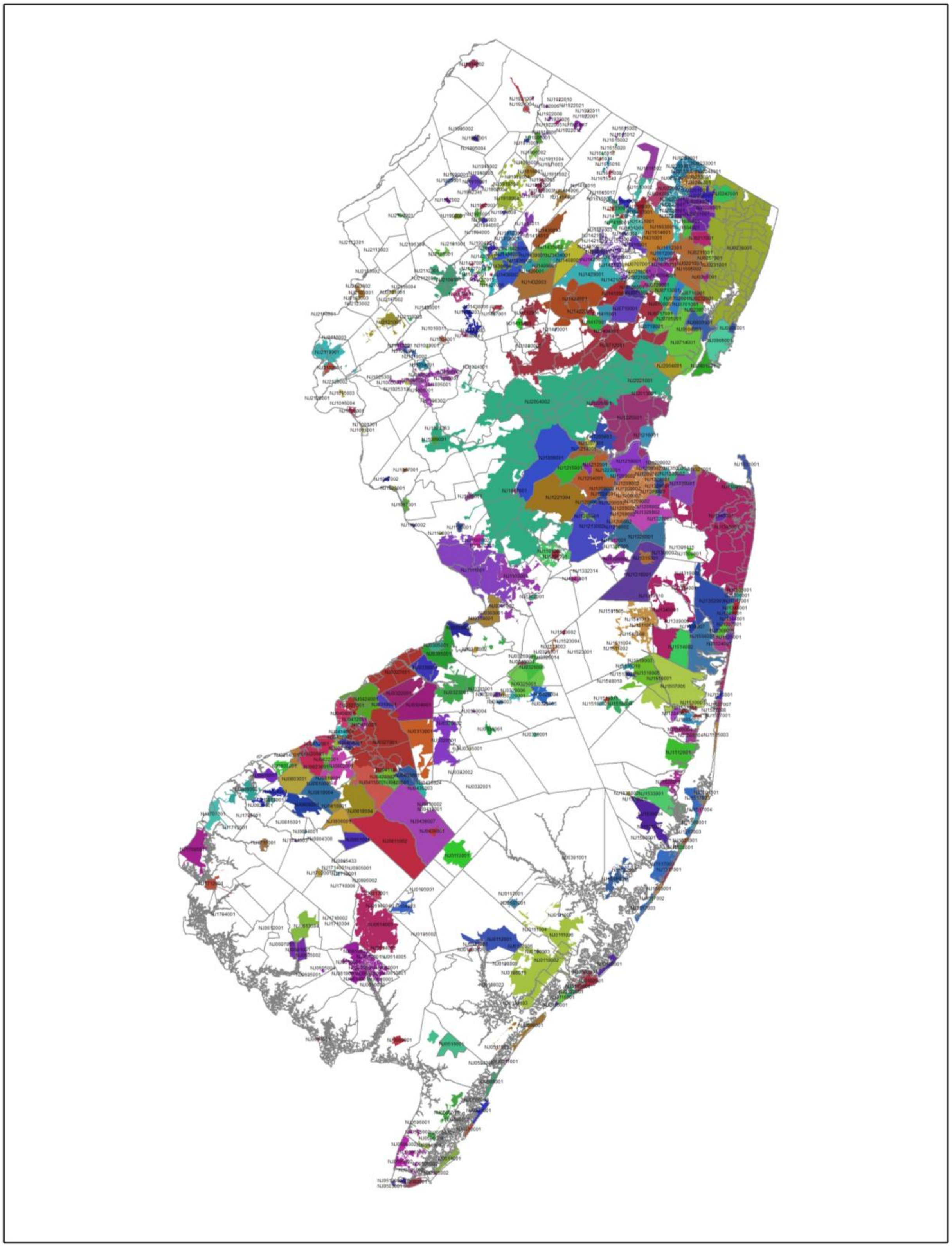


Figure ES-1. Public Community Water Supply System Service Areas, 2017

Water Demand Model for 2010

Residential water demand estimates for 2010 were developed based upon the 2010 population estimates, for the case study PCWS systems (using supplied data) and then for all other PCWS systems (using the critical factors of housing density and location – Coastal Plain; Piedmont; Highlands and Ridge & Valley). In addition, systems with extensive service area along the Atlantic Coast were evaluated to determine the extent to which summer demands were affected by seasonal populations, beyond the increases expected due to normal summer demands by year-round residents. In these cases, a summer demand estimate was added.

Commercial and industrial demands were more problematic. Based on the limited available information regarding demands, a rough correlation was developed between demands and the percent commercial and industrial land area within PCWS service area. The assumptions used for estimation of these demand components were necessary due to a lack of data, but they are a concern as they introduce significant potential for error.

Water loss rates were available from NJDEP or the Delaware River Basin Commission for 228 of the 584 PCWS systems, providing a robust view of the very wide range of losses, from below 5 percent to over 50 percent for major systems. However, some large and medium and many small systems lacked reported water losses and so the available information was used to develop assumed water loss rates based on system size and service area location, either Coastal Plain or Bedrock geology, as the median and mean water losses differed significantly based on these factors, from a median (excluding outliers) of 22.3 percent for small bedrock systems to roughly 10 to 11 percent for coastal systems of all sizes. There is no way to ascertain whether the assumed rates are appropriate for each system, introducing a potential for error. The use of percentage losses is appropriate for this purpose, as the focus is on total demands, not whether the losses are acceptable.

The total modeled water demands incorporate Residential, Industrial and Commercial (RIC) demands plus water losses. These totals were compared to two measures of recent delivered water (i.e., the water released into the distribution system): the peak annual demand in the last five years (NJDEP Water Supply Deficit/Surplus analysis); and the average annual demand for 2008-2015 (NJ Water Tracking database, NJWaTr), which matches the years for available data from most of the case study PCWS systems. Peak years can differ among the systems, occurring any time from 2012 through 2016, and as of the close of 2017 the year 2012 peaks will drop from the analysis and 2017 will be added. Neither of these measures was developed for the specific purpose, but were useful for comparison.

A modeled result within roughly 20 percent of either of the two measures is considered useful, given the assumptions made within the modeling system and the nature of the comparison measures. While the results for many PCWS systems were nearly identical to one or both of these measures, and many more were within 20 percent, there were many where the differences were larger. Specific causes could not be determined without detailed system-specific information. However, the assumptions regarding Commercial and Industrial demands, the use of average residential per capita demand rates, and the assignment of water loss rates are potential causes. For the smallest systems, the uncertainty regarding service area populations is a major issue, though these systems provide a very small fraction (roughly 2 percent) of the total state demand.

Water Demand Models for 2040

Water demand projections scenarios were developed to estimate 2040 demands as paired sets. Within each set, one scenario assumes that water loss rates match the current median levels, while another scenario assumes that all systems achieve water loss rates equivalent to the current 25th percentile level, an aggressive assumption for conservation.

Two sets are based on the same demand model as for the 2010 demands, with one set assuming that Residential per capita and Commercial demand rates do not decline (No Conservation scenario), and the other set assuming that Residential rates do decline wherever they are above specific values based on "best practice" (Conservation scenario). The Conservation scenario is not highly aggressive, but rather assumes continued, gradual decline in per capita demands. In both cases, Commercial demands are assumed to vary in pace with Residential demands, and Industrial demands remain at the 2010 level. Given the consistent assumptions within these models, they provide a good assessment of the direction and magnitude of change, but accuracy is an issue.

The other sets take a completely different approach. They use the percent change from 2010 to 2040 demands from the No Conservation and Conservation scenarios of the first set of models as an indication of the magnitude of anticipated change, but then apply those percentages to the peak annual and average annual demands discussed above. In this approach, known demands are the foundation for the projection, but the modeling process provides a way to differentiate among systems, to avoid applying a standard rate of change to all systems regardless of location, service area type, etc. These approaches are considered the most robust method for projecting 2040 demands based on the currently available information and the modeling approaches uses.

Table ES-2 provides the results of the recommended set of scenarios for the 37 PCWS systems that provided 80 percent of total PCWS demands from the NJWaTr database.

- **Current Demands**: For the 37 largest systems, the total of all peak demands from the Water Supply Deficit/Surplus analysis is 919.229 MGD, of a total for all systems of 1238.906 MGD. For the 37 largest systems, the total of all 2008-2015 average demands was 702.879 MGD, of a total for all systems of 983.892 MGD. The average demands for the 37 systems are 79.4 percent of the peak demands for all systems. In both cases, these demands are considered the starting point for projections.

- **No Conservation Scenarios**: For the 37 largest systems, the total 2040 demands in the No Conservation scenario with Nominal Water Losses are 726.174 MGD. The No Conservation scenario but with Optimum Water Losses results in demands of 684.463 MGD, a reduction of 5.75 percent from the Nominal Water Loss approach, and a reduction of 2.62 percent from the NJWaTr 2008-2015 average.

- **Conservation Scenarios**: Finally, the Conservation scenarios with Nominal and Optimum Water Losses result in demands for the 37 largest systems of 680.541 MGD and 641.464 MGD, respectively. The Conservation scenarios results in a drop of 6.28 percent from each of the No Conservation scenarios. The difference between the No Conservation/Nominal Water Loss and Conservation/Optimum Water Loss scenarios is **11.67 percent**. Based on these projections, modeled customer conservation and water loss reductions have roughly equal effects on water demands.

The conclusions from this study are several. First, the experience from literature and New Jersey is that indoor water demands are declining. Second, population trends in New Jersey are highly dependent on net migration more than fertility and mortality, and all three factors vary considerably from county to county and municipality to municipality. Third, water losses will play a major role in future water delivery requirements; an aggressive program to minimize water losses can offset a large population increase. Fourth, more aggressive efforts to reduce per capita demands can achieve 2040 demands even below what is projected through this report.

There are a variety of future improvements that can be made to the evaluations and modeling approaches in this report. Over decades of effort, each water supply planning effort in New Jersey has used a more detailed and defensible approach than the prior effort. The priorities from this project will be using the results in the best manner possible, and improving the technique so that this approach is superseded by better results.

Table ES-2. 2040 Water Demand Projections from 2008-2015 Average Demands for the Largest 37 PCWS Systems Based on NJWaTr 2008-2015 Average Demands

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet				NJWaTr	2040 No Conservation Scenario		2040 Conservation Scenario	
PWSID #	**County**	**Name**	**D/S Peak Annual Demand (MGD)**	**2008-2015 Average Demand (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**
0238001	Bergen	Suez New Jersey - Haworth & Franklin Lakes (PWSID 022001)	119.315	112.557	124.097	116.797	107.219	100.912
2004002	Union	New Jersey American Water - Raritan System	137.913	97.057	103.994	97.876	101.713	95.730
0714001	Essex	Newark Water Department	84.753	55.247	49.742	46.816	45.585	42.903
1605002	Passaic	Passaic Valley Water Commission	101.915	51.051	44.491	41.873	42.387	39.894
1345001	Monmouth	New Jersey American Water - Coastal North	47.568	37.114	39.483	37.405	36.365	34.451
0712001	Essex	New Jersey American Water - Passaic Basin	41.736	36.508	36.909	34.738	35.490	33.403
0906001	Hudson	Jersey City MUA	47.419	31.100	37.473	35.269	34.518	32.487
0327001	Burlington	New Jersey American Water - Delaware Division	30.872	28.847	31.300	29.653	30.308	28.713
1225001	Middlesex	Middlesex Water Company	52.145	24.977	24.346	22.914	23.295	21.925
1111001	Mercer	Trenton Water Works	26.773	23.930	26.121	24.584	24.832	23.371
2004001	Union	Liberty Water Company	13.360	13.229	15.671	14.749	14.466	13.615
1507005	Ocean	Suez Toms River	12.204	12.778	15.272	14.469	14.527	13.763
0119002	Atlantic	New Jersey American Water - Atlantic	12.635	12.007	16.402	15.538	15.965	15.125
0102001	Atlantic	Atlantic City MUA	11.571	11.004	7.799	7.389	7.550	7.153
1214001	Middlesex	New Brunswick Water Department	16.612	10.864	7.947	7.479	7.464	7.025
0408001	Camden	Camden City Water Department	11.006	10.435	5.616	5.320	5.499	5.209
0901001	Hudson	Bayonne City Water Department	8.932	8.759	10.452	9.838	9.823	9.245
1424001	Morris	Southeast Morris County MUA	9.555	8.374	7.811	7.352	7.536	7.093
0614003	Cumberland	Vineland City Water and Sewer Utility	8.368	8.072	9.833	9.316	9.467	8.969
0705001	Essex	East Orange Water Commission	7.367	7.876	6.242	5.875	5.634	5.303
0251001	Bergen	Ridgewood Water Department	8.146	7.818	6.082	5.725	5.967	5.616
0702001	Essex	Bloomfield Water Department	7.431	7.630	5.552	5.225	5.188	4.883

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet				NJWaTr	2040 No Conservation Scenario		2040 Conservation Scenario	
PWSID #	County	Name	D/S Peak Annual Demand (MGD)	2008-2015 Average Demand (MGD)	Nominal Water Loss Scenario (MGD)	Optimal Water Loss Scenario (MGD)	Nominal Water Loss Scenario (MGD)	Optimal Water Loss Scenario (MGD)
1614001	Passaic	Wayne Township Division of Water	7.797	7.459	8.641	8.133	8.431	7.935
1204001	Middlesex	East Brunswick Water Utility	7.231	7.013	7.336	6.950	7.084	6.711
1429001	Morris	Parsippany - Troy Hills	6.535	6.292	6.205	5.840	5.983	5.631
1209002	Middlesex	Old Bridge Township MUA	9.096	6.058	6.881	6.519	6.577	6.231
0424001	Camden	Merchantville Pennsauken Water Commission	5.962	6.040	6.006	5.690	5.843	5.535
1808001	Somerset	Franklin Township Department Public Works	6.628	6.015	7.082	6.665	6.720	6.324
1205001	Middlesex	New Jersey American Water Company - Edison	5.887	6.004	6.589	6.201	6.401	6.024
0907001	Hudson	Kearny Town Water Department	10.310	5.470	5.917	5.569	5.591	5.262
1221004	Middlesex	South Brunswick Township Sewer & Water Dept	6.052	5.309	7.965	7.496	7.635	7.186
2013001	Union	Suez Rahway	5.315	5.247	4.421	4.161	4.229	3.980
1215001	Middlesex	North Brunswick Water Department	5.421	5.185	5.311	4.999	5.057	4.759
1506001	Ocean	Brick Township MUA	9.752	5.118	6.015	5.699	5.793	5.488
1216001	Middlesex	Perth Amboy Department of Municipal Utilities	5.994	5.079	5.124	4.823	5.026	4.730
1326001	Monmouth	Gordons Corner Water Company	5.096	4.760	5.029	4.765	4.777	4.526
0324001	Burlington	Mount Laurel Township	4.557	4.596	5.017	4.753	4.596	4.354
TOTALS (Largest 37 PCWS Systems, representing 80 percent of total 2010 statewide demands)			**919.229**	**702.879**	**726.174**	**684.463**	**680.541**	**641.464**
TOTALS (All PCWS Systems) NB: Many very small systems lack available information on current and therefore projected demands			**1250.478**	**994.896**	**1045.664**	**985.4604**	**986.391**	**929.615**

1. Project Purpose and Methodology Considerations

The New Jersey Department of Environmental Protection (NJDEP) contracted with Rutgers-The State University of New Jersey (Rutgers) to estimate water demands for each Public Community Water Supply (PCWS) system in New Jersey to the year 2040. The project results will support future water supply planning by NJDEP, including the Statewide Water Supply Plan.

How will New Jersey's water demand and use change in the next decades? No definitive prediction is possible, but reasonable scenarios can be developed that will aid in planning. Understanding viable scenarios is vital for useful water supply planning, especially for the urbanized areas that dominate the total demands for potable water in New Jersey. The northeastern and central regions of New Jersey are mostly supplied by reservoirs but with important supplies from aquifers, the lower Delaware Valley area relies on a combination of aquifers and Delaware River supplies, and much of the Jersey Shore uses aquifers. Each of these water resources has limitations that must be addressed for the benefit of the state, now and into the future.

Water demand projections for urbanized areas are highly sensitive to projections and forecasts[1] of population, industrial uses and per capital residential and commercial/business demands.

The first issue is with population forecasts. These are highly dependent on past population trends (including both natural growth and migration) and economic trends, and expectations as to how these trends will continue or change over time in response to a wide range of impacts including public policy. Both population and economic trends are subject to significant variation over time. Trends involving larger populations tend to be more stable and predictable than projections involving individual municipalities or other small areas. Within smaller areas especially, short and long-term population trends will be affected by available land, the economics of redevelopment to higher (or lower) densities, a shift from residential to non-residential land uses or vice versa, changes in household size due to demographic shifts (such as changes in ethnic makeup or the proportion of new immigrants), and changes in lifestyle preferences (such as the apparent recent interest in urban areas with high cultural amenities). Development trends have shifted in the past (from urban growth to suburban and exurban growth) and are apparently shifting again toward urban growth; however, there is no guarantee that this shift will continue over the next twenty to thirty years. New Jersey has routinely experienced net migration to other states, but even higher immigration from other countries. Changes in national immigration policies could determine whether New Jersey grows at all, or grows faster. Changes in the desirability of New Jersey to current residents could alter net domestic migration. The only certainty in population forecasts is that they will be incorrect in detail, though they may be correct in general trend and scale.

Water use trends also change. Areas with large existing populations can see significant changes in total water demand based on relatively small changes in per capita water use. Total demand per capita has been trending downward since 1990, according to data compiled by the NJDEP. This change could be the result of new or updated building codes as applied over time, increased water costs (rates), changing household size, personal preferences for water-using or water-saving devices,

[1] According to the U.S. Bureau of the Census, population projections are "estimates of the population for future dates. They illustrate plausible courses of future population change based on assumptions about future births, deaths, net international migration, and net domestic migration. Projected numbers are typically based on an estimated population consistent with the most recent decennial census as enumerated, projected forward using a variant of the cohort-component method." Forecasts include consideration of other factors such as policies, investment impacts, land availability, etc., to evaluate various possible assumptions and determine the most probable. They explicitly include the potential that trends may be changed through public policy.

lawn irrigation practices, etc. However, a review of the 1982 New Jersey Water Supply Master Plan (Task 2-Needs Assessment) indicates that residential per capita demands, based on information provided by 98 water purveyors in response to a survey of 500 systems (see page 1-7 of that report), were not significantly different from the findings of this report, and in some cases were less. The results are shown in **Table 1-1**.

Table 1-1. Residential Water Use Rates in 1975 (gpcd).
(New Jersey Water Supply Master Plan. Task 2-Needs Assessment, p. 1-8)

County	Residential Demand	County	Residential Demand
Atlantic	66.70	Middlesex	62.12
Bergen	74.23	Monmouth	56.71
Burlington	54.59	Morris	59.67
Camden	59.59	Ocean	53.91
Cape May	68.74	Passaic	73.98
Cumberland	50.49	Salem	50.19
Essex	74.73	Somerset	56.37
Gloucester	52.74	Sussex	50.45
Hudson	74.73	Union	74.73
Hunterdon	45.1	Warren	50.55
Mercer	61.12		

Commercial/office water use trends may likewise be affected by changes in building codes, but also by technology improvements for lavatories and HVAC units to reduce water supply and sewer charges. Industrial uses are far harder to forecast, depending as they do on the presence/absence of specific industrial facilities, major process changes, technology upgrades, etc. Industries tend to be concentrated in urban areas, while most of New Jersey's office development is in suburban areas such as the Interstate 287 corridor.

For all these reasons, simple application of an aggregate per capita RIC (residential, industrial, commercial) water demand rate to a given population projection is not highly dependable. As noted above, the 1982 NJ Water Supply Master Plan gathered information on per capita residential demands in an effort to assess how demands would differ around the state. The 1996 Statewide Water Supply Plan developed estimates of 1990 water demands that lumped RIC demands.

These issues apply at the statewide scale, but even more so at the PCWS system level. Water supply utilities generally do not track in detail the total number of residents served, and even less so the total employment associated with retail commercial, institutional and office locations. Their focus is on the number of customers and service connections, and on water sales. Estimating per person residential demands, per employee demands or even demands per unit area of commercial space is not an easy calculation, unless a utility served an entire municipality so that the local population is equal to the service population. Even then, demands will differ depending on the nature and density of development, so analyses are needed to identify sub-populations that will have different demand patterns.

In sum, demand projections are inherently uncertain. They also are necessary and useful, if sufficient caution is used in their application to water supply planning.

Rutgers developed a detailed evaluation of the variables involved in developing more solidly grounded scenarios for future water use. This two-part study addresses:

- Anticipated population growth statewide and PCWS service areas, with a sensitivity analysis based on reasonable scenarios for statewide and county-level population change using reasonably viable assumptions. What are the anticipated or most likely demographic shifts?
- Anticipated water use rates and total water use within the service areas of PCWS systems, again with a set of scenarios based on reasonably viable assumptions. Also, peak demand is a key component of water availability analysis and an important factor is sizing water system capacities and infrastructure so detailed information is critical to NJDEP water supply planning, safe drinking water permitting, and asset management. Therefore, along with annual demands, trends in seasonal water use will be important. Industrial use forecasts were not attempted due to the uncertainties involved.

The study estimates water demand forecasts for all 584 PCWS systems. The results of this study provide a set of input projections for use in water supply planning, which will occur through other projects.

2. General Project Methodology

The methodology has three major components. First, available regional and statewide population projections were evaluated to determine relative levels of uncertainty based on the assumptions used in key variables such as fertility, mortality and net immigration rates. Second, existing water demands and demand rates were determined through the evaluation of metered water delivery and water loss rates for specific types of development within case study areas, and then extrapolated to all other PCWS systems. Third, water demands were projected for 2040 by PCWS system using multiple methods. Each of these methods has advantages and disadvantages, which are discussed later in this report.

This section provides a general overview of the methodology, drawn from the final Methodology Report submitted to and approved by NJDEP (See **Appendix E**). More detailed information is provided in Chapters 3 through 5.

Population Projections/Forecasts Analysis Method

Step P-1: Existing Projections: Population projections/forecasts to 2040 were assembled from the three Metropolitan Planning Organizations (North Jersey Transportation Planning Authority, Delaware Valley Regional Planning Commission, and the South Jersey Transportation Planning Organization) and population projections to 2032 and 2034 were used from the NJ Department of Labor and Workforce Development (NJDOL). The MPO projections are to the municipal level, while the NJDOL projections are statewide and county only. The MPO projections in total were found to be somewhat higher than the NJDOL projections using its Economic-Demographic Model, which is designated "preferred" by NJDOL, but the MPO projections were used for this project as the only available source of municipal projections, which are critical to the project.

Step P-2: Critical Variables: Rutgers compared the various projections and forecasts, evaluated the assumptions, assessed the reasons for differences among the existing projections, and assessed alternative assumptions (including but not limited to shifts in the proportion of residential development that occurs through redevelopment versus "green field" development). Variables of interest include the base population, fertility and mortality rates, and net migration.

Step P-3: Historic Trends: Rutgers evaluated the ranges and trends for the key variables to provide a basis for scenario development and the "outer bounds" of likely future trends.

Step P-4: Sensitivity Analyses: Using the available population projection models, Rutgers assessed the sensitivity of 2040 population statewide and county projections to modifications in the primary variables, within the historic range of each variable and with attention to situations where the simultaneous modifications of multiple variables may result in invalid evaluations (e.g., historic high migration rates into New Jersey are unlikely to occur at the same time as an historic low employment growth rate).

Step P-5: Selection of Scenarios and Projections: The next step of the project is to recommend one projection, a combination of sub-region projections, or a subset of the evaluated projections that would be best utilized for NJ Statewide Water Supply Plan needs. Critical uncertainties are discussed to demonstrate the potential impacts of such uncertainties on water demand forecasting. However, given the need for municipal population projections, the MPO projections were the only relevant 2040 projections available and so are used in this project. Planners should be aware of the sensitivity analyses when evaluating PCWS systems with demands that are close to their system limits, as shifts in population trends could create a deficit situation.

Step P-6: Build-out Analyses: It is recognized that limitations on available land may redirect growth locally but not greatly alter regional or statewide forecasts. The MPO projections appear to implicitly or explicitly incorporate limitations imposed by the Pinelands Comprehensive Management Plan and the Highlands Regional Master Plan. Analyses of land limitations on development, developed for the Council on Affordable Housing (COAH), were not available for this project. PCWS systems should be aware of the build-out potential of their service areas and the extent to which it is constrained by state laws or local conditions.

Current Water Demand Rates Method

Step D-1: Statewide Data Acquisition: Data used on this project included:

- 2012 Land Use/Land Cover (LULC) Data in GIS (NJDEP)
- Listing of Public Community Water Supply (PCWS) Systems (NJDEP) (as of May 2017)
- PCWS service areas in GIS (NJDEP, work in progress as of June 2017)
- PCWS Safe Drinking Water Program data on current and committed peak demands, contracted water supplies, firm capacity, etc. (NJDEP, current to May 2017)
- NJ Water Tracking (NJWaTr) database on water demands per year 1990-2015 (NJDEP)
- Water loss data (NJDEP, Delaware River Basin Commission) (compiled as of June 2017 from multiple data sources)

Step D-2: Evaluation of PCWS Service Areas and Populations: Rutgers estimated the population served for each PCWS. The dasymetric analysis identifies spatial clusters of populations that can be used to estimate PCWS system demands. It also identifies the populations associated with water demands from each residential area within the case example PCWS systems, for the estimation of per capita demands in various development categories. Finally, it is used to help assign future residential demands for all PCWS in a later step.

Step D-3: Identification of Case Example PCWS Systems: Rutgers identified a stratified sample of 10-15 PCWS systems, based on annual average daily demands (over 50 MGD, 20-50 MGD, 5-19 MGD and 2-5 MGD), that collect and compile demands from residential, industrial and commercial (RIC) water uses based on individual metering. The selections were based on systems of varying capacity, geographic location, demographic makeup, and built environment characteristics.

Table 2-1. Variables Use to Identify Case Example PCWS Systems (Step D-3)

Variables	Unit of Measure	Source
Housing Density	Residential Units per acre (units/acre)	2010 U.S. Census
Precipitation	Annual / Monthly Precipitation (inches/ year or inches/month)	Office of the New Jersey State Climatologist
Housing unit age	Housing unit age (years)	Most recent American Community Survey
Household Size	Average number of people per household (persons/unit)	2010 U.S. Census
Land use patterns	Concentrations of different Land Use types	2012 LU/LC data
Topography	Topographic Variability (e.g., percent of service area greater than 10% slope)	USGS 10-meter Digital Elevation Module
Region	Metropolitan Planning Organization regions, Physiographic Provinces	MPO Counties; State Geophysical Province Map

Step D-4: Data Collection from Case Example PCWS Systems: Utilities were solicited for monthly water demands by user by municipality to the extent feasible. Where available, information on water demand trends and water loss rates and trends by PCWS system were also collected.

Step D-5: Data Evaluation from Case Example PCWS Systems: Rutgers developed a database and analytical approach to assess average water demand rates for various categories of land development, for peak and low annual and seasonal periods over the period of record.

Step D-6: Land Use Categorization for All PCWS Systems: Rutgers used the 2012 NJDEP LU/LC data (regarding the amount and relative percentages of residential development of various densities, and of commercial and industrial lands) and American Community Survey data on housing age. Census block group data (as interpreted through dasymetric analysis), LULC data and PCWS system service areas were used to evaluate relative population, land use and housing age distributions within each PCWS system service area

Step D-7: Current Water Demands for All PCWS Systems: Using information from the prior steps, Rutgers estimated current residential, commercial and industrial water demand rates and water losses by PCWS system.

Step D-8: Peak Season Water Use for All PCWS Systems: Rutgers also evaluated seasonal aggregate per capita water use patterns (summer versus non-summer use) for all PCWS systems, and drew conclusions where possible regarding trends in seasonal water use patterns for urban, suburban and Atlantic Coast water systems.

Future Water Demand Method

Step D-9: Water Demand Trend Analysis: Rutgers developed water use efficiency and conservation scenarios for application to future demands in all PCWS systems, assessing: comparison rates available through a national literature search; New Jersey non-revenue water and water losses; industrial uses; seasonal peaking factors; and conservation and efficiency trends.

Step D-10: Water Demand Trend Projections: Based on the current demand estimates and the water demand trend scenarios, Rutgers forecast water demand rates for residential and office/commercial uses, using generalized rates that are applicable to groups of PCWS systems, municipalities or both, with clearly identified assumptions and conditions. For each scenario, the population trend scenarios from Step P-5 were applied.

Table 2-2. Population Trend Scenarios (Step D-10)

Scenarios	Demand Scenario	Water Losses
Scenario 1	Constant Per Capita	Current State Median
Scenario 2	Constant Per Capita	Current 25th Percentile
Scenario 3	Decrease Per Capita	Current State Median
Scenario 4	Decrease Per Capita	Current 25th Percentile
Scenario 5	Current Peak Demands X Percent Change from Scenario 3	Current State Median
Scenario 6	Current Peak Demands X Percent Change from Scenario 4	Current 25th Percentile
Scenario 7	Current Average Demands X Percent Change from Scenario 3	Current State Median
Scenario 8	Current Average Demands X Percent Change from Scenario 4	Current 25th Percentile

Step D-11: Water Demand Projections for All PCWS Systems: Finally, Rutgers developed water demand projections for all PCWS in New Jersey for each scenario, with an uncertainty analysis, and provided recommendations regarding a “most probable” scenario and water demand for each PCWS system.

3. Population Projections and Forecasts

Projections of water demands are necessarily dependent on projections or forecasts of population through the planning period. The acquisition and analysis of available projections provided a foundation for further modeling work.

Statewide and Regional Population Projections

New Jersey has two major sources of population projections, but they are not directly comparable. One is statewide with disaggregation to the county level, and the other set is regional with disaggregation to the municipal level. While the best resource for this modeling work would be a statewide population projection that is disaggregated to the municipal level, such projections do not exist and the statewide projections cannot be used in concert with the regional projections for this purpose.

NJ Department of Labor & Workforce Development

The NJDOL periodically provides projections of statewide population and employment using several different models. NJDOL states that "The Economic-Demographic Model is designated 'preferred' due to its greater scope of input information and its consistency with the year 2024 employment projections prepared by the New Jersey Department of Labor. Other models are included mainly for illustrative purpose." Therefore, Rutgers used the NJDOL Economic-Demographic Model as the point of comparison to the regional models discussed next. As shown in **Table 3-1**, the projections currently go only to 2034, not 2040 which is the target year of this project. The 2034 projected population is 9,733,400 statewide. However, the NJDOL projections for this year are not disaggregated by county.

Table 3-1. Projections of Total Population by Projection Model
New Jersey: 2014 to 2034 (NJDOL)

Projection Model	**Census**	**Estimates**	**Projections to July 1,**			
	4/1/2010	**7/1/2014**	**2019**	**2024**	**2029**	**2034**
Economic-Demographic	8,791,894	8,938,200	9,132,700	9,338,000	9,531,200	**9,733,400**
Zero Migration	8,791,894	8,938,200	9,128,200	9,258,000	9,326,000	9,342,500
Historical Migration	8,791,894	8,938,200	9,109,800	9,263,100	9,402,600	9,522,200
Linear Regression	8,791,894	8,938,200	9,438,900	9,750,900	10,062,800	10,374,700

A prior NJDOL projection to 2032 was disaggregated by county, as shown in **Figure 3-1**. The results clearly show an expectation that major growth will happen in counties that are already heavily developed, such as Bergen, Middlesex, Essex, Hudson, Monmouth, Ocean and Union Counties.

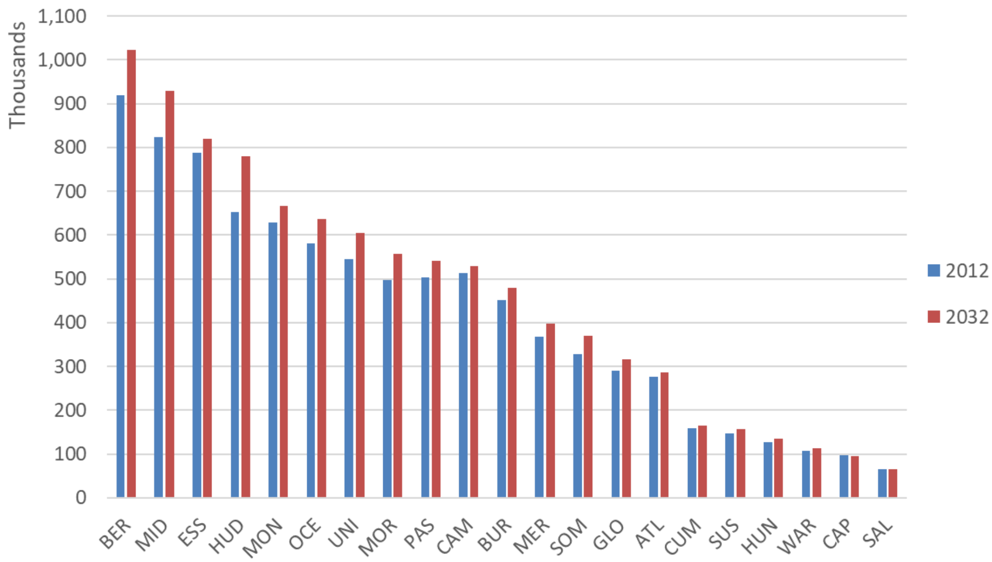


Figure 3-1. NJDOL Population Projections by County: 2012 to 2032

However, NJDOL does not provide disaggregated population projections to the municipal scale. That task is addressed by the Metropolitan Planning Organizations (MPOs) designated by the U.S. Department of Transportation to handle regional transportation planning, especially regarding projects to be funded in part or in whole by the federal government.

Metropolitan Planning Organizations

The North Jersey Transportation Planning Authority (NJTPA) is responsible for transportation planning in the 13 northern counties of New Jersey: the Counties of Bergen, Essex, Hudson, Hunterdon, Middlesex, Morris, Monmouth, Ocean, Passaic, Sussex, Union and Warren. The Delaware Valley Regional Planning Commission (DVRPC) is a bi-state planning agency responsible for transportation and other planning in the New Jersey Counties of Burlington, Camden, Gloucester and Mercer. Finally, the South Jersey Transportation Planning Organization (SJTPO) addresses transportation planning in the southern Counties of Atlantic, Cape May, Cumberland and Salem. These agencies have all developed county and municipal population projections to the year 2040, and in various ways have attempted to address constraints and uncertainties within the projection models. One of the most notable points from **Table 3-2** is that the NJTPA has by far the most populated region, comprising 76% of the state's population. As such, it will also include by far the largest populations that are served by PCWS systems.

Table 3-2. MPO Population Projections

Approach	NJTPA	DVRPC	SJTPO	TOTAL
MPO 2040	7,910,400	1,789,881	710,254	**10,410,535**
Share of Total	76.0%	17.2%	6.8%	100%

Comparison of Available Projections

The NJDOL and MPO results do not entirely agree. While no detailed inquiry was performed, apparently each MPO contracts for their own modeling process, which will reflect the techniques and available information of each region. Rutgers added the MPO results for 2040, which totaled over 10.4 million. The NJDOL results for 2030 totaled over 9.6 million. Extrapolations of the NJDOL 2030 value to 2040 used the average per year growth of both the NJDOL (for 2010 to

2030) of 0.47% and the MPOs (for 2010 to 2040) of 0.56%. In each case the extrapolated NJDOL results for 2040 were lower than the MPO aggregate results, by roughly 100,000 to 200,000, as shown in **Table 3-3**. The MPO aggregate population represents an 18% increase over 2010 Census results, while the extrapolation of the NJDOL 2030 projections yielded growth of 15% or 16%. The U.S. Census population estimate for 2016, is 8,944,469, an increase of 1.7% from the 2010 population of 8,791,894 in six years (or only 0.28% per year) of the 30-year period to 2040. Though it is important to keep the different results from these models in mind, the MPO projections were used in this report as the only source of municipal-level population projections.

Table 3-3. Comparison of NJDOL and MPO Population Projections

Population Projection Source	Total	Increase from 2010
MPO 2040 Aggregate Population	**10,410,535**	18%
NJDOL 2030 (Economic/Demographic Model)	9,648,100	10%
2040 Extrapolation of NJDOL 2030 at 0.47% per year (NJDOL average)	**10,106,982**	15%
2040 Extrapolation of NJDOL 2030 at 0.56% per year (MPO average)	**10,207,170**	16%

Evaluation of Sensitivity to Variations in Critical Variables

Using the Age-Cohort population projection models and available data, we determined the sensitivity of 2040 population projections to modifications in the primary variables, such as fertility rate and mortality rate, within the historic range of each variable and with attention to situations where the simultaneous modifications of multiple variables may result in invalid evaluations (e.g., where historic high migration rates into New Jersey are unlikely to occur at the same time as an historic low employment growth rate). The base population model uses the 2012 statewide fertility rate by the National Vital Statistics Report, the 2011 statewide mortality rate by New Jersey Department of Health, and the average migration rate during the period of 2000 to 2010 in New Jersey. The following analysis recognizes the potential for regions to have different results based on local circumstances, such as the evolution of the casino industry in Atlantic City. However, these are inherently unpredictable circumstances that will be affected by industry-specific economic issues, as well as changing laws in New Jersey and elsewhere. As such, these issues must be addressed through uncertainty factors that overlay the population projections.

Approach

The base population, fertility rate, mortality rate, and employment rate are all the independent variables, available from various agencies. The historical net migration is dependent on the base population, births, and deaths, as migration is not directly measured but rather is inferred from the values of the independent variables. The National Center for Health Statistics (NCHS) also provides an upper and a lower limit (95% confidence interval) for each fertility and mortality rate, which could be used to conduct the sensitivity test. Through a control variable method, we assess how changes to the fertility rate and mortality rate may affect the final population projections (**Table 3-4**).

Table 3-4. State Population Variability Scenarios

	Fertility Rate	Mortality Rate	Migration Rate
Sensitivity Test 1	Constant	Upper/Lower Limit	Constant
Sensitivity Test 2	Upper/Lower Limit	Constant	Constant
Sensitivity Test 3	Upper/Lower Limit	Upper/Lower Limit	Constant

New Jersey's population profile is significantly different from that of the United States, as shown in **Figure 3-2**, below. New Jersey generally has a higher percentage of both males and females in the cohorts from age 40 and up, and a lower percentage in younger cohorts, especially for females. The underrepresentation of females of child-bearing age will affect New Jersey's fertility rate, while the overrepresentation of older cohorts will eventually affect mortality rates.

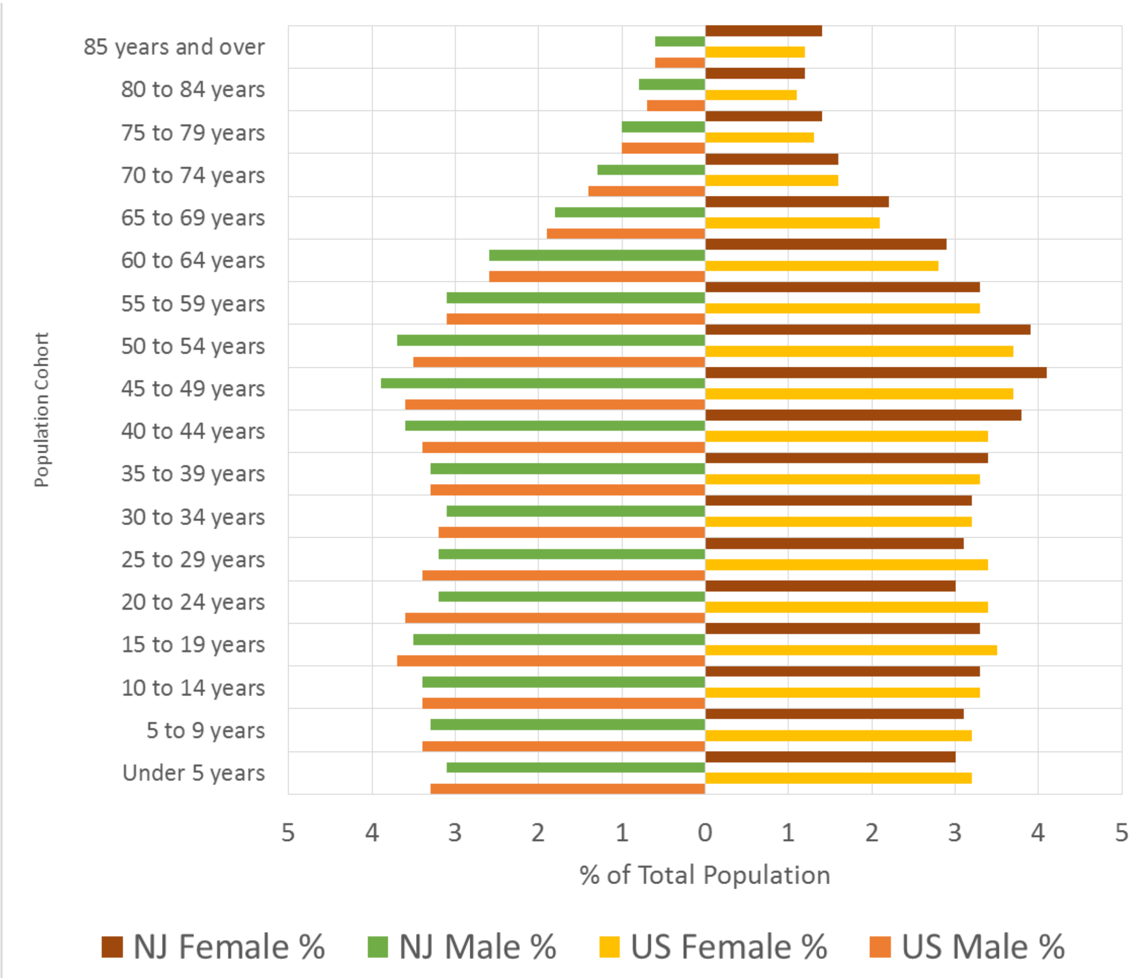


Figure 3-2. U.S. and NJ Population Pyramids (Cohort by Percent)
(derived from 2010 U.S. Census)

Sensitivity Test 1: Mortality Rates

In this part of the sensitivity test, we investigate how changes to the mortality rate affect the final population projections in New Jersey. We used the upper and lower limit (95% confidence interval) of the 2011 statewide mortality rate, the 2013 United States mortality rate and a mortality rate that is 2% lower than 2011 data in the age-cohort model to project alternative statewide populations through 2040.

95% Upper and lower limit of the 2011 NJ mortality rate

The upper and lower bounds of a 95% confidence interval are the 95% confidence limits, which give an estimated range of most probable 2011 statewide mortality rate. The lower the mortality rate, the higher the survival rate. Therefore, the upper limit of the 2011 New Jersey mortality rate could be used to estimate a lower boundary of the population projection and vice versa.

2013 US mortality rate

New Jersey has a lower mortality rate per 100,000 population than United States (802.3 vs. 821.5 in 2013), which means about 19 fewer people per 100,000 population die in New Jersey per year. The mortality rate for almost all age groups in United States is higher than in New Jersey, an important consideration given the New Jersey's population is older than the national population, on average. Therefore, 2013 US mortality rate could be used to estimate the lower boundary of the population projection in New Jersey.

2% lower than 2011 NJ mortality rate

From 2009 to 2013, the mortality rate in New Jersey decreased 2%. In this test, we assume the ongoing mortality rate is 2% lower than the 2011 statewide mortality rate.

Analytical Results

Figure 3-3 and **Table 3-5** below show the results for sensitivity tests when only the mortality rate changes in the age-cohort model. The upper limit of statewide population projection appears when using the lower limit 2011 NJ mortality rate, and the lower limit appears when using the 2013 United States mortality rate. The range for the modified forecasted population in 2040 is from 9,646,755 to 9,805,543 (1.09% lower and 0.54% higher than the baseline projection, respectively). Thus, the most likely range of mortality rates will not affect the population projection significantly.

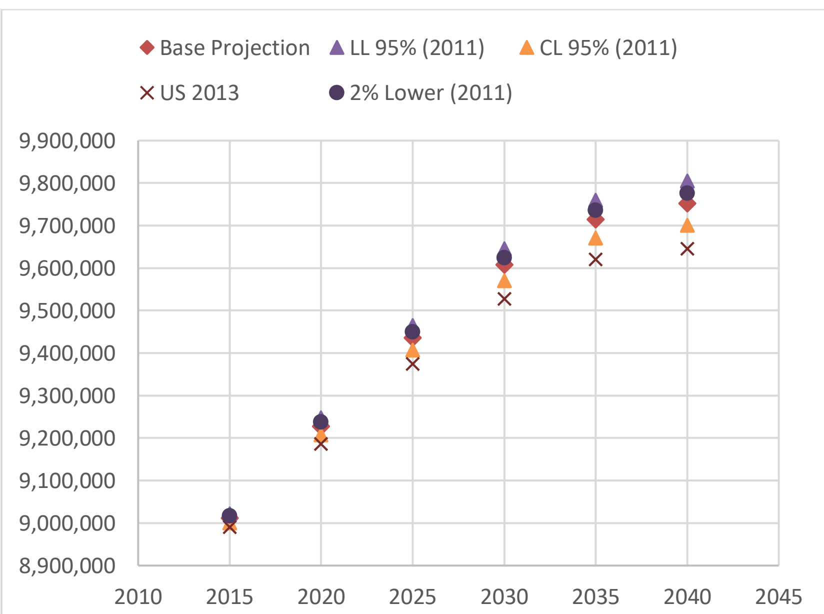


Figure 3-3. Sensitivity Test 1 (Mortality Rate) from 2010 Census Population

Table 3-5. Results for Sensitivity Test 1 from 2010 Census Population:

		2015	2020	2025	2030	2035	2040
LL 95% (2011 NJ)	Population	9,022,091	9,248,032	9,464,999	9,645,556	9,760,872	9,805,543
	Difference	10,330	19,878	28,865	37,439	45,376	52,325
	%	0.11%	0.22%	0.31%	0.39%	0.47%	0.54%
CL 95% (2011 NJ)	Population	9,001,462	9,208,396	9,407,510	9,571,064	9,670,667	9,701,612
	Difference	-10,299	-19,758	-28,624	-37,053	-44,828	-51,607
	%	-0.11%	-0.21%	-0.30%	-0.39%	-0.46%	-0.53%
US 2013	Population	8,990,654	9,186,263	9,374,509	9,528,624	9,620,901	9,646,755
	Difference	-21,107	-41,892	-61,624	-79,493	-94,595	-106,464
	%	-0.23%	-0.45%	-0.65%	-0.83%	-0.97%	-1.09%
2% lower	Population	9,017,150	9,238,029	9,449,836	9,625,325	9,735,981	9,776,605
	Difference	5,389	9,875	13,703	17,208	20,486	23,386
	%	0.06%	0.11%	0.15%	0.19%	0.23%	0.26%

Sensitivity Test 2: Fertility Rates

In this part of sensitivity test, we investigate how changes to the fertility rate could affect the final population projections in New Jersey. The statewide average fertility rate (1990-2012), 2012 United States fertility rate, the lower limit (95% confidence interval, shown as 95% LL) of the 2012 statewide fertility rate, the 2015 estimated fertility rate using linear regression model, and the 2015 estimated fertility rate using exponential regression model are used in the age-cohort method (with no modification of other variables) to forecast statewide population through 2040. The relationship between these variables is shown in **Figure 3-4**.

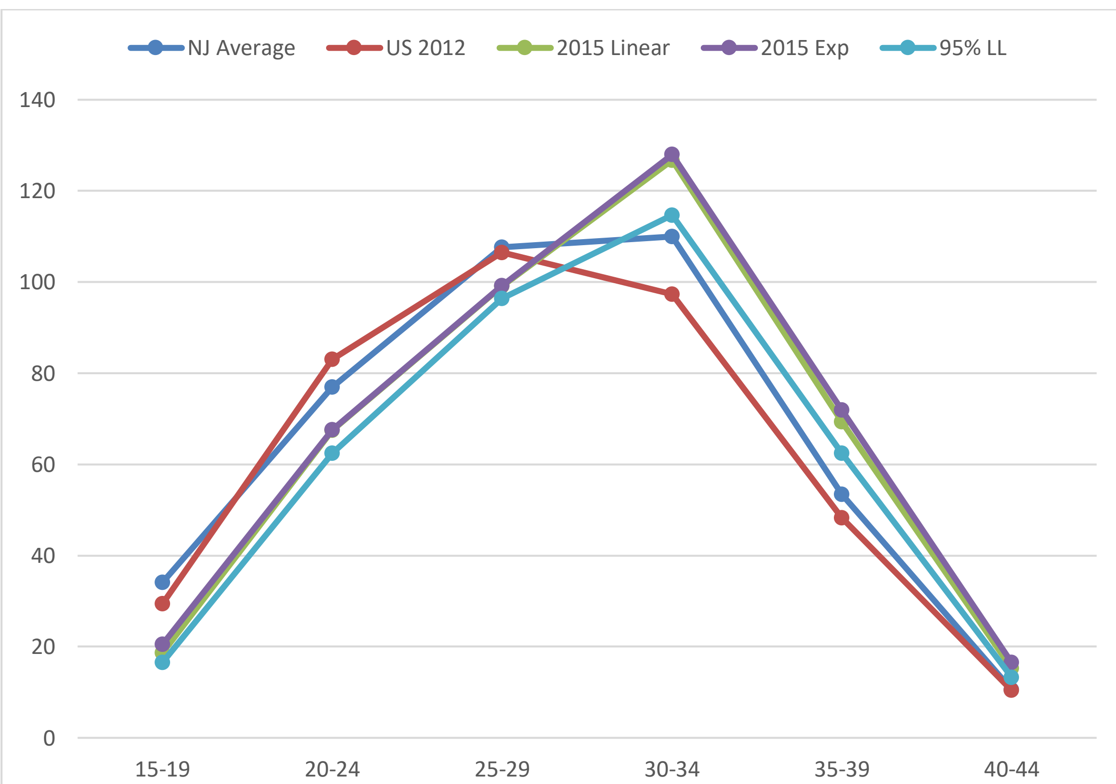


Figure 3-4. Fertility Rate by Mother's Age for Sensitivity Test 2

NJ average fertility rate (1990-2012)

The NJ average fertility rate is the average number of fertility rate for each female, child-bearing age group during the period of 1990 to 2012.

2012 United States fertility rate

New Jersey has a lower general fertility rate (measured as the average annual births per 1,000 female population aged 15-44) than United States (60.4 vs. 63.0 in 2012), which means about 2.7 fewer children would be born to each 1,000 female population aged 15-44 per year in New Jersey than in United States. **Figure 3-5** shows the relationship of the fertility rate for each female age group between New Jersey and United States. Females in New Jersey tend to later childbearing, so the peak cohort for the United States, at 25-29, differs from the New Jersey peak in the 30-34 age group.

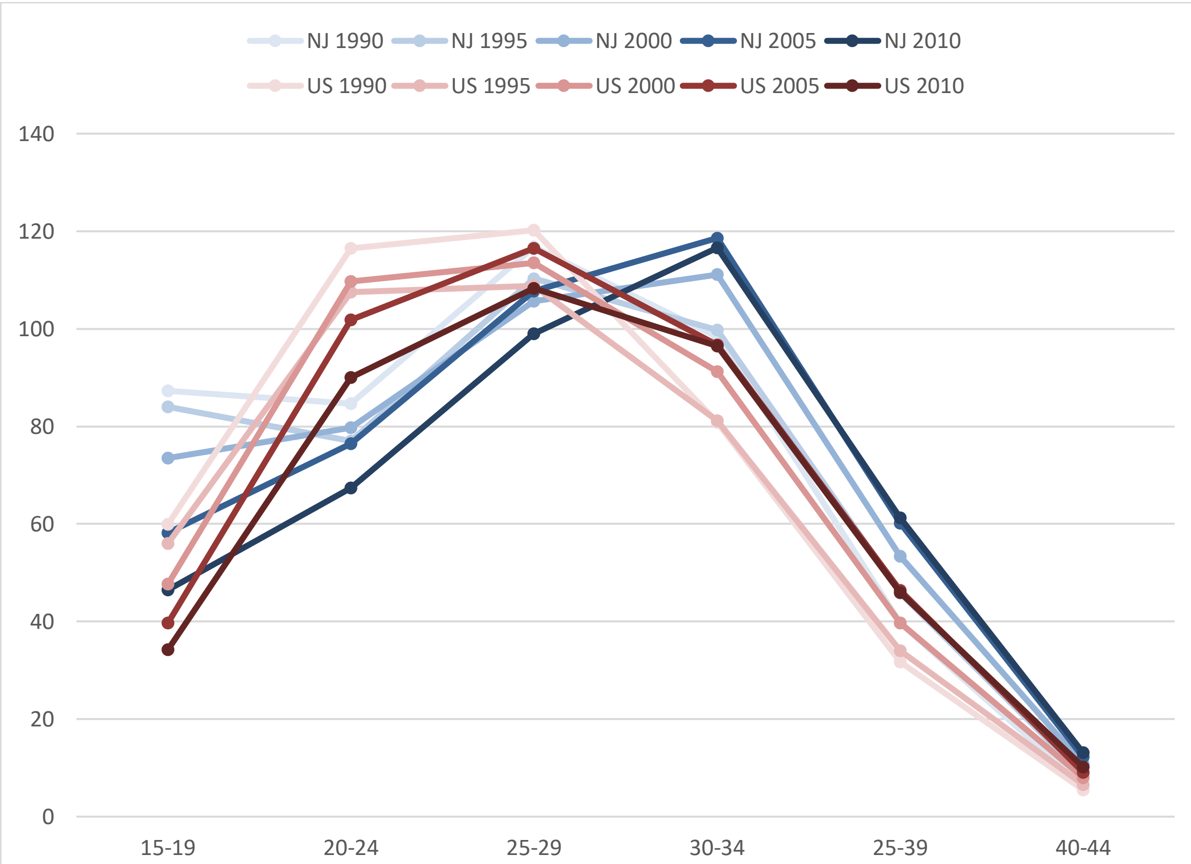


Figure 3-5. Fertility Rate by Mother's Age (NJ vs. U.S.)

95% lower limit of 2012 NJ fertility rate

The lower bounds of a 95% confidence interval are the 95% confidence limits, which give an estimated lower limit of 2012 statewide fertility rate and lower boundary of the population projection.

2015 estimated fertility rate (linear regression)

A linear regression model is used to estimate the 2015 statewide fertility rate based on the historical statewide data.

2015 estimated fertility rate (exponential regression)

An exponential regression model is used to estimate the 2015 statewide fertility rate based on the historical statewide data. The result is an extrapolated change that is faster than that suggested by the linear regression model.

Analytical Results

Figure 3-6 and **Table 3-6** below show the results for sensitivity tests when only the fertility rate changes in age-cohort model. It is clear that the upper limit of statewide population projection appears when using the 2015 exponential rate; the lower limit appears when using the 95% lower limit rate. The range for the forecasted population in 2040 is from 9,732,096 to 10,081,240 (0.22% lower and 3.36% higher than the baseline projection, respectively). Thus, the most likely range of fertility rates will not affect the population projection significantly. (The differences appear larger in the figure due to the truncated axis for population.)

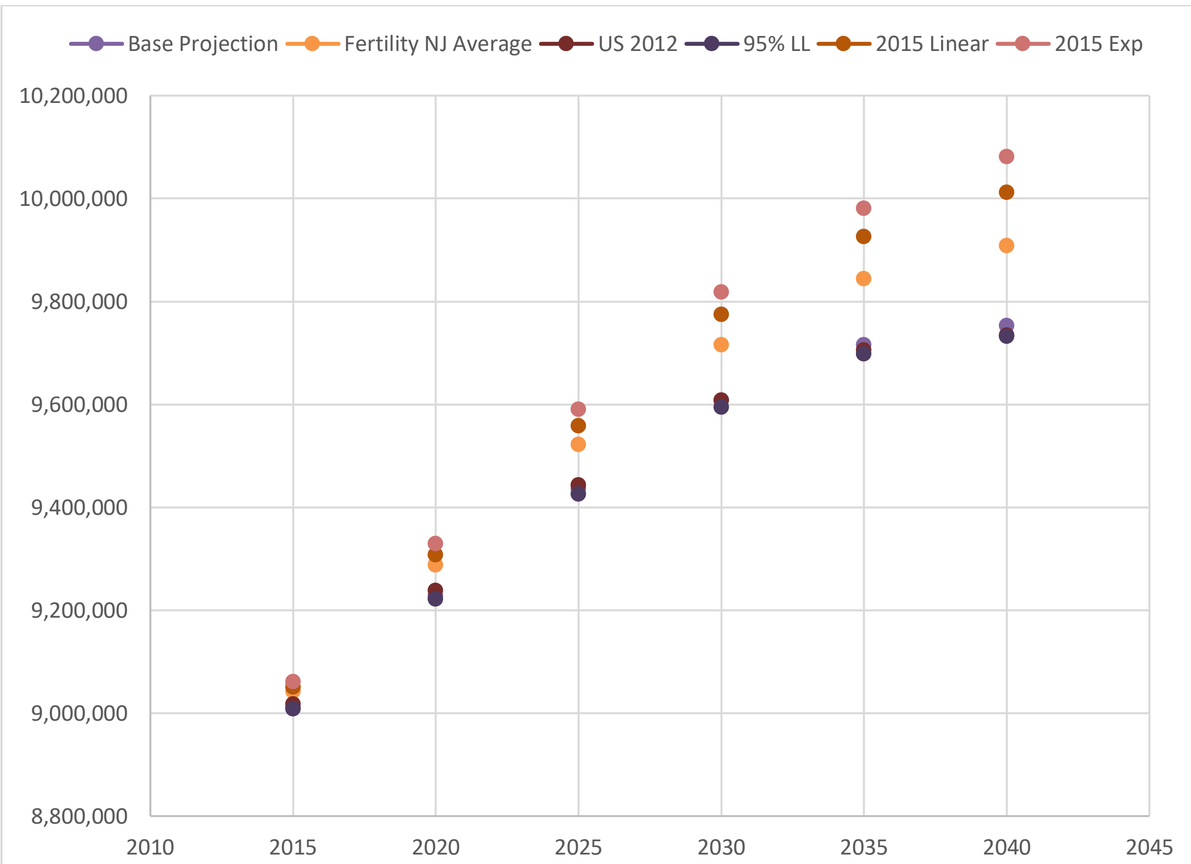


Figure 3-6. Sensitivity Test 2 (Fertility Rate) from 2010 Census Population

Table 3-6. Results for Sensitivity Test 2 from 2010 Census Population

		2015	2020	2025	2030	2035	2040
NJ Average	Population	9,041,855	9,288,055	9,522,434	9,716,086	9,844,102	9,907,862
	Difference	30,094	59,900	86,301	107,969	128,606	154,643
	%	0.33%	0.65%	0.91%	1.12%	1.32%	1.59%
US 2012	Population	9,017,540	9,237,619	9,443,357	9,607,667	9,704,990	9,733,922
	Difference	5,778	9,464	7,224	-450	-10,506	-19,296
	%	0.06%	0.10%	0.08%	0.00%	-0.11%	-0.20%
95% LL	Population	9,008,447	9,221,459	9,425,975	9,594,480	9,698,312	9,732,096
	Difference	-3,314	-6,696	-10,158	-13,637	-17,183	-21,122
	%	-0.04%	-0.07%	-0.11%	-0.14%	-0.18%	-0.22%
2015 Linear	Population	9,050,522	9,307,722	9,558,529	9,774,153	9,925,496	10,012,061
	Difference	38,761	79,568	122,396	166,036	210,000	258,842
	%	0.43%	0.86%	1.30%	1.73%	2.16%	2.65%
2015 Exp	Population	9,061,239	9,328,973	9,590,799	9,817,731	9,981,051	10,081,240
	Difference	49,478	100,819	154,666	209,614	265,556	328,021
	%	0.55%	1.09%	1.64%	2.18%	2.73%	3.36%

Sensitivity Test 3: Mortality and Fertility Rates

Given the two tests discussed above, the next question is how population projections would change if both mortality and fertility rates were varied within the ranges discussed. Historically, mortality rates (**Figure 3-7**) in both the United States and New Jersey have fallen over time, with New Jersey's rate falling faster despite its more rapidly aging population. Fertility rates (**Figure 3-8**) have a more volatile pattern, both falling (the 1990s and during the Great Recession) and rising (during the financial boom period just prior to that recession). The differences between the national and state rates also are more variable than for mortality, with the mid-1990s showing little difference and other periods showing larger differences. However, New Jersey fertility rates are always significantly lower.

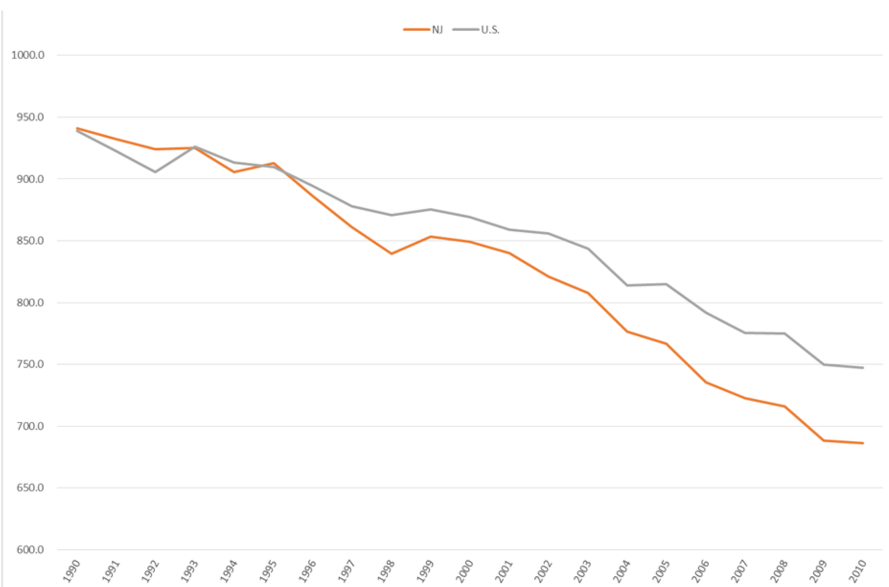


Figure 3-7. Age-adjusted Death Rate by Year, NJ and U.S. (1990-2010)

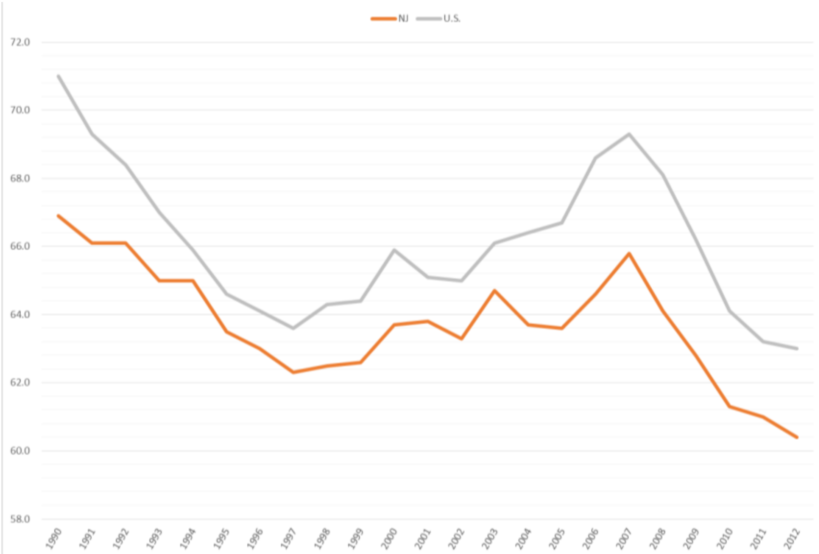


Figure 3-8. Total Fertility Rate per 1,000, NJ and U.S. (1990-2012)

In this part of the sensitivity test, we investigate how population projections would change if both mortality and fertility rates were varied within the ranges discussed above. Given the historic data and trends, it is highly likely that both rates will remain lower for New Jersey than national rates, that mortality rates will be stable or decline for each cohort, and that fertility rates will not increase to historic highs. Two extreme cases are used to explore how both variables would affect the final population projections in New Jersey. One uses the 95% lower limit of the 2012 statewide fertility rate combined with the 2013 United States mortality rate, and the second uses the 2015 estimated fertility rate (exponential regression) with the 95% lower limit of the 2011 NJ mortality rate.

Analytical Results

Figure 3-9 and **Table 3-7** show the results of sensitivity tests when both the mortality rate and fertility rates change in age-cohort model. These results are also compared to the extreme cases when only one variable changed. The range for the modified forecasted population in 2040 has increased, from 9,625,680 to 10,134,109 (1.31% lower and 3.91% higher than the baseline projection, respectively). This change is somewhat larger than when only one variable is changed. However, the differences from the baseline population projections are still relatively small even using extreme scenarios. It is likely that actual conditions will not approach the extremes for either variable, and it is even more likely that the two variables will not both approach the extremes and in ways that result in the highest or lowest population projections.

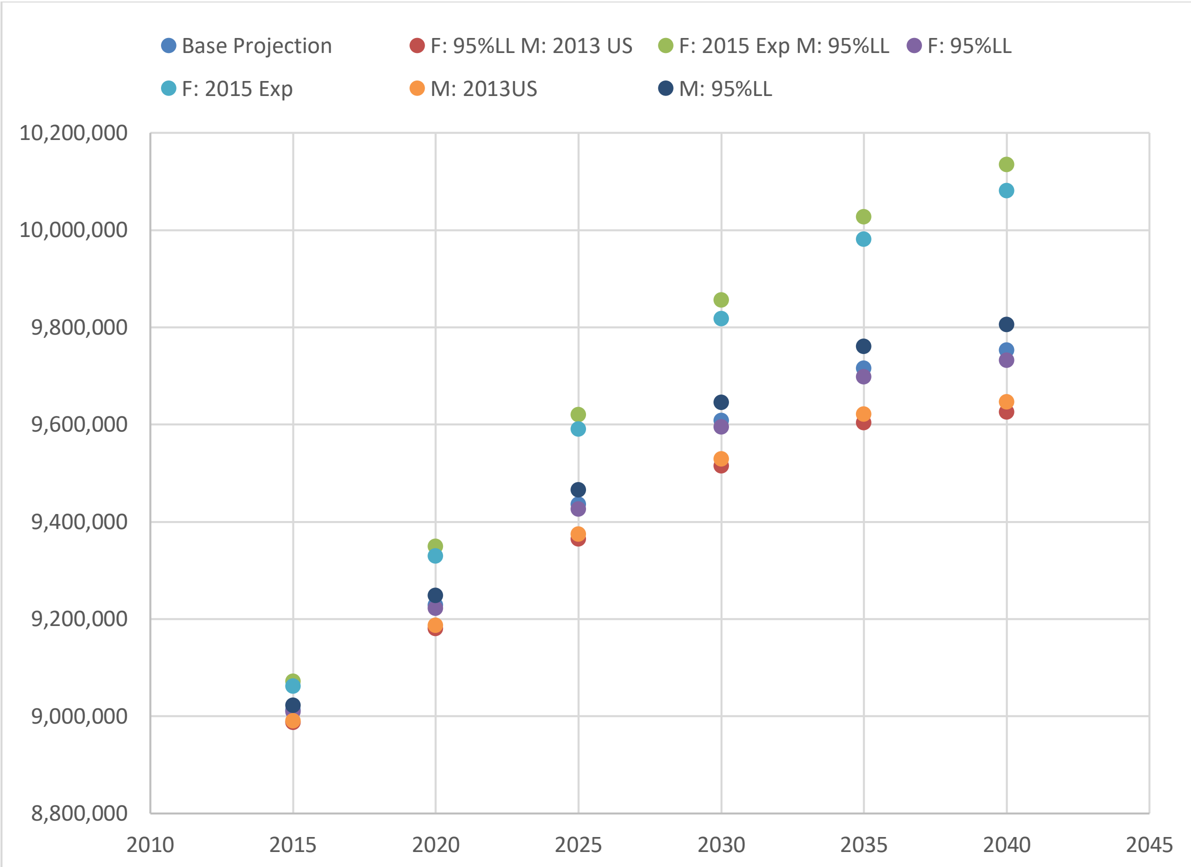


Figure 3-9. Sensitivity Test 3 from 2010 Census Population

Table 3-7. Results for Sensitivity Test 3 from 2010 Census Population

		2015	2020	2025	2030	2035	2040
F: 95%LL M: 2013US	Population	8,987,340	9,179,573	9,364,363	9,515,007	9,603,751	9,625,680
	Difference	-24,421	-48,582	-71,770	-93,110	-111,744	-127,539
	%	-0.27%	-0.53%	-0.76%	-0.97%	-1.15%	-1.31%
F: 2015 Exp M: 95%LL	Population	9,071,569	9,348,901	9,619,791	9,855,401	10,026,793	10,134,109
	Difference	59,807	120,746	183,658	247,285	311,297	380,891
	%	0.66%	1.31%	1.95%	2.57%	3.20%	3.91%

Sensitivity Test 4: Net Migration

The 2014 population of New Jersey was estimated at 8.94 million. **Figure 3-10** shows the annual population growth rate between 1981 and 2014. The population growth rate was 0.53% per year in 2010, down from 0.85% in 2000. This slowdown in population growth is largely attributed to net domestic out-migration from New Jersey to other states. Rates of immigration from other countries also can vary widely. Therefore, the net migration component represents a large portion of the uncertainty in population projection.

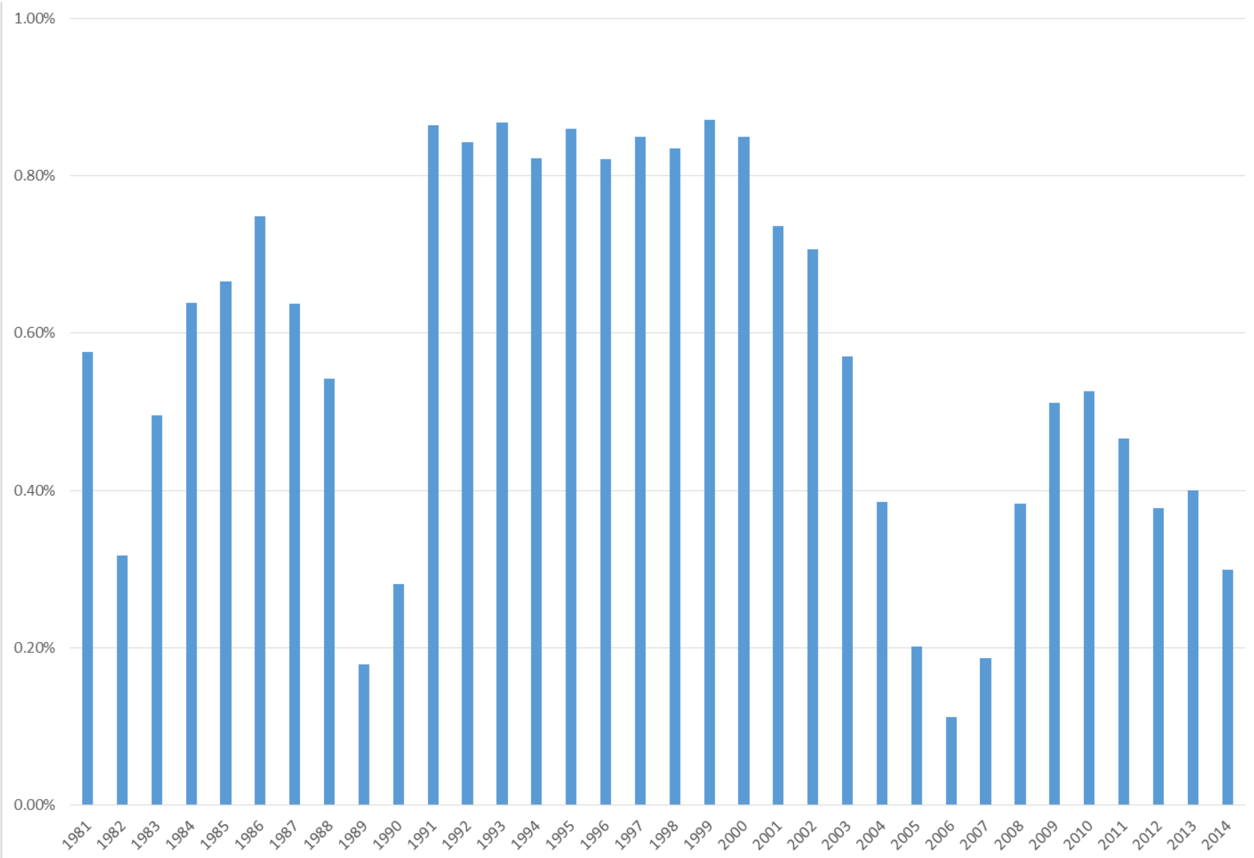


Figure 3-10. New Jersey Population Annual Growth Rate (1981-2014)

As noted in the introduction to this section, migration rates are not directly measured. Rather, they are calculated by comparing the change in total population to the rate of natural increase or decrease (births minus deaths), with the migration rate being that portion of population change not explained by the natural increase or decrease. In this age-cohort population projection model, the average migration rate during the period of 2000 to 2010 in New Jersey is used. **Figure 3-11** provides the calculated net migration rate for New Jersey from 1990 to 2011, clearly showing significant volatility within that average.

There are some other sources of net migration estimates. According to the U.S. Census Bureau's domestic migration estimates, New Jersey has experienced net domestic out-migration since at least 1991 (see **Figure 3-12**). This has closely paralleled the overall migration trends in the northeastern United States. High cost of living and housing might be the main factor that leads to the state's net domestic out-migration. However, New Jersey has also received a large net inflow of international immigrants, which sometimes more than compensates for the domestic outflow.

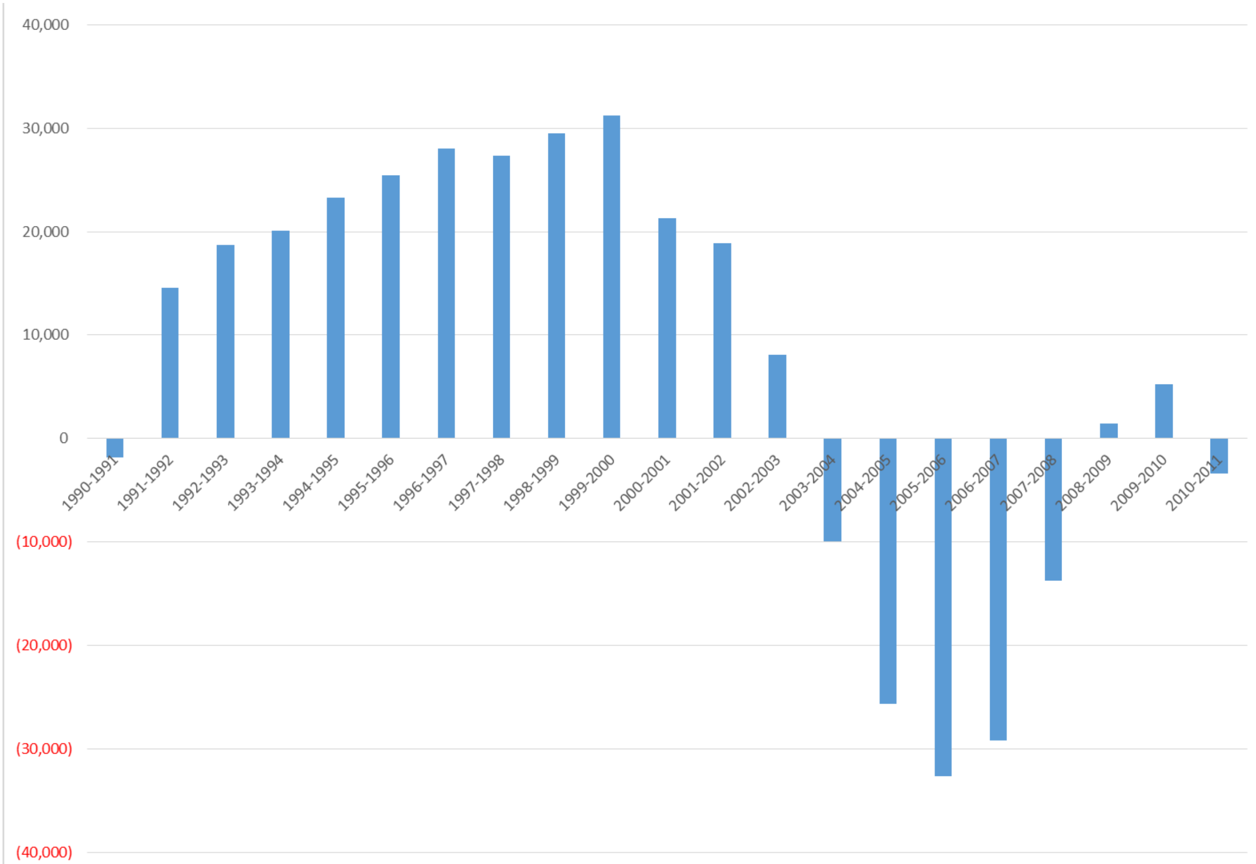


Figure 3-11. Calculated Net Migration, New Jersey (1990-2011)

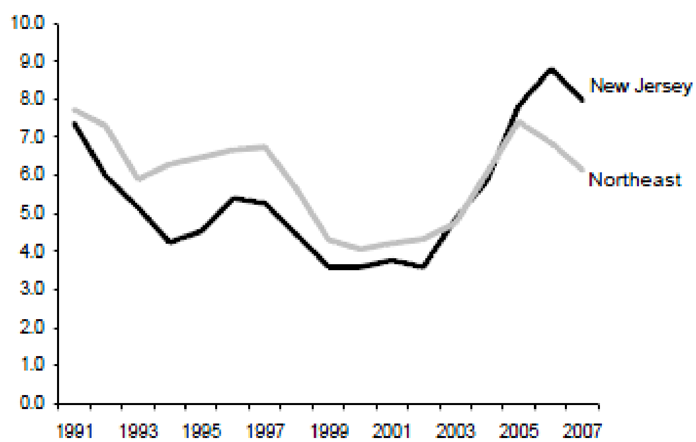


***Figure 3-12.* Net Domestic Out-Migration per 1000 from New Jersey and the Northeast, 1991-2007 (U.S. Bureau of the Census)**

The Statistics of Income Division (SOI) of the Internal Revenue Service (IRS) also provides the area-to-area migration data in the United States, using records of all individual income tax forms filed in each year. For each State, there are inflow and outflow spreadsheets, which show the number of returns (used to estimate households) from a U.S. address and a foreign country. **Table 3-8** below shows the SOI Tax Statistics Migration Data in New Jersey from 2004 to 2011, providing a general idea of the relationships between inflow, outflow, domestic, and international migration rates. However, the source and design of this dataset present some limitations in that the numbers in this table cannot match the values in previous table and figure. People who are not required to file United States federal income tax returns are not included in this file, and so the data will under-represent the poor and the elderly who have limited or no taxable income. As can be seen in the table, the net domestic migration values are negative for all years shown, net foreign migration values are very modestly positive or negative for all years, and net total migration is negative for all years.

Table 3-8. SOI Tax Statistics, Migration Data, New Jersey (IRS)

		US	Foreign	Total
2004-2005	Inflow	79,062	5,840	84,902
	Outflow	(104,014)	(3,015)	(107,029)
	Total	(24,952)	2,825	(22,127)
2005-2006	Inflow	80,561	4,635	85,196
	Outflow	(109,461)	(2,872)	(112,333)
	Total	(28,900)	1,763	(27,137)
2006-2007	Inflow	76,751	4,638	81,389
	Outflow	(102,940)	(2,828)	(105,768)
	Total	(26,189)	1,810	(24,379)
2007-2008	Inflow	79,519	5,041	84,560
	Outflow	(101,091)	(2,754)	(103,845)
	Total	(21,572)	2,287	(19,285)
2008-2009	Inflow	77,106	4,751	81,857
	Outflow	(92,412)	(3,064)	(95,476)
	Total	(15,306)	1,687	(13,619)
2009-2010	Inflow	73,241	1,837	75,078
	Outflow	(87,630)	(3,016)	(90,646)
	Total	(14,389)	(1,179)	(15,568)
2010-2011	Inflow	74,343	2,195	76,538
	Outflow	(93,872)	(3,026)	(96,898)
	Total	(19,529)	(831)	(20,360)

Using net migration rates from the various sources provide significantly different population estimates. In this part of sensitivity test, we investigate how changes in net migration rates (domestic and foreign combined) could affect population projections in New Jersey through 2040. The average net migration rates during 2005 to 2010 and during 2010 to 2014 are used to replace the average rate during 2000 to 2010 (which was the basis for the current 2040 projections).

Average net migration rate during 2010 to 2014

The U.S. Census Bureau, Population Division provides the estimates of the components of resident population change in New Jersey from 2010 to 2014 (see **Table 3-9**). The number of total net migration varies significantly, from -14,355 to 1,338. The average is -4,888, which represents a net of nearly 5,000 people moving from New Jersey to other locations every year during 2010 to 2014.

Table 3-9. Estimates of the Components of Resident Population Change (U.S. Census Bureau)

Year	Total Population Change	Natural Increase	Vital Events		Net Migration		
			Births	Deaths	Total	International	Domestic
2010-2011	21,562	35,971	104,343	68,372	-14,355	30,889	-45,244
2011-2012	29,817	32,693	102,379	69,686	-2,691	46,609	-49,300
2012-2013	31,590	34,017	104,769	70,752	1,338	46,373	-45,035
2013-2014	26,673	31,741	103,440	71,699	-3,843	51,626	-55,469

Analytical Results

Table 3-10 and **Figure 3-13** (following page) show the results of sensitivity tests when the net migration rate is changed in the age-cohort model. The range for the modified forecasted population in 2040 has increased, from 9,372,695 to 10,267,065 (3.90% lower and 5.27% higher than the baseline projection, respectively). This change is much more significant than other scenarios, which indicates net migration rate plays the most important role in population projection model. However, due the lack of accurate and complete data on the net migration rate by sex and age group, this variable is still the most uncertain within the population projection model. As a result, water demand projections will need to address this uncertainty in a useful and useable manner.

Table 3-10. Results for Sensitivity Test 4 from 2010 Census Population

		2015	2020	2025	2030	2035	2040
2005 to 2010	Population	8,955,323	9,102,565	9,232,968	9,333,557	9,383,631	9,372,695
	Difference	-56,439	-125,590	-203,165	-274,560	-331,865	-380,523
	%	-0.63%	-1.36%	-2.15%	-2.86%	-3.42%	-3.90%
2010 to 2014	Population	9,021,490	9,303,748	9,614,885	9,898,652	10,115,104	10,267,065
	Difference	9,729	75,593	178,752	290,535	399,609	513,846
	%	0.11%	0.82%	1.89%	3.02%	4.11%	5.27%

County Level Sensitivity Analyses

The state level sensitivity analyses discussed above indicate that modifications of fertility and mortality, individually and combined, do not show a major shift in projected population through 2040. Net migration has a somewhat larger potential effect and is much more volatile than fertility and mortality. Further, net migration may affect fertility and mortality rates, depending on the age, gender and (for females) fertility rates of those who move into and out of New Jersey.

Water demand projections for this project are focused on individual water supply systems, and therefore statewide sensitivity to variables is only part of the question. We therefore assessed the potential for significant changes in county population projections.

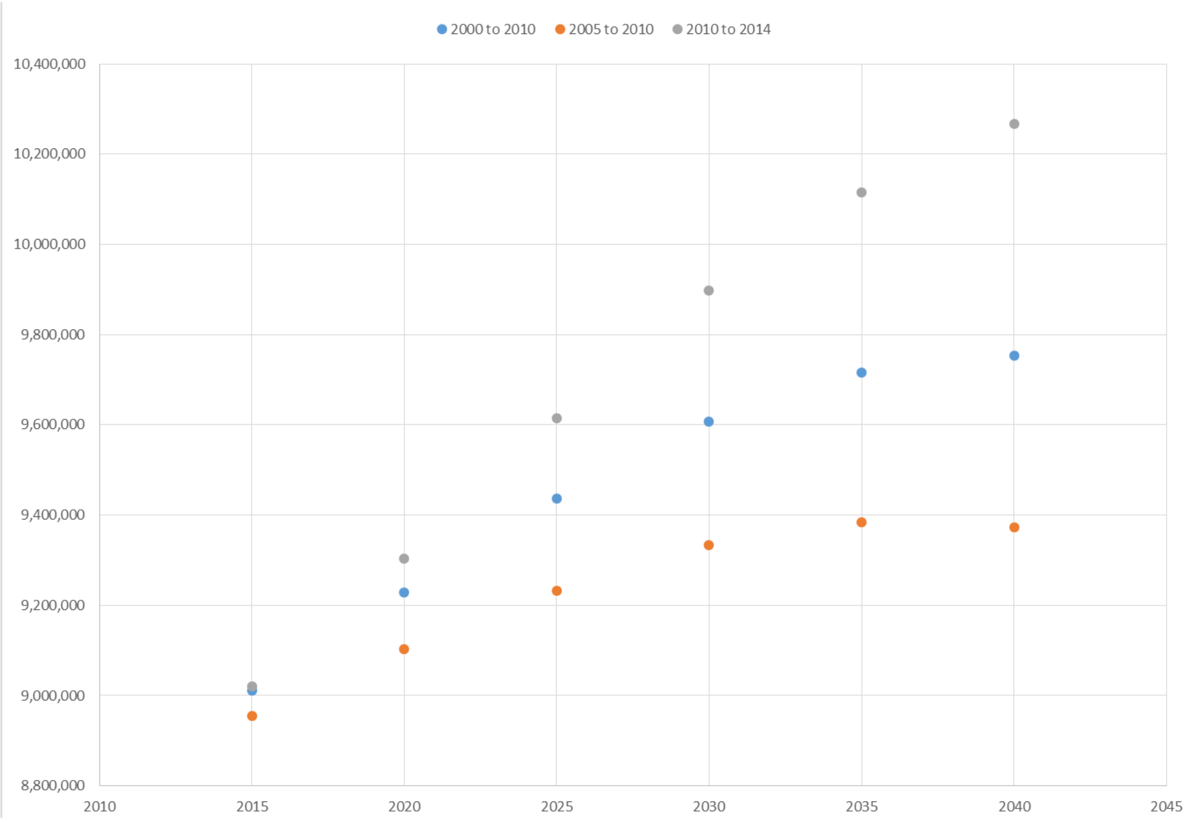


Figure 3-13. Sensitivity Test 4 for Net Migration Rate from 2010 Census Population

The county level sensitivity analyses also use the Age-Cohort population model to determine the sensitivity of 2040 population projections in each county by modifications in the primary variables, such as fertility rate and mortality rate. The base population model estimates use the 2001-2011 county level fertility rates and mortality rates from New Jersey State Health Assessment Data, and the average New Jersey migration rate during the period of 2000 to 2010. The four county level sensitivity tests are designed based on the results of statewide sensitivity tests. Migration rates are even less well known at the county level, and therefor are not modified in these tests.

Table 3-11. County Population Variability Scenarios

	Fertility Rate	Mortality Rate	Migration Rate
Sensitivity Test C1	2012 US	Constant	Constant
Sensitivity Test C2	2012 NJ	Constant	Constant
Sensitivity Test C3	Constant	2013 US	Constant
Sensitivity Test C4	Constant	2011 NJ	Constant

Sensitivity Tests C1 and C2: Fertility Rates

In county sensitivity test 1 and 2 (C1 and C2), we investigate how changes to the fertility rates affect the final population projections in each county. The 2012 United States and New Jersey fertility rates are used in tests. **Figure 3-14** shows the fertility rates in each female age group in the United States and New Jersey. It is clear that their trends are similar, but the peak in New Jersey (age group: 30-34) lags behind the nation as a whole (age group: 25-29). The influence of fertility rate depends on the demographic structure of each county.

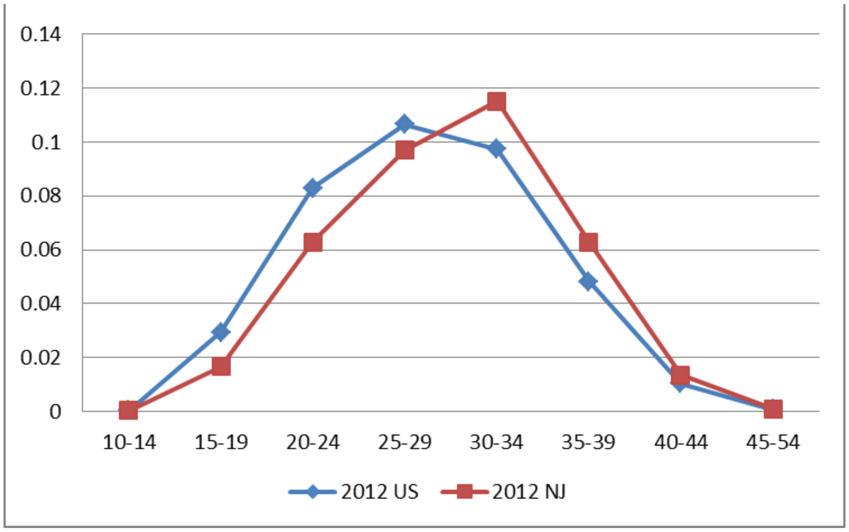


Figure 3-14. 2012 Fertility Rates in United States and New Jersey (per 1000 women)

Analytical Results

Table 3-12 below shows the results for sensitivity test C1 and C2. The range for the percentage difference is from 0.05% to 10.49%. Only Cumberland and Ocean County show a sensitivity percentage difference larger than 5%, which indicates the fertility rate has a great impact on population in these two counties and also suggests the 2040 estimated population based on Age-Cohort population model in these two counties is not accurate. For other counties, the most likely range of mortality rates will not affect the population projection significantly.

Other than Cumberland County and Ocean County, the four fastest growth counties in New Jersey using the baseline projection are Gloucester County, Middlesex County, Somerset County, and Atlantic County where the population growth is faster than New Jersey as a whole. The four slowest growth counties are Cape May County, Sussex County, Monmouth County, and Camden County where the population growth lags behind the state as a whole and some even experience population decline.

Table 3-12. Sensitivity Tests C1 and C2, Modifying Fertility Rates

County	Year	Base	Growth Rate 2010-2040	F: 2012 NJ	Change from Baseline (%)	F: 2012 US	Change from Baseline (%)
Atlantic	2010	274,549	16.62%	274,549		274,549	
	2040	320,189		313,165	-2.19%	314,545	-1.76%
Bergen	2010	905,116	5.19%	905,116		905,116	
	2040	952,117		984,796	3.43%	985,301	3.49%
Burlington	2010	448,734	10.64%	448,734		448,734	
	2040	496,457		500,115	0.74%	501,266	0.97%
Camden	2010	513,657	-1.68%	513,657		513,657	
	2040	505,037		499,316	-1.13%	500,508	-0.90%
Cape May	2010	97,265	-20.46%	97,265		97,265	
	2040	77,366		76,271	-1.42%	76,643	-0.93%
Cumberland	2010	156,898	20.14%	156,898		156,898	
	2040	188,498		175,038	**-7.14%**	175,808	**-6.73%**
Essex	2010	783,969	8.20%	783,969		783,969	
	2040	848,224		843,491	-0.56%	843,773	-0.52%

County	Year	Base	Growth Rate 2010-2040	F: 2012 NJ	Change from Baseline (%)	F: 2012 US	Change from Baseline (%)
Gloucester	2010	288,288	30.26%	288,288		288,288	
	2040	375,520		381,698	1.65%	383,771	2.20%
Hudson	2010	634,266	15.63%	634,266		634,266	
	2040	733,421		742,619	1.25%	736,589	0.43%
Hunterdon	2010	128,349	2.02%	128,349		128,349	
	2040	130,941		134,903	3.03%	135,270	3.31%
Mercer	2010	366,513	11.88%	366,513		366,513	
	2040	410,047		415,387	1.30%	418,394	2.04%
Middlesex	2010	809,858	20.13%	809,858		809,858	
	2040	972,861		988,633	1.62%	991,640	1.93%
Monmouth	2010	630,380	-0.57%	630,380		630,380	
	2040	626,767		630,823	0.65%	632,948	0.99%
Morris	2010	492,276	5.24%	492,276		492,276	
	2040	518,080		524,861	1.31%	523,574	1.06%
Ocean	2010	576,567	39.51%	576,567		576,567	
	2040	804,342		720,006	**-10.49%**	722,808	**-10.14%**
Passaic	2010	501,226	5.63%	501,226		501,226	
	2040	529,423		506,534	-4.32%	508,810	-3.89%
Salem	2010	66,083	3.34%	66,083		66,083	
	2040	68,293		67,174	-1.64%	67,534	-1.11%
Somerset	2010	323,444	16.05%	323,444		323,444	
	2040	375,350		376,415	0.28%	375,535	0.05%
Sussex	2010	149,265	-3.95%	149,265		149,265	
	2040	143,367		145,531	1.51%	145,957	1.81%
Union	2010	536,499	6.91%	536,499		536,499	
	2040	573,552		562,307	-1.96%	562,666	-1.90%
Warren	2010	108,692	6.54%	108,692		108,692	
	2040	115,803		119,353	3.07%	119,739	3.40%

Sensitivity Tests C3 and C4: Mortality Rates

In sensitivity test C3 and C4, we investigate how changes to the mortality rates would affect the final population projections in each county. The 2013 United States and 2011 New Jersey mortality rates are applied to these tests. **Figure 3-15** is the survival rates in each male and female age group in United States and New Jersey. The trends of them are same, but New Jersey has a slightly higher survival rate than the nation. Moreover, when people are older than the age of 40, females have a much higher survival rate than males.

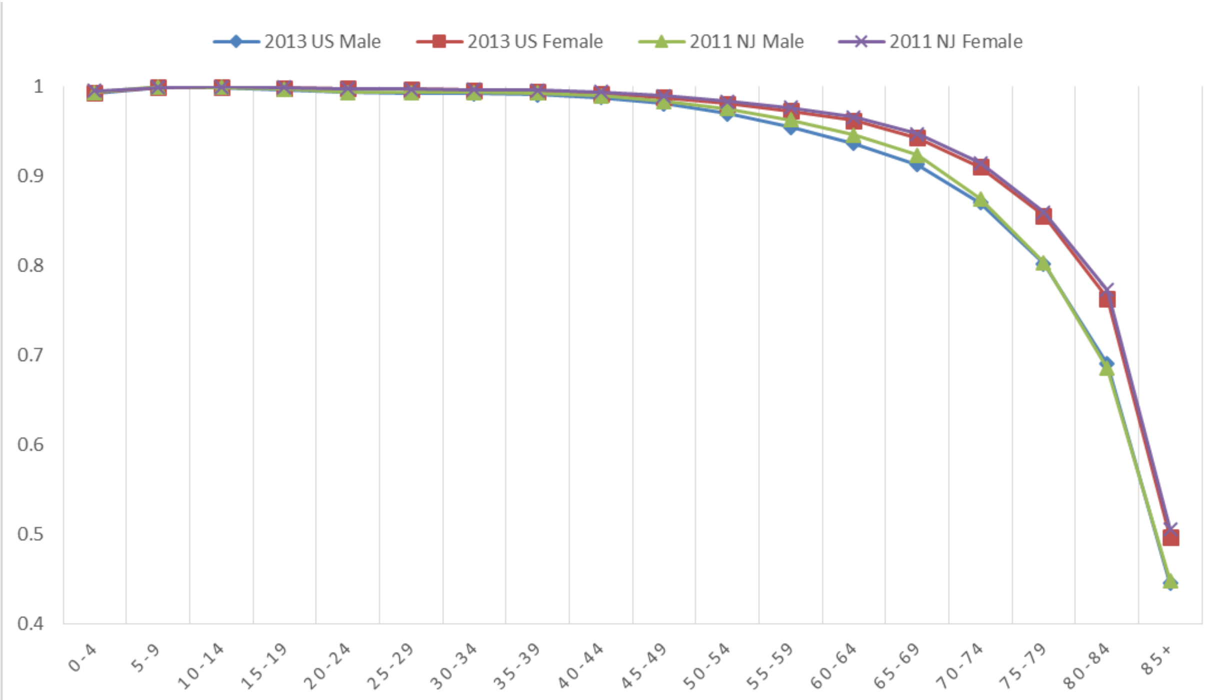


Figure 3-15. 2013 US & 2011 NJ Survival Rate

Analytical Results

Table 3-13 shows the results for sensitivity test 3 and 4. The range for the percentage difference is from 0.05% to 4.24%. All counties in New Jersey have sensitivity percentage differences lower than 5%. Thus, in conclusion, the most likely range of mortality rates will not affect the population projection significantly.

Table 3-13. Sensitivity Tests 3 and 4, Modifying Mortality Rates

County	Year	Base	Growth Rate 2010-2040	M: 2013 US	Change from Baseline (%)	M: 2011 NJ	Change from Baseline (%)
Atlantic	2010	274,549	16.62%	274,549		274,549	
	2040	320,189		324,484	1.34%	328,035	2.45%
Bergen	2010	905,116	5.19%	905,116		905,116	
	2040	952,117		917,233	-3.66%	927,834	-2.55%
Burlington	2010	448,734	10.64%	448,734		448,734	
	2040	496,457		491,924	-0.91%	497,546	0.22%
Camden	2010	513,657	-1.68%	513,657		513,657	
	2040	505,037		510,592	1.10%	516,478	2.27%
Cape May	2010	97,265	-20.46%	97,265		97,265	
	2040	77,366		78,564	1.55%	79,725	3.05%
Cumberland	2010	156,898	20.14%	156,898		156,898	
	2040	188,498		191,934	1.82%	193,898	2.86%
Essex	2010	783,969	8.20%	783,969		783,969	
	2040	848,224		854,213	0.71%	863,709	1.83%
Gloucester	2010	288,288	30.26%	288,288		288,288	
	2040	375,520		376,883	0.36%	380,765	1.40%
Hudson	2010	634,266	15.63%	634,266		634,266	
	2040	733,421		726,523	-0.94%	733,754	0.05%

County	Year	Base	Growth Rate 2010-2040	M: 2013 US	Change from Baseline (%)	M: 2011 NJ	Change from Baseline (%)
Hunterdon	2010	128,349	2.02%	128,349		128,349	
	2040	130,941		125,388	-4.24%	127,058	-2.97%
Mercer	2010	366,513	11.88%	366,513		366,513	
	2040	410,047		407,102	-0.72%	411,416	0.33%
Middlesex	2010	809,858	20.13%	809,858		809,858	
	2040	972,861		954,599	-1.88%	964,334	-0.88%
Monmouth	2010	630,380	-0.57%	630,380		630,380	
	2040	626,767		617,940	-1.41%	625,652	-0.18%
Morris	2010	492,276	5.24%	492,276		492,276	
	2040	518,080		501,409	-3.22%	507,315	-2.08%
Ocean	2010	576,567	39.51%	576,567		576,567	
	2040	804,342		803,765	-0.07%	811,511	0.89%
Passaic	2010	501,226	5.63%	501,226		501,226	
	2040	529,423		524,498	-0.93%	530,080	0.12%
Salem	2010	66,083	3.34%	66,083		66,083	
	2040	68,293		70,148	2.72%	70,972	3.92%
Somerset	2010	323,444	16.05%	323,444		323,444	
	2040	375,350		363,185	-3.24%	367,309	-2.14%
Sussex	2010	149,265	-3.95%	149,265		149,265	
	2040	143,367		142,630	-0.51%	144,530	0.81%
Union	2010	536,499	6.91%	536,499		536,499	
	2040	573,552		564,715	-1.54%	570,958	-0.45%
Warren	2010	108,692	6.54%	108,692		108,692	
	2040	115,803		114,217	-1.37%	115,604	-0.17%

Conclusions

The population sensitive tests indicate that statewide populations are not likely to be much affected by changes in mortality or fertility rates, but do show the potential for greater differences based on net migration rates. These patterns are amplified at the county level, and logically at the municipal level, as some parts of the state will be more prone to net out-migration while others are more prone to in-migration. Unfortunately, it is not possible to predict the potential for significant changes in domestic or foreign migration patterns and levels, as shown by the high variability in net migration rates since 1980. Therefore, the municipal population estimates from the Metropolitan Planning Organizations are used in the remainder of this report, recognizing that there is inherent uncertainty in this projections that will warrant periodic reevaluation of the water demand projections.

4. Evaluation of Current Water Demands

Most of the public community water supply (PCWS) system data available through the NJDEP address total withdrawals from water supply sources (i.e., as reported in water allocation permit reports) and total water delivered into the water supply system (i.e., as reported for the Water Supply Deficit/Surplus analysis). Utilities provide information on the relative demands for residential, industrial and commercial uses (and unaccounted-for water) when needed to justify water allocation permits, generally when they propose an increased allocation. As water allocation permits have a 10-year lifespan and in many cases utilities are not requesting increases or needing to justify existing allocations, this information is sparse. Some PCWS systems don't have water allocation permits at all, as they are too small (i.e., capable of pumping less than 100,000 gallons per day) or receive their water from other utilities that have their own water allocation permits, making it difficult to know how much water is used by the originating utility for its own purposes and how much is provided to bulk contract customers. Therefore, assumptions must be made based on available information.

Given the major differences in PCWS systems, from rural, residential service areas to highly urbanized and industrialized areas, no single method for apportioning and estimating demands for residential, industrial and commercial (RIC) demands is feasible. This chapter addresses the methods and results for assessing the nature of current water demands for the 584 PCWS systems currently tracked by NJDEP. Approximately 80 percent of all delivered public water in New Jersey is provided by just 37 systems, based on NJDEP's NJ Water Tracking system (NJWaTr) information regarding average annual delivered water.

PCWS Service Areas, Populations and Land Use

The first step in assessing current demands was to acquire available information from NJDEP's Water Supply Deficit/Surplus Analysis data base, which provides available capacity (self-supplied and bulk purchases under contract from other sources, minus bulk water delivered to other PCWS systems under contract) and the highest demand levels in the previous five calendar years. The result indicates whether a utility has surplus capacity or a deficit at the monthly or annual level. NJDEP provided successive versions of the Water Supply Deficit/Surplus Analysis in spreadsheet form for use in this project; the May 2017 version is used in this project with some corrections that were agreed to by NJDEP. This spreadsheet was the most complete listing of PCWS systems available to this project at the time. For the purposes of this project, the annual values were used as one point of comparison to the modeled demands, or as a basis from which demands were calculated, depending on the availability of information regarding the PCWS system in question. NJDEP's NJ Water Tracking system (NJWaTr) is the other basis for calculating demands.

Next, the population of each PCWS system service area was estimated. This estimate differs from the total accounts served, as each residential account often involves more than one person, and non-residential accounts serve individuals only as customers, clients and workers. The following data were used:

- 2010 Census data by Census Block Group
- Land Use Data in GIS (NJDEP 2012 LULC dataset, as the closest data to the 2010 Census)
- Listing of Public Community Water Supply (PCWS) Systems (NJDEP, current to May 2017)
- Revised PCWS service areas in GIS (NJDEP work in progress, 2015 and June 2017)

Using the 2012 LULC dataset and 2010 Census data, a GIS-based dasymetric analysis identified the residential land uses within each Census block group and then related the population from the

Census block group to the residential areas using a proportionality method. Dasymetric mapping is a method of using an ancillary data source to spatially distribute data that are initially organized by large or arbitrary boundaries, to achieve greater spatial accuracy. Dasymetric mapping is employed in this study to more accurately distribute population within the land area of the block groups, the smallest available cartographic units with associated U.S. Bureau of Census Decennial population data. This technique preserves each block group's total census population. The complete method of GIS analysis is in Appendix A.

The 2012 Land Use/Land Cover (LULC) dataset was used to spatially distribute Census population data within block groups. The 2012 version was used rather than the 2007 LULC, because it was closest in time to the 2010 Census and because the available water demand data from PCWS case systems overlapped that date, usually from 2008 to 2014, but up to 2016. Given the effects of the economic recession on land development in New Jersey from 2008 on, the expectation is that little change in land uses occurred in the initial years following the 2012 LULC.

The LULC dataset includes a comprehensive statewide layer of land use polygons using the Anderson coding system. For the purposes of this study, only the residential land use polygons are used. Residential LULC polygons are categorized into four residential density categories: High (1110), Medium (1120), Low (1130), and Rural Density (1140). The last two were grouped for this analysis, as there is very little Rural Density development within PCWS service areas. Within each block group, the residential LULC polygons are grouped by these density categories.

Using this approach, the Anderson LULC classification of 1110 (high-density development, at 5 dwelling units (DU)/acre or more) would receive proportionally more population than 1120 (moderate density development, at 2 to 5 DU/acre), which likewise would receive proportionally more than 1130/1140 (low and rural density development, at 2 DU/acre or less). Population density ratios were developed for this purpose (**Table 4-1**), using groups of counties that have similar development patterns, to recognize that development types in the most urbanized counties (e.g., Hudson County) may have significantly different population densities than the same classifications in other counties (e.g., Warren County). The four groups of counties are as follows:

- **Dense Urban Core Counties**: Hudson
- **Major Urban Counties**: Essex, Union, Bergen, Passaic, Middlesex, Camden, Mercer
- **Suburban Counties**: Monmouth, Somerset, Morris, Ocean, Gloucester, Burlington, Atlantic
- **Exurban/Rural Counties**: Cape May, Cumberland, Warren, Hunterdon, Sussex, Salem

Table 4-1. New Jersey Population Density Ratios

County Group	Land Use Density Category		
	High	**Medium**	**Low/Rural**
Dense Urban Core	0.79	0.17	0.04
Major Urban	0.75	0.20	0.05
Suburban	0.55	0.36	0.09
Exurban/Rural	0.70	0.25	0.05

Using this information and the PCWS service areas from NJDEP, the existing residential land use areas (high, medium and low/rural density) and related population served for each PCWS system were estimated. Due to project timing, the 2015 version of the PCWS service areas was used for this analysis, except where the June 2017 version provided major updates or entirely new service area delineations. The 2017 version for the complete analysis became available at the very end of the project; using this version for all analyses would have required a complete reconstruction of the population estimates and all subsequent steps for the project, which was not feasible given the remaining time and funds in the project. The modifications addressed the following systems:

- NJ1208001: NJ American Jamesburg (new service area)
- NJ1426004: United Water Arlington Hills (new service area)
- NJ1439001: Wharton Water Department (new service area)
- NJ1509001: Harvey Cedars Borough Water Department (new service area)
- NJ1436002 Roxbury Water Company, NJ1436003 Roxbury Twp WD - Shore Hills, NJ1436004 Roxbury Twp WD – Skyview, and NJ1436006 Roxbury Twp WD – Evergreen (new service area replacing prior Roxbury Water Company delineation and providing Roxbury Township areas)
- NJ417001: Haddonfield Water Department (no service area mapped, but this system is now part of the NJ American-Delaware system, NJ0327001; the entire township was added to that system)
- NJ0708001: Glen Ridge Water Dept (modified service area)
- NJ1316001: Freehold Twp Water Department (modified service area)

One result of having population estimates from two different versions of the service area mapping is that the estimates in some cases are slightly different between two tables used in the report. One table provides the populations associated with High, Medium and Low Density residential development, while the other provides the populations associated with these development densities but further subdivided by geophysical province, slope, housing age and precipitation (see Per Capita Residential Water Demands by Housing Category).

The GIS analysis also allows for identification of non-developed lands within and outside of PCWS service areas that are not constrained by major environmental features such as preserved lands, wetlands and flood plains. The latter information can help assess the potential constraints on increasing population within the PCWS service areas. However, a build-out evaluation is beyond the scope of the study.

Service Area Population Results

Based on this analysis, roughly 90 percent of all New Jersey residents receive their water from PCWS systems, a total of 7,884,569, compared to the 2010 Census of 8,791,894. The thirteen largest systems serve slightly more than **50 percent** of all New Jersey residents within PCWS service areas, as shown in **Table 4-2**. As mentioned at the beginning of this section, the largest 37 PCWS systems account for 80 percent of all PCWS demands in New Jersey, out of 584 systems in the NJDEP dataset.

Table 4-2. New Jersey Water System Population by Residential Development Density (Top 50%)

PWID	System	High Density	Moderate Density	Low Density	Total Population	% of PCWS Population
NJ0238001	Suez - Hackensack System	448,835	286,380	39,932	775,148	9.83%
NJ2004002	NJ American - Raritan	263,497	294,324	148,708	706,529	8.96%
NJ1345001	NJ American - Coastal North	103,861	191,690	71,594	367,145	4.66%
NJ0327001	NJ American - Delaware Basin	257,948	37,473	979	296,400	3.76%
NJ1605002	Passaic Valley Water Commission	82,799	189,811	18,424	291,034	3.69%
NJ0712001	NJ American - Passaic	257,094	1,654	-	258,749	3.28%
NJ0714001	Newark Water & Sewer Dept.	104,820	108,349	41,754	254,923	3.23%

PWID	System	High Density	Moderate Density	Low Density	Total Population	% of PCWS Population
NJ0906001	Jersey City MUA	238,444	-	-	238,444	3.02%
NJ1225001	Middlesex Water Company	113,203	70,866	12,429	196,498	2.49%
NJ1111001	Trenton City Water Dept.	101,201	82,855	8,375	192,431	2.44%
NJ2004001	NJ American - Liberty	116,348	5,473	1	121,822	1.55%
NJ0119002	NJ American - Atlantic	21,665	73,312	19,359	114,336	1.45%
NJ1507005	Suez - Toms River System	32,661	66,153	12,142	110,955	1.41%

The dasymetric mapping technique provides a more refined estimation of population distribution and densities than is otherwise possible. The refined population distribution is advantageous for accurately assigning water use data to populations. Another benefit of the dasymetric mapping technique is that it allows for a more detailed comparison for water use across residential density types.

Sources of Population Uncertainty

The dasymetric analysis incorporates inherent uncertainties, which propagate through the study. Some uncertainties arise from the land use analysis and the dasymetric evaluation. The 2012 Land Use/Land Cover mapping released by the New Jersey Department of Environmental Protection was used as the best available source of information on residential land uses. However, these land uses and their categorization are based on aerial photograph interpretation.

Some housing units are located within dominant commercial land uses and therefore coded as commercial, not residential. Detailed analysis of water customer locations in urban areas identified a number of these circumstances, which represented a small percentage of total customer records but still indicated that some residences are not captured in this project. In addition, mixed use developments may be delineated as such in the LULC mapping, but the residential density is impossible to ascertain. Also, the residential densities are provided as ranges, and therefore some residential areas may tend toward the high or low side of the range and yet be categorized as the same density class and receive equal distributions of population. In each case, uncertainties exist as to the actual location and densities of residential units and thus populations.

The dasymetric evaluation process is valuable in that it assigns population to the residential portions of census tracts, proportional to development density, rather than assuming that population is evenly spread across the census tract. However, the nature of census information is that the dasymetric evaluation cannot determine actual population by household. Rather, household averages for the census areas are used. This assumption incorporates uncertainties based on the nature of the census information.

All these uncertainties are more consequential as water supply service area decreases in size or the residential development increases in diversity. For this reason, the population estimates for the smallest size water systems have the greatest potential for error. Very large systems are more likely to have inaccuracies that cancel each other at the system level. All systems with estimated populations of 2,500 people or greater (approximately 230 systems) were compared to census information regarding their service areas, and in each case the two values compared well. However, it was not feasible to examine the population estimates for all 584 systems. Therefore, the population estimates for the smallest systems should be used with great care and re-evaluated where issues are raised regarding water supply adequacy. On the other hand, nearly all the small systems were built to serve specific developments or facilities, and therefore the populations (and water demands) are highly unlikely to change a great deal into the future. They also represent a very small demand per system and even in aggregate, and therefore are likely to have a very limited impact on net water demand or availability for a watershed or aquifer.

Another source of uncertainty relates to the PCWS service areas. NJDEP has developed a detailed mapping of water supply service areas but this product was not finalized and public as of this analysis; NJDEP provided versions of a confidential copy of the GIS files for this project, with the most recent date of June 2017, and intends to release a public version subsequent to a verification process. For this reason, certain water systems exist (as listed in other NJDEP permit and data systems), but were not yet mapped. Population estimates could not be developed for roughly 144 PCWS systems, nearly all of which are very small systems.

Some systems have or may have been absorbed into other systems, either for mapping purposes or as formal consolidations. As one example, the service area for Haddonfield Water Department (NJ0417001) was not delineated in the GIS files provided. This system recently became part of the NJ American Water-Delaware system, but this change was not yet incorporated into NJDEP mapping, resulting in a gap in the mapping, and therefore in the original population projections for this project. Rutgers assumed that the service area boundaries for Haddonfield are essentially contiguous with the township boundaries (given that this general area is very developed and Haddonfield shows as a hole between all the surrounding water service areas). We derived the population estimates for the former Haddonfield system based on the township population, and added the results to NJ American Water-Delaware.

As mentioned in the prior section, some of the analyses were based on the 2015 version of the service area mapping. The 2017 version was used to add newly delineated service areas and to correct the analysis for systems where the estimated populations were very different from the actual municipal populations due to the 2015 version not including the complete service area. The differences are likely to be small, but still will have some effect on calculated water demands.

Per Capita Residential Water Demands by Housing Category

The modeling method assumes that households will have varying demand rates depending on several characteristics. To test this assumption, the following available data were acquired:

- NJ Parcel Boundary Dataset (NJ Office of Information Technology)
- Residential customer water demand data from selected PCWS systems
- PCWS Safe Drinking Water Program data on current and committed demands, contracted water supplies, firm capacity, etc. (NJDEP Water Supply Deficit/Surplus Analysis data base, May 2017)

In consultation with NJDEP and the Water Supply Advisory Council, Rutgers identified a stratified sample of PCWS systems, based on annual average daily demands (over 50 MGD, 20-50 MGD, 5-19 MGD, 2-5 MGD), from which water demand data were sought from residential customers based on individual metering. Monthly demand data were preferred, but in some cases only quarterly data were available within a specific land use type. The target systems were identified to provide the maximum geographical and land development diversity, based on the variables in **Table 4-3**.

Table 4-3. Geographic Variables of Water Demand

Variables	Unit of Measure	Levels
Housing Density	Residential Units per acre (units/acre) (Anderson classes)	High =>5 units per acre Medium >2<5 units per acre Low/Rural <=2 units per acre
Housing age	Mean Housing age (years)	Old (Mean <=1990); New (Mean >1990)
Topography	Mean Topographic Variability	Flat (Mean <10%); Steep (Mean >=10%)
Region	Physiographic Provinces	Highlands/Valley & Ridge, Piedmont, Coastal Plain
Precipitation	Annual Precipitation (inches/year)	High (within highest 5th quintile); Low (other)

The five variables resulted in 96 unique land area categories. These were compared to all PCWS systems with significant service areas using the 2015 GIS mapping of service areas from NJDEP. Roughly 50 of the 96 categories were represented in at least one PCWS service area of any significant size. The largest PCWS service area was then identified for each of these classifications, along with other PCWS systems that might serve as backups should the required data not be available from the first choice. Based on this analysis, 20 PCWS systems were identified as priorities, and of those a total of eleven addressed the largest land area categories. Another 16 systems were identified as potential backups.

Data Acquisition and Analysis

Some of the priority PCWS systems were willing to provide data, but some collected only quarterly data and of those, only a few collected the quarterly data in a pattern that allowed for effective geographic analysis (i.e., collecting data the same month from an entire municipality within a larger service area, rather than in multi-month staging within each municipality). Other potential candidate systems declined or did not respond to the request for data. The following water utilities provided data usable in the project, with the understanding that Rutgers would not provide the original data to other users without the written permission of the data provider, and that personal identifications of customers would not be used or provided to any other entity. However, interpreted information, such as the analyses used in this project, are in the public domain. Nearly all the utilities in **Table 4-4** provided data for the period 2008 through 2014; this period represents both wet and moderately dry years, but includes no drought periods that required declaration of a drought emergency. One utility provided information for a later period, 2015-2016, because they had recently changed to a different metering schedule and accounting system, and so earlier data were not comparable.

Table 4-4. Water Utilities Providing Residential Water Demand Data

Water Utility	Service Area	Demand Period	Service Area Population
Mount Laurel MUA	Township	Monthly	40,272
Newark Water & Sewer	City	Monthly	272,919
New Jersey American Water	28 separate systems	Monthly	2,077,148
Passaic Valley Water Commission (PVWC)	Regional (direct service to Paterson, Clifton, Passaic, Prospect Park, Lodi, North Arlington, and a section of Woodland Park)	Quarterly	345,502
Ridgewood Water Department	Regional (Glen Rock, Midland Park, Ridgewood, Wyckoff)	Quarterly	60,113
Roxbury Township Water	Portion of municipality	Quarterly	10,773
Suez-New Jersey	Hackensack System	Monthly	781,624
		Total Service Area Population	**3,588,351**
		Percentage of State Population 2010	40.81%
		Percentage of 2010 Population Served by PCWS Systems	45.51%

Of these systems, Newark, PVWC, portions of the NJ American system (Raritan, Coastal North, Delaware Basin, Harrison-Gloucester County, Washington-Warren County) and Roxbury Township were original high priorities for data acquisition, as they represent many of the largest land area classifications in New Jersey. Suez-NJ (Hackensack) provided a very valuable addition to the available data, covering many older suburbs of northern New Jersey. Mount Laurel is a prototypical suburban municipality in southern New Jersey, providing valuable monthly data for that land use type. Ridgewood Water provided quarterly data but there were complexities involved in the analytical process that did not allow for their inclusion in the analysis of per capita residential demands for this report, though the data were used as a basis for 2010 estimates of Ridgewood Water demands. The result is that data were available from most of the targeted land area classifications; those classifications represented almost 88% of all PCWS service areas in New Jersey. While additional data sets would have further benefitted this work, the available data provide a solid foundation for analysis of per capita residential demands.

In each case, the first step was associating the water demand data to parcels, using the customer addresses and NJ Parcel Boundary data set; in some cases, a GIS dataset of customer locations was provided by the utility. Using the dasymetric analysis previously discussed, the demand data were then associated with the appropriate residential development density and the associated populations. The result was a per capita residential demand for each unique combination of Census block group and residential development density.

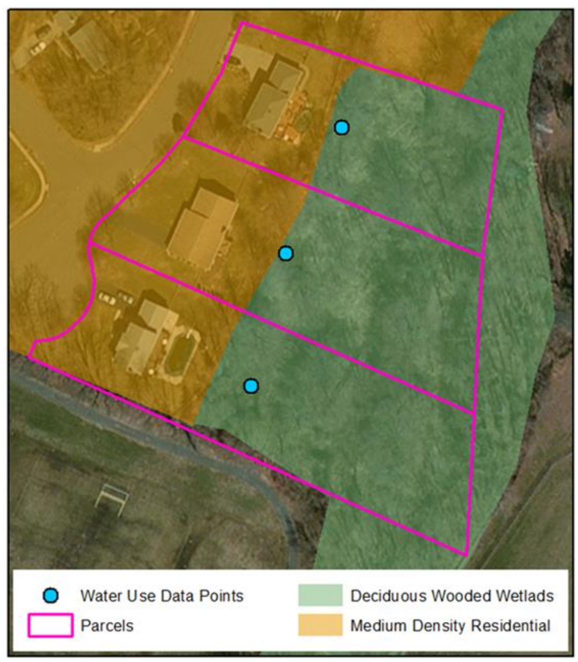


Figure 4-1. Example Relationship of Water Use Data Points and Land Use/Land Cover

This step required additional analysis, as in many cases the relevant parcel included more than one LULC coding, and the geocoded customer location was in a portion of the parcel mapped as non-residential. LULC data are created at such a fine scale that any given parcel could contain multiple land use classifications. Simply overlaying the water use data points on top of the LULC polygons results in points being assigned to unrealistic and incorrect land use classifications such as forest or wetland. **Figure 4-1** is an example from a service area that illustrates a common situation where the data points are clearly supposed to be associated with the houses within the parcel, but the data points are located outside of the medium density residential LULC classification. To remedy the discrepancy between the LULC data and the parcel data, a series of processing steps are completed to assign each parcel a land use classification that is most appropriate for this study. Land use classifications that are not associated with residential water use are ignored and overridden. In this example, the deciduous wooded wetlands land use classifications are ignored and each of the three parcels is given a land use classification of Medium Density Residential only.

The results are developed for annual, summer and non-summer demands for each year in the period of record, and the same for the entire period of record. Summer months are defined as June through September to correspond with the major growing season, and Non-Summer as October through May.

In areas that have large seasonal population shifts, demands are also differentiated between "all users" and "year-round users" to allow an evaluation of how seasonality affects per capita demands. By definition, use of Census population data in this analysis means that it is not possible to determine the summer population. However, the water demand data do provide a good estimate of the total number of housing units with seasonal demands.

The results also are associated through GIS with the land area classifications previously described (i.e., housing age, topography, residential density, geography and rainfall). In this manner, per capita demands can be described for each Census block group/residential density combination, each Census block group for all residential areas, each residential development density within a total service area, all residential areas within a service area, each land area classification at any geographic scale, and each municipality or other geographic area. It is this broad range of aggregation opportunities that allow the following steps.

Characterization of Case Example Water Systems

The service areas for the larger PCWS Systems that provided water data are described in **Table 4-5** and **Table 4-6**, below, which shows the breakdown of the service area according to the variables described above. NJ American Water also provided information on numerous smaller systems, which are not shown in this table. Within the analyses performed, low and rural residential density service areas were combined, but they are shown separately below.

Table 4-5. Relationship of PCWS System Service Areas to Project Land Classifications (High/Medium Residential Densities)

PWID	System Name	Type	Total Acres	HD_O_F_PM_L	HD_O_F_HL_H	HD_O_F_HL_L	HD_O_F_CP_L	HD_O_F_PM_H	MD_O_F_PM_L	MD_O_F_HL_L	MD_N_F_CP_L	MD_O_S_HL_H	MD_O_F_CP_L	MD_O_F_PM_H
0324001	Mount Laurel MUA	G	4,406				746						2,161	
0714001	Newark Water & Sewer Dept.	G	4,570	4,570										
2004002	NJ American - Raritan	I	82,356	**12,011**					**26,924**					
1345001	NJ American - Coastal North	I	44,912				**5,476**						20,195	
327001	NJ American - Delaware Basin	I	28,992				3,490						**21,799**	
808001	NJ American - Harrison	I	2,427								**279**			
2121001	NJ American - Washington	I	1,924			**106**				**770**				
1605002	Passaic Valley Water Commission	G	7,843					**5,561**						**2,282**
251001	Ridgewood Water	G	7,561						4,757					
1436003	Roxbury Water Dept.	G	3,902		**95**							**1,954**		
0238001	Suez-NJ-Hackensack	I	45,284	10,265					24,690					

I = Investor-owned   G = Governmental entity (municipal, municipal utility authority, regional agency)

The columns use a five-variable convention: **Housing Density-Housing Age-Topography-Region-Precipitation** with the following abbreviations:

Variables	Unit of Measure	Levels
Housing Density	Residential Units per acre (units/acre)	High (**HD**), Medium (**MD**), Low (**LD**) (Anderson classes)
Housing age	Mean Housing age (years)	Old (**O**) (Mean <=1990), New (**N**) (Mean >1990)
Topography	Mean Topographic Variability	Flat (**F**) (Mean <10%), Steep (**S**) (Mean >=10%)
Region	Physiographic Provinces	Highlands/Valley & Ridge (**HL**), Piedmont (**PM**), Coastal Plain (**CP**)
Precipitation	Annual Precipitation (inches/year)	High (**H**) (within highest 5th quintile), Low (**L**) (other)

Grid cells shown in blue with bold text are PCWS system service areas with the largest area within the indicated land classification.

Table 4-6. Relationship of PCWS System Service Areas to Project Land Classifications (Low and Rural Residential Densities)

PWID	System Name	Type	Total Acres	LD_O_F_PM_L	LD_O_F_HL_H	LD_O_F_HL_L	LD_N_F_CP_L	LD_O_F_CP_L	RD_N_F_CP_L	RD_O_F_PM_L	RD_O_F_HL_H	RD_O_F_HL_L	RD_O_F_CP_L
0324001	Mount Laurel MUA	G	4,406					1.058					441
0714001	Newark Water & Sewer Dept.	G	4,570										
2004002	NJ American - Raritan	I	82,356	**20,760**						**22,661**			
1345001	NJ American - Coastal North	I	44,912					**10,873**					**8,368**
327001	NJ American - Delaware Basin	I	28,992					2,321					1,381
808001	NJ American - Harrison	I	2,427				**648**		**1,500**				
2121001	NJ American - Washington	I	1,924			**523**						**525**	
1605002	Passaic Valley Water Commission	G	7,843										
251001	Ridgewood Water	G	7,561	2,804									
1436003	Roxbury Water Dept.	I	3,902		**1,375**						**478**		
0238001	Suez-NJ Hackensack			6,885						3,444			

I = Investor-owned G = Governmental entity (municipal, municipal utility authority, regional agency)

The columns use a five-variable convention: **Housing Density-Housing Age-Topography-Region-Precipitation** with the following abbreviations:

Variables	Unit of Measure	Levels
Housing Density	Residential Units per acre (units/acre)	High (**HD**), Medium (**MD**), Low (**LD**) (Anderson classes)
Housing age	Mean Housing age (years)	Old (**O**) (Mean <=1990), New (**N**) (Mean >1990)
Topography	Mean Topographic Variability	Flat (**F**) (Mean <10%), Steep (**S**) (Mean >=10%)
Region	Physiographic Provinces	Highlands/Valley & Ridge (**HL**), Piedmont (**PM**), Coastal Plain (**CP**)
Precipitation	Annual Precipitation (inches/year)	High (**H**) (within highest 5th quintile), Low (**L**) (other)

Grid cells shown in blue with bold text are PCWS system service areas with the largest area within the indicated land classification.

Residential Annual Average, Non-growing Season and Growing Season Demands

The results from an example service area in **Table 4-7** below show a relationship of increasing per capita water use with decreasing residential density, which is expected. High density residential development has the lowest annual per capita water use. Per capita water use for medium density residential development is slightly greater than high density residential development water use. Low density residential development has a much greater per capita water use than medium and high density residential development, roughly double the per capita water use of medium density residential development.

The other major point in this table is the significant variation from year to year in summer per capita demands for the medium and low density residential development, as compared to high density development, and from that, a large variation in the summer to non-summer ratio. These variations raise a problem regarding selection of a "beginning point" for the modeling process. Arguments can be made for using the most recent years (to capture the most recent effects of any ongoing trends), an average of all the years (capturing both wetter and drier years), or the peak year (focusing on stressed conditions). For the purposes of this model, the multi-year average of all annual results is used to reflect dominant conditions. During a severe drought, demands will be artificially suppressed through state mandates, and so using a peak year is less appropriate for water supply planning than it is for infrastructure capacity analysis (a focus of NJDEP's Water Supply Deficit/Surplus Capacity analysis).

Table 4-7. Example Per Capita Residential Demands and Summer to Non-Summer Demand Ratios

Metric	Density	01/08-09/08	10/08-09/09	10/09-09/10	10/10-09/11	10/11-09/12	10/12-09/13	10/13-09/14	10/14-09/15	Average
Average Annual Per Capita Per Day	high	68.37	64.99	65.25	65.37	64.00	61.53	58.68	59.38	63.45
	medium	80.16	66.47	74.59	72.29	68.19	58.89	58.74	63.37	67.84
	low	100.29	77.40	91.21	89.12	84.31	69.02	74.11	81.84	83.41
Average Summer Use Per Capita Per Day	high	73.60	67.07	74.00	73.99	70.51	65.55	62.47	65.12	69.04
	medium	112.87	80.95	116.65	107.20	102.24	76.47	79.23	92.23	95.98
	low	153.72	100.42	157.00	138.66	136.80	92.63	107.09	128.69	126.88
Average Non-Summer Use Per Capita Per Day	high	64.15	63.94	60.85	61.04	60.73	59.52	56.77	56.50	60.44
	medium	53.74	59.20	53.48	54.77	51.10	50.06	48.46	48.88	52.46
	low	57.13	65.85	58.18	64.25	57.95	57.17	57.56	58.32	59.55
Ratio of Summer to Non-Summer Use Per Capital Per Day	high	1.15	1.05	1.22	1.21	1.16	1.10	1.10	1.15	1.14
	medium	2.10	1.37	2.18	1.96	2.00	1.53	1.63	1.89	1.83
	low	2.69	1.53	2.70	2.16	2.36	1.62	1.86	2.21	2.14

The monthly nature of the water use data allows for an analysis of seasonal differences in water use. For this analysis the months of June, July, August, and September are classified as "Summer" (i.e., growing season) months and the remaining months are classified as "Non-Summer" months. Water use per capita per day during the Summer is greater than water use per capita per day during the Non-Summer across every residential density category. However, as shown in the example of **Table 4-8** below, the ratio of Summer to Non-Summer demands is markedly different for each residential density category. For high density residential development in this example, the median increase in water use per capita per day from non-summer to summer is approximately 47%. For medium density residential development, the median increase is approximately 76%. For low density residential development, the median increase is approximately 120%. Different systems have different seasonal relationships. In highly urbanized areas such as Newark, high density residential development shows negligible differences between Summer and Non-Summer demands, approximately 5%.

Table 4-8. Example Residential Water Demand Per Capita Per Day (gpcd) for a PCWS Service Area

Residential Demand Metric	Residential Density	6-Year Average
Average Annual Per Capita Per Day	high	53
	medium	62
	low	138
Average Summer Use Per Capita Per Day	high	68
	medium	87
	low	217
Average Non-Summer Use Per Capita Per Day	high	46
	medium	49
	low	99
Ratio of Summer to Non-Summer Use Per Capital Per Day	high	1.47
	medium	1.76
	low	2.20

The spatial patterns of seasonal water use are also of interest for this study. **Figure 4-2**below is drawn from an analysis of data from the NJ American Water-Coastal North Division, and shows the ratio of Summer to Non-Summer water use per capita per day. A larger ratio represents a larger percent increase in water use in the summer months. Although rare, some ratios are less than one which means those areas experienced a decrease in water use per capita per day in the summer. While not explored in this analysis, causes of this anomaly could be residential schools (i.e. colleges) or residences that are vacated during the summer. The map shows that much of the coast, including virtually all the barrier islands in the south, experienced a large increase in water use during the summer months. Appendix D includes figures showing the patterns of per capita demands and seasonal ratios for the major case PCWS systems.

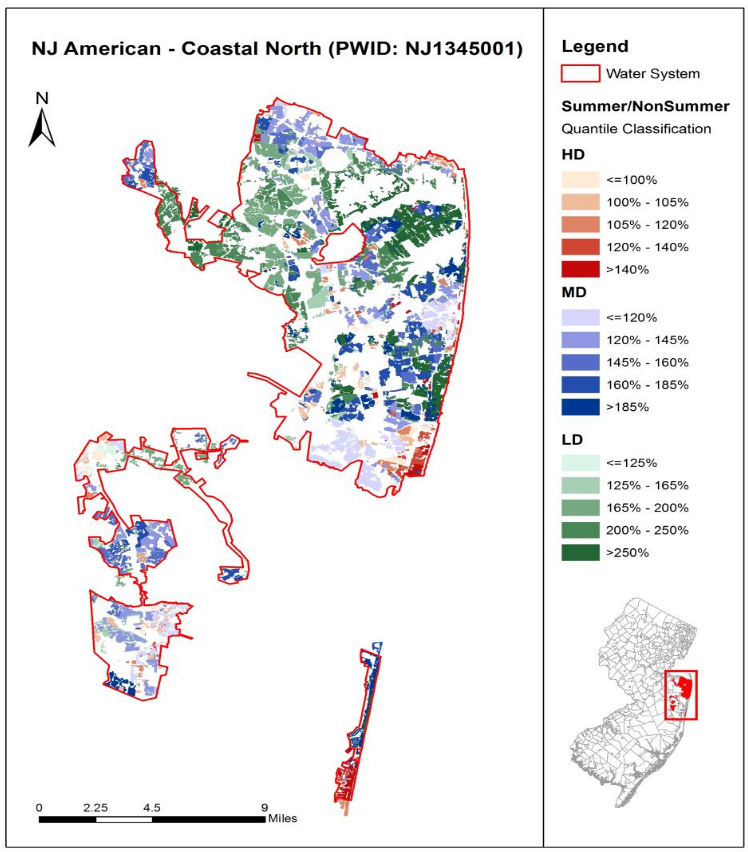


Figure 4-2. Example Ratios of Summer to Non-Summer Per Capita Per Day Water Use

Of interest in this study is the effect that seasonal populations can have on localized water demands. This factor is particularly relevant to coastal and vacation communities that experience a large influx of population during the tourism season, such as the coastal communities shown in **Figure 4-2** above. To understand the effect of this seasonal population, a classification of "year-round user" was created for the water use data points. The criterion for a year-round user is any customer that has fewer than three months with zero water use. Any customer with three or more months of zero water use is assumed to be a seasonal residence, a vacation property or a rental property that is often vacant during the off-season.

Comparing the water use of year-round residents with the water use of all users provides one approximation of the effect that seasonal populations have on water use, as shown in the example of **Table 4-9**. These results were developed for the PCWS systems for which customer data were provided. Non-Summer uses are not materially different, which is expected as the seasonal increase in users does not affect off-season uses. However, Summer uses are significantly different, with higher per capita uses and Summer to Non-Summer ratios across all residential densities. This effect reflects how the seasonal populations increase water demands within the block group, but the underlying Census population of the block groups is unchanged. The significant shifts shown in this table for Summer uses emphasize the importance of addressing seasonal demands within the projection of water demands to 2040. As coastal residential properties either shift to year-round residents or to rental of previously year-round properties, the ratios of Summer to Non-Summer demands will likewise change. There is no certain mechanism for projecting these shifts, which will be driven by economics, demographic change and possibly storm damages. The method of analysis for other PCWS systems is discussed in the Residential Demands section under Extrapolation to Other PCWS Systems.

Table 4-9. Example Per Capita Residential Demands, Year-Round versus All Users

All Users				"Year Round" Users		
Analysis	**Density**	**6-Yr Avg**		**Analysis**	**Density**	**6-Yr Avg**
Average Summer Use Per Capita Per Day	high	68		**Average Summer Use Per Capita Per Day**	high	53
	medium	87			medium	77
	low	217			low	196
Average Non-Summer Use Per Capita Per Day	high	46		**Average Non-Summer Use Per Capita Per Day**	high	44
	medium	49			medium	48
	low	99			low	99
Ratio of Summer to Non-summer Use Per Capital Per Day	high	1.47		**Ratio of Summer to Non-summer Use Per Capital Per Day**	high	1.21
	medium	1.76			medium	1.59
	low	2.20			low	1.98

The residential water demand data from the case study PCWS systems resulted in a range of per capital water demands for the various land classification categories. **Table 4-10** provides a summary of the median and weighted average water demands (and the percent difference between these values) for high, medium and low density residential development for the full year, Summer and Non-Summer, and the ratio of Summer to Non-Summer demands. The weighted averages are higher in all circumstances, especially for low density development, indicating that the larger systems showed higher demands on average. Summer and Non-Summer demands differ little for high density development, while for low density development differences are very large (especially on a weighted average basis). These values were derived after excluding outliers based on an analysis of all values; results below 15 and above 250 gpcd (gallons per capita day) in annual average demands are considered not representative of legitimate water demands but rather reflecting a difficulty in the dasymetric analysis. In addition, results for areas with very low populations were excluded.

Table 4-10. Median and Weighted Average Residential Water Demands, Case PCWS Systems

Metric	Density	Median	Weighted Average	Percent Difference
Average Annual Per Capita Per Day	**high**	41.67	49.89	19.7%
	medium	53.51	60.79	13.6%
	low	75.31	87.10	15.7%
Total Summer Use Per Capita Per Day	**high**	45.32	52.96	16.9%
	medium	67.26	78.23	16.3%
	low	88.14	128.51	45.8%
Average Non-Summer Use Per Capita Per Day	**high**	39.10	46.23	18.2%
	medium	49.62	52.09	5.0%
	low	58.42	62.93	7.7%
Ratio of Summer Use to Non-Summer Use (Per Capita Per Day)	**high**	1.10	1.15	4.1%
	medium	1.31	1.50	14.5%
	low	1.32	2.04	54.4%

The results were evaluated to determine whether sufficient results were available for each land classification category to support a robust evaluation of per capita demands. Categories with less than roughly 0.5 percent of the total assessed population (17,940 of 3,588,351) were combined with other comparable categories. No categories with N (New Housing) or H (High Precipitation) met this threshold; the only areas with High Precipitation are in the Highlands Region. One category (High Density-Highlands-Flat Slope) was too small to include but there was no other appropriate High Density-Highlands category for merging, and so High Density-Piedmont-Flat Slope was used. The merged categories are as in **Table 4-11**.

Table 4-11. Merged Land Classification Categories due to Low Associated Populations

Original Category	Parameter with Insufficient Population Results	Population	% of Assessed Population	New Category
HD_N_F_CP_L	Housing Age	2,713	0.08%	HD_O_F_CP_L
HD_N_F_HL_H	Housing Age, Precipitation	292	0.01%	HD_O_F_HL_L
HD_O_F_HL_L	High Density with Flat Slope	4,350	0.12%	HD_O_F_PM_L
HD_O_F_PM_H	Precipitation	5,905	0.17%	HD_O_F_PM_L
LD_N_F_CP_L	Housing Age	1,655	0.05%	LD_O_F_CP_L
LD_O_F_HL_H	Precipitation	360	0.01%	LD_O_F_HL_L
LD_O_F_PM_H	Precipitation	177	0.00%	LD_O_F_PM_L
LD_O_S_PM_L	Steep Slope	127	0.004%	LD_O_F_PM_L
MD_N_F_CP_L	Housing Age	3,038	0.09%	MD_O_F_CP_L
MD_O_F_HL_H	Precipitation	605	0.02%	MD_O_F_HL_L
MD_O_F_PM_H	Precipitation	7,071	0.20%	MD_O_F_PM_L

Where multiple results were available for a single land classification category, the results were evaluated for diversity in per capita rates within the individual PCWS system and among multiple systems (where applicable), using a comparison of the system results to the weighted average of results across all systems. Where variability among the larger systems was relatively small (generally less than 20% plus or minus), the weighted average was used. Results for the smallest systems are assumed to have the largest potential for analytical error, because the dasymetric analysis of population becomes less robust with small populations; the denominator for per capital demands (the associated population) can have a large effect on the results. In some cases, the results showed a wide variety among the systems. In this case, a qualitative evaluation was used to identify an appropriate value to use in the water demand analysis, based on information regarding the nature of the service areas.

In one instance, High Density in the Highlands, no information was available from systems with monthly data, and therefore values from a nearby area with similar characteristics (e.g., bedrock geology and valley-fill aquifers) was selected, in this case the High Density-Piedmont results from the NJ American Water-Passaic System, at 42.04 gpcd. Values from Roxbury Water Department were considered as a basis for comparison (using quarterly data rather than monthly), as this system is fully within the Highlands; however, Roxbury has almost no high density residential population and the High Density results are anomalous, being much higher than for medium and low density residential demands. For this reason, the High Density-Piedmont results were also used in Roxbury to substitute.

This evaluation was performed for annual demands. Demands for the growing and non-growing seasons were then selected using the same approach. Based on this approach, the per capita residential demands in **Table 4-12** were selected for use. The selected per capital demands are used as the basis for estimating residential demands in all other PCWS systems, as discussed below in Extrapolation to Other PCWS Systems.

Table 4-12. Selected Per Capita Residential Demands (gallons per day)

Residential Density/Region	Coastal Plain (CP)	Piedmont (PM)	Highlands and Ridge & Valley (HL)
High Density (HD) Annual	47.92	58.46	42.04
Medium Density (MD) Annual	59.04	61.20	53.52
Low Density (LD) Annual	93.27	73.95	61.09
High Density (HD) Summer	53.49	62.61	42.47
Medium Density (MD) Summer	75.88	76.62	59.42
Low Density (LD) Summer	141.05	108.92	81.75
High Density (HD) Non-Summer	45.13	56.27	41.82
Medium Density (MD) Non-Summer	50.59	53.17	50.62
Low Density (LD) Non-Summer	69.36	56.61	50.84

Results for the larger PCWS case systems are shown in **Table 4-13**.

Table 4-13. Comparison of Per Capita Residential Demands for Largest Case PCWS Systems

Group	NJ0119002	NJ0238001	NJ0327001	NJ0712001	NJ0714001	NJ1345001	NJ2004002
	NJAW-Atlantic	Suez-Haworth	NJAW-Delaware	NJAW-Passaic	Newark	NJAW-Coastal North	NJAW-Raritan
	Population						
HD_O_F_CP_L	14,211		61,723			84,257	9,373
HD_O_F_PM_L		409,407		182,129	224,518		434,714
LD_O_F_CP_L	7,770		5,509			44,824	40,255
LD_O_F_HL_L				16,729			2,944
LD_O_F_PM_L		25,987		60,409			213,521
MD_O_F_CP_L	80,960		189,134			201,660	7,556
MD_O_F_HL_L				8,333			728
MD_O_F_PM_L		281,938		208,707	1,275		562,122
Grand Total	102,941	717,332	256,366	476,307	225,793	330,742	1,271,213
Population by PWSID as % of Group							
HD_O_F_CP_L	7%		29%			40%	4%
HD_O_F_PM_L		32%		14%	18%		34%
LD_O_F_CP_L	7%		5%			40%	36%
LD_O_F_HL_L				76%			13%

Group	NJ0119002	NJ0238001	NJ0327001	NJ0712001	NJ0714001	NJ1345001	NJ2004002
	NJAW-Atlantic	Suez-Haworth	NJAW-Delaware	NJAW-Passaic	Newark	NJAW-Coastal North	NJAW-Raritan
LD_O_F_PM_L		8%		20%			69%
MD_O_F_CP_L	15%		34%			36%	1%
MD_O_F_HL_L				37%			3%
MD_O_F_PM_L		26%		19%			52%
Total Demand Unweighted Average							
HD_O_F_CP_L	48.10		38.88			48.97	54.18
HD_O_F_PM_L		69.70		42.04	66.02		51.22
LD_O_F_CP_L	73.81		109.73			128.00	65.91
LD_O_F_HL_L				62.05			51.97
LD_O_F_PM_L		103.49		73.95			50.14
MD_O_F_CP_L	60.86		62.89			57.48	63.43
MD_O_F_HL_L				79.86			55.75
MD_O_F_PM_L		72.53		64.34	47.49		54.75
Total Demand as Portion of Weighted Average							
HD_O_F_CP_L	3.25		11.41			19.62	2.42
HD_O_F_PM_L		22.65		6.08	11.76		17.67
LD_O_F_CP_L	5.06		5.33			50.62	23.41
LD_O_F_HL_L				47.30			6.97
LD_O_F_PM_L		8.72		14.48			34.71
MD_O_F_CP_L	8.83		21.32			20.78	0.86
MD_O_F_HL_L				29.72			1.81
MD_O_F_PM_L		19.02		12.49	0.06		28.62
Difference between System and Total Weighted Average Demand Difference (as %)							
HD_O_F_CP_L	0%		-19%			2%	13%
HD_O_F_PM_L		19%		-28%	13%		-12%
LD_O_F_CP_L	-21%		18%			37%	-29%
LD_O_F_HL_L				2%			-15%
LD_O_F_PM_L		71%		22%			-17%
MD_O_F_CP_L	3%		7%			-3%	7%
MD_O_F_HL_L				49%			4%
MD_O_F_PM_L		19%		5%	-22%		-11%

Commercial and Industrial Demands

Commercial demands include those related to all classes of retail and wholesale businesses, and to office buildings that are not associated with manufacturing. For this analysis, demands from public facilities such as municipal, educational and recreational facilities were also included in the category of Commercial.

Industrial demands are associated with manufacturing and all ancillary demands, such as on-site office space. Water delivered under the category "Fire Protection" was consistently well below 1% of total demands for those case PCWS systems providing data, and therefore is not included in this analysis.

In both cases, only demands that are supplied by the PCWS system are addressed. Self-supplied demands are tracked separately by NJDEP where they involve either a water allocation permit or a non-community water supply, such as an on-site well, and are not addressed in this project.

Most of the case PCWS systems also provide data on the relative demand of Residential (all categories), Commercial (usually with private and public customers separately) and Industrial customers. The results are shown in **Table 4-14**. Residential demands are lowest in Newark and highest in the Ridgewood system. Commercial demands are commonly around 30%, with the highest values in the NJ American Water-Passaic System and Mount Laurel MUA, but Ridgewood is far lower at 13.1%, reflecting its very high Residential components. Only Newark has a high (20.3%) Industrial demand, with the NJ American Water-Raritan System a very distant second at 6.9%. In each case, the percentages were used directly to drive model demands for these systems.

Table 4-14. Residential, Commercial and Industrial Demands by Case PCWS System

PCWS System	PWSID	Residential Demand	Commercial Demand	Industrial Demand
Mount Laurel MUA (2015)	NJ0323001	67.3%	32.7%	~0%
Newark Water & Sewer Dept (2014)	NJ0714001	57.4%	22.3%	20.3%
NJ American (2014-2016 average)				
• Atlantic System	NJ0119002	70.8%	29.2%	~0%
• Coastal North System	NJ1345001	73.3%	26.6%	0.1%
• Delaware River System	NJ0327001	65.3%	34.0%	0.7%
• Mount Holly System	NJ0323001	72.9%	26.6%	0.5%
• Passaic System	NJ0712001	61.4%	36.6%	2.0%
• Raritan System	NJ2004002	63.2%	30.0%	6.9%
Ridgewood Water Dept (2014)	NJ0257001	86.9%	13.1%	~0%
Suez New Jersey – Haworth (2016)	NJ0239001	72.8%	24%	3.3%
Average		**69.1%**	**27.5%**	**5.6%**
Median		**69.1%**	**27.9%**	**2.7%**

For each case PCWS system, the ratio of commercial land use to residential land use was compared to utility-reported commercial demands, to determine whether this ratio could serve as a proxy for commercial demands in systems where a residential-industrial-commercial breakdown was not available.

In general, Industrial demands were higher where industrial land area is higher, except the NJ American-Mount Holly System that had low industrial demands despite one of the higher concentrations of industrial land area. The Mount Holly industrial area may be warehouses or similar low-demand but high-area facilities, or there could be a land use coding discrepancy. By comparison, the NJ American-Raritan System has the same industrial land area value as Mount Holly (4%) but a much higher Industrial demand (6.9%, compared to 0.5% for Mount Holly), which may reflect a much more active manufacturing base in the Raritan System (e.g., pharmaceuticals).

Three ratios are provided to help evaluate the relationships of Residential and Commercial demands. The results are shown in **Table 4-15**.

- **Ratio of Residential Demand (as %) to Residential Area (as %):** This ratio provides a sense of residential demand intensity, similar to population density but reflecting the fact that per capita demands decline as population density increases. Newark has the highest ratio at 2.61, which is reasonable given that nearly its entire residential area is high density. The lowest ratios are in Ridgewood and the NJ American Delaware River and Passaic systems, at less than 1.2. The other systems are in a fairly narrow band (1.37 to 1.65) except for Mount Laurel at 1.87.
- **Ratio of Commercial Demand (as %) to Commercial Area (as %):** The ratio of Commercial demand relative to Commercial land area is generally much higher than for

Residential, with a median of 3.5. The lowest values are in Ridgewood and Newark; the latter may reflect large commercial areas that have little water demand (as would also be true for warehouse development in many suburbs), despite the existence of many office buildings. The highest ratios are in three NJ American systems – Atlantic, Passaic and Raritan, with ratios ranging from more than 4 to move than 5.

- **Ratio of Residential Demand (as %) to Commercial Demand (as %):** The values here are quite different among the systems, which Ridgewood being an extreme outlier at 6.63, indicating that the commercial demand supported by its population must be located outside its service area. The other systems have a range of 1.68 (NJ American-Passaic) to 3.03 (Suez). The low value for NJ American-Passaic reflects its high Commercial demand at 36.6%, which was the highest of any system. Of considerable interest is Newark, where a combination of low per capita Residential demands (and perhaps lower household income levels) and a low Commercial demand percentage result in a ratio that is close to that of other systems with far different development patterns (e.g., NJ American-Mount Holly and Coastal North systems).

Newark's ratio of residential demand to residential land area is highest, reflecting its much higher proportion of high density residential development. However, Newark's ratio of Commercial demand to Commercial land area is much lower than all other systems except for Ridgewood. Ridgewood has the highest proportion of residential land area, reflecting its primarily suburban nature with no industrial land uses and roughly average commercial land area.

Interestingly, the amount of commercial land in the service areas ranged only from 7% to 12% while the range for Commercial demand was 13.1% to 36.6%, indicating that the relative intensity of Commercial demand is not related closely to the percentage of service area within that land use. Commercial land area in these systems is generally in the 7% to 10% range, with Newark high at 12%. Industrial land area is even lower, at 1% to 5%, again with Newark high at 10%. One conclusion is that Newark is fundamentally different in composition from the other systems, all of which are either suburban or mixed urban/suburban. Therefore, the results from Newark should only be applied to similar urban core areas.

The ratio of Residential and Commercial demands is mostly in the range of 2:1 to 2.75:1, with a median and average in that range as well. Ridgewood is unusual again, in having a very high ratio of 6.63:1, indicating a lack of commercial land uses supporting that population. The NJ American Water-Passaic System is unusually low, reflecting its high Commercial demand as a percentage of total demand.

Table 4-15. Comparison of Residential, Commercial and Industrial Land Uses and Demand Comparisons by Case PCWS System

PCWS System	Residential Land in WSSA	Commercial Land in WSSA	Industrial Land in WSSA	Ratio RES Demand to Area	Ratio COMM Demand to Area	Ratio of Demand RES:COMM	General Development Pattern
Mount Laurel MUA	36%	9%	2%	1.87	3.63	2.06	Suburban
Newark Water & Sewer Dept	22%	12%	10%	2.61	1.86	2.57	Urban
NJ American Water							
• Atlantic System	43%	7%	2%	1.65	4.17	2.42	Suburban
• Coastal North System	48%	7%	1%	1.53	3.80	2.76	Suburban
• Delaware River System	56%	10%	2%	1.17	3.40	1.92	Suburban
• Mount Holly System	44%	8%	4%	1.66	3.33	2.74	Suburban
• Passaic System	53%	7%	1%	1.16	5.23	1.68	Suburban
• Raritan System	44%	7%	4%	1.44	4.29	2.11	Mixed
Ridgewood Water Dept	76%	8%	1%	1.14	1.64	6.63	Suburban
Suez-NJ – Haworth System	53%	10%	5%	1.37	2.40	3.03	Mixed
Average	**47.5%**	**8.5%**	**3.2%**	**1.6**	**3.4**	**2.8**	
Median	**46.0%**	**8.0%**	**2.0%**	**1.5**	**3.5**	**2.5**	

Case Study Water Losses and Total Water Demands

In some cases, the case PCWS systems provided water loss information, and in other cases the estimates were provided by NJDEP and the Delaware River Basin Commission (DRBC) from submittals received in response to regulatory requirements. The section below on Non-Revenue Water and Water Losses provides more detailed information on this topic from a statewide perspective. **Table 4-16** provides the water loss results for the case PCWS systems along with the estimates of residential, industrial and commercial demands based on the analysis described above.

Table 4-16. Annual Average Residential, Industrial and Commercial Demands, and Most Recent Water Loss Estimates by Case PCWS System

PCWS System	**Water Loss (MGD)**	**Residential (MGD)**	**Commercial (MGD)**	**Industrial (MGD)**	**Total (MGD)**
Mount Laurel MUA	0.305	2.770	1.390	0.000	4.465
Newark Water & Sewer Dept.	27.884	16.525	12.682	17.205	74.295
NJ American Water					
• Atlantic System	0.754	7.005	3.469	0.000	11.229
• Coastal North System	6.607	23.160	10.896	0.048	40.711
• Delaware River System	1.667	16.769	9.930	0.216	28.581
• Mount Holly System	0.450	1.801	0.965	0.020	3.237
• Passaic System	10.388	14.351	11.473	0.835	37.047
• Raritan System	28.686	36.332	32.768	9.516	107.302
Suez-NJ – Haworth System	23.672	54.233	22.954	3.937	104.797

A critical point here is that the water losses are based on the most recent reported values of non-revenue water or unaccounted-for water, while the demands are based on multi-year averages. Water losses (both rates and totals) change from year to year, based on changes in demands and alterations to the systems (in both positive and negative directions). A more appropriate analysis would use annual water loss rates with annual demands and determine an average for both; however, annual water loss rate estimates were not available. Therefore, the water loss estimates should be seen as general estimates, and incorporate some uncertainty.

Extrapolation to Other PCWS Systems

Extrapolation to other PCWS systems requires several steps. First is the estimation of water that is treated and placed into distribution but is not shown as metered demands. Subtracting this amount from the total system delivered water yields an estimate of water that reaches a customer meter. Next, residential demands are estimated using information from the dasymetric analysis and the case studies. Commercial and industrial demands are based on information from the PCWS system, where available, and otherwise on a formula related to residential demands and commercial or industrial land area, respectively, within the PCWS service area, using information from the case studies. The totals are then compared to the maximum annual system water demands provided by NJDEP in the Water Supply Deficit/Surplus Analysis and the NJWaTr database to identify systems where those demands are significantly different from modeled results. Sources of uncertainty are discussed in the final port of this chapter.

Non-Revenue Water and Water Losses

Non-revenue water is the difference between the water that is delivered into the PCWS system and what is measured at the customer meter. This difference is called "Unaccounted-for Water" or UAW, and is the method required by the NJDEP. A more detailed method is the Water Loss Accounting Manual (M36) and associated spreadsheet program from the American Water Works Association, which calculates Non-Revenue Water (NRW) and breaks NRW down into categories of "real" water losses (e.g., leakage, firefighting, water main flushing) and "apparent" losses (e.g., metering inaccuracy, unmetered demands). Infrastructure Leakage Index, or ILI, is the ratio of real losses to the Unavoidable Annual Real Losses (UARL). As ILI approaches one (1), the system approaches zero real water loss that can be addressed cost-effectively through maintenance and replacement. No system can achieve zero real losses, and the cost-effective rate of real losses will vary by system. While national practice is moving away from uniform percent loss thresholds for regulatory purposes (i.e., to define what level of losses is acceptable or unacceptable), the use of reported and projected losses is appropriate for water supply planning purposes.

As infrastructure ages, non-revenue water loss is expected to increase unless the infrastructure is replaced or repaired. Scenarios for water loss rates for this project were developed based on benchmarking for most systems, as insufficient data are available to assess water losses in many utilities outside of the Delaware River Basin. Insufficient information is available to assess water loss trends, though this will become possible over the next decade in the Delaware River Basin if the Delaware River Basin Commission (DRBC) continues with its water loss audit requirements, or if NJDEP includes water loss audits in new regulations implementing the Water Quality Accountability Act of 2017.

Detailed information on system water losses as of 2014 was available from the DRBC for the New Jersey PCWS systems under their jurisdiction (DRBC, 2016). While 2012 and 2014 reports are available, the most recent available year was used, with the assumption that the provided information has become more accurate as PCWS systems gain experience with the reporting requirements and IWA/AWWA Manual M36 process. The recent report on the 2014 submittals (DRBC, 2016) includes the results of 276 water audits in the four states of the Basin, of which 20 systems accounted for roughly 70% of the total volume of water production (with the largest by far being Philadelphia), and only 11 systems exceeding 10 MGD.

The report notes that NRW exceeded 15% of total water produced for 151 of the 276 audits, but indicates that using this percentage as a threshold is not modern practice because it will understate NRW problems in utilities that have inefficient water customers (i.e., higher total volume) but otherwise equivalent NRW volumes. **Figure 4-3** shows the results.

The DRBC 2014 audit results indicate that apparent losses for the 20 largest systems in their region (including the other states) generally range from 3 to 8 gallons per service connection per day (median of roughly 7), a normalized metric that allows comparisons among systems. Real losses for same systems were much higher, at roughly 40 to over 100 gallons per service connection per day, with a median of approximately 65. In other words, for these systems, real losses were most of total water losses, an average of 82%. The same larger utilities in the DRBC region reported a median ILI of roughly 3, with most result ranging from 2.5 to over 9. **Figure 4-4** shows the regional result for all utilities that filed their water audits.

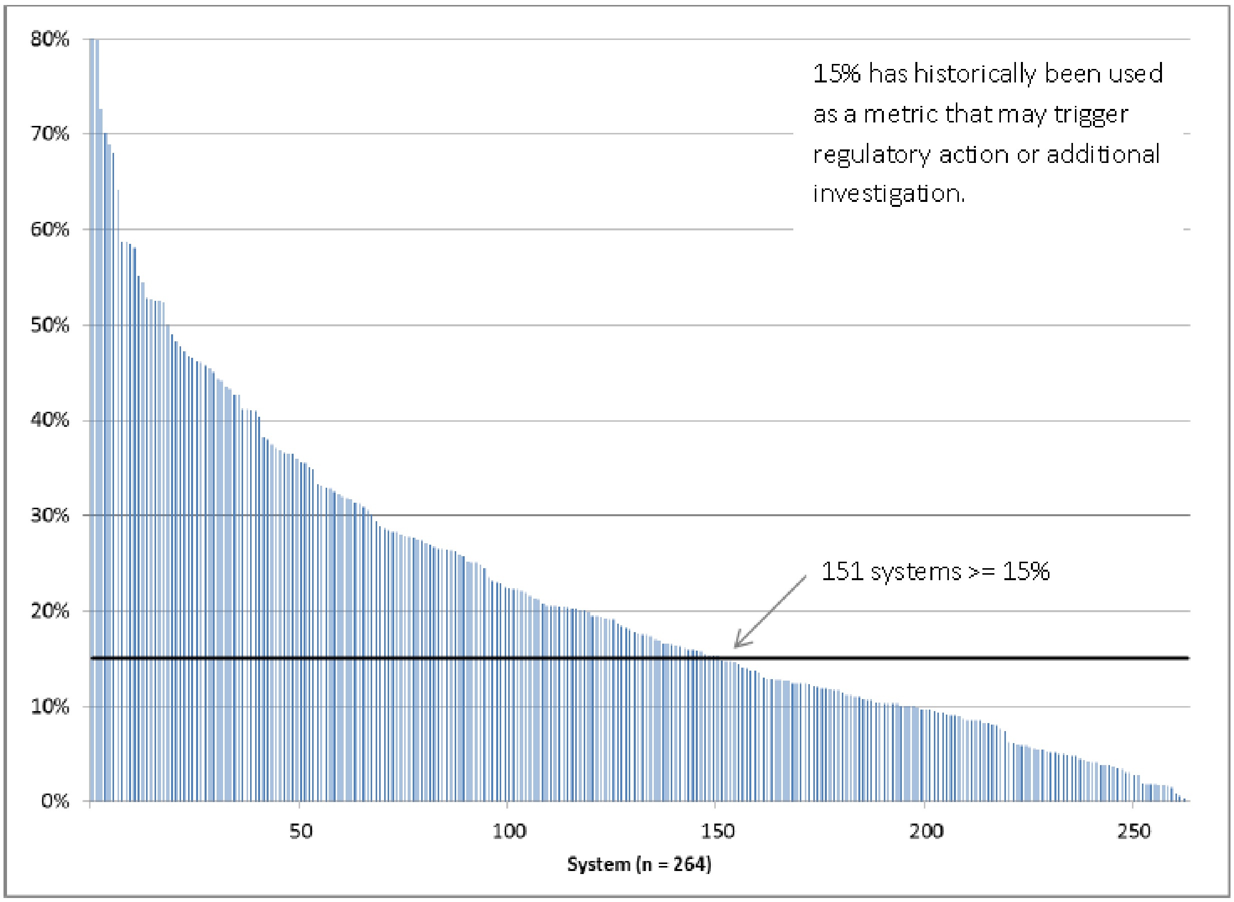
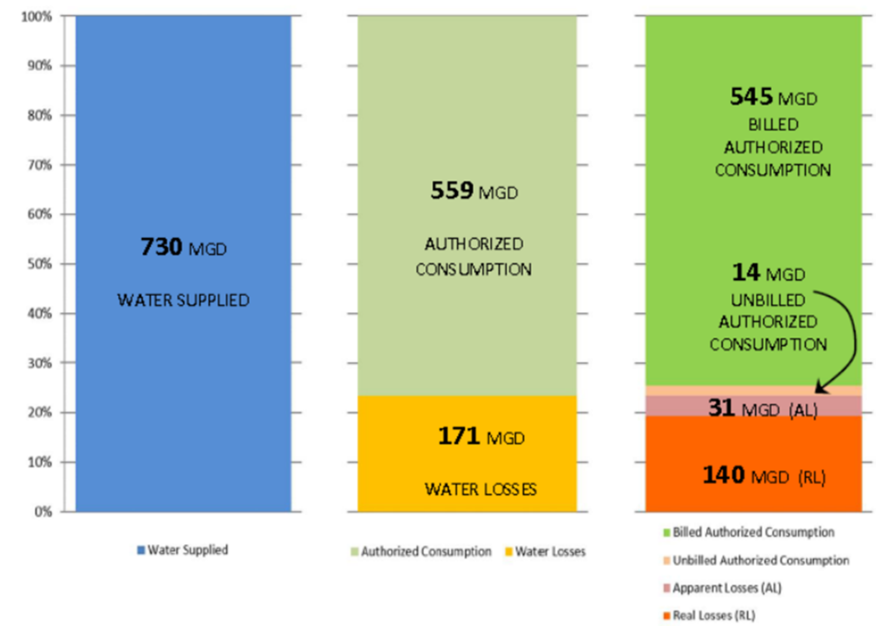


Figure 4-3. Non-Revenue Water as a Percent by Volume of Water Supplied for 276 Systems Reporting Water Audit Results to the Delaware River Basin Commission (DRBC, 2016)



Billed authorized: All consumption that is billed to customers of the utility; this includes metered and unmetered connections.

Unbilled Authorized: All consumption that is unbilled but is still authorized by the utility. This is likely to include water used in activities such as firefighting, flushing of mains and sewers, street cleaning and fire flow tests. It may also include water consumed by the utility itself in treatment or distribution operations, or metered water provided to civic or institutions free of charge.

Figure 4-4. Aggregate Summary Graphic for 276 Systems Reporting Water Audit Results to the Delaware River Basin Commission (DRBC, 2016)

Information on water losses was also received from NJDEP based on reporting in response to the recent drought warning. NJDEP requires use of the UAW method at a minimum, but some utilities did provide information using the AWWA method. The combined information from DRBC and NJDEP result in nearly all the reporting utilities having results from within the last five years. Most of the smaller and some of the larger utilities have no reported information on water losses. In all, 228 New Jersey systems are represented.

The New Jersey results for UAW and NRW are shown in the following figures. As can be seen in the scattergrams (**Figure 4-5**), the values range widely and differ significantly between bedrock geology (figures on the left) and coastal geology (figures on the right). The largest systems in bedrock geology all have UAW/NRW of at least 10%, with one outlier of more than 50%. Conversely, many large systems in coastal geology have UAW/NRW below 10%, though the systems reporting zero or near-zero losses are questionable. Again, there are upper outliers among the large coastal systems, but in this case, anything about 25% is highly unusual.

Medium and small systems in the two geology types have similar patterns but are more scattered. Again, the near-zero values are questionable, and the one medium coastal system reporting a negative loss (i.e., a gain) indicates a calculation error. Upper outliers for both bedrock and coastal geology exceed 50% for medium and small systems, with two small coastal systems reporting a startling 90% and 100%. These extreme outliers may also represent incorrect use of the methods.

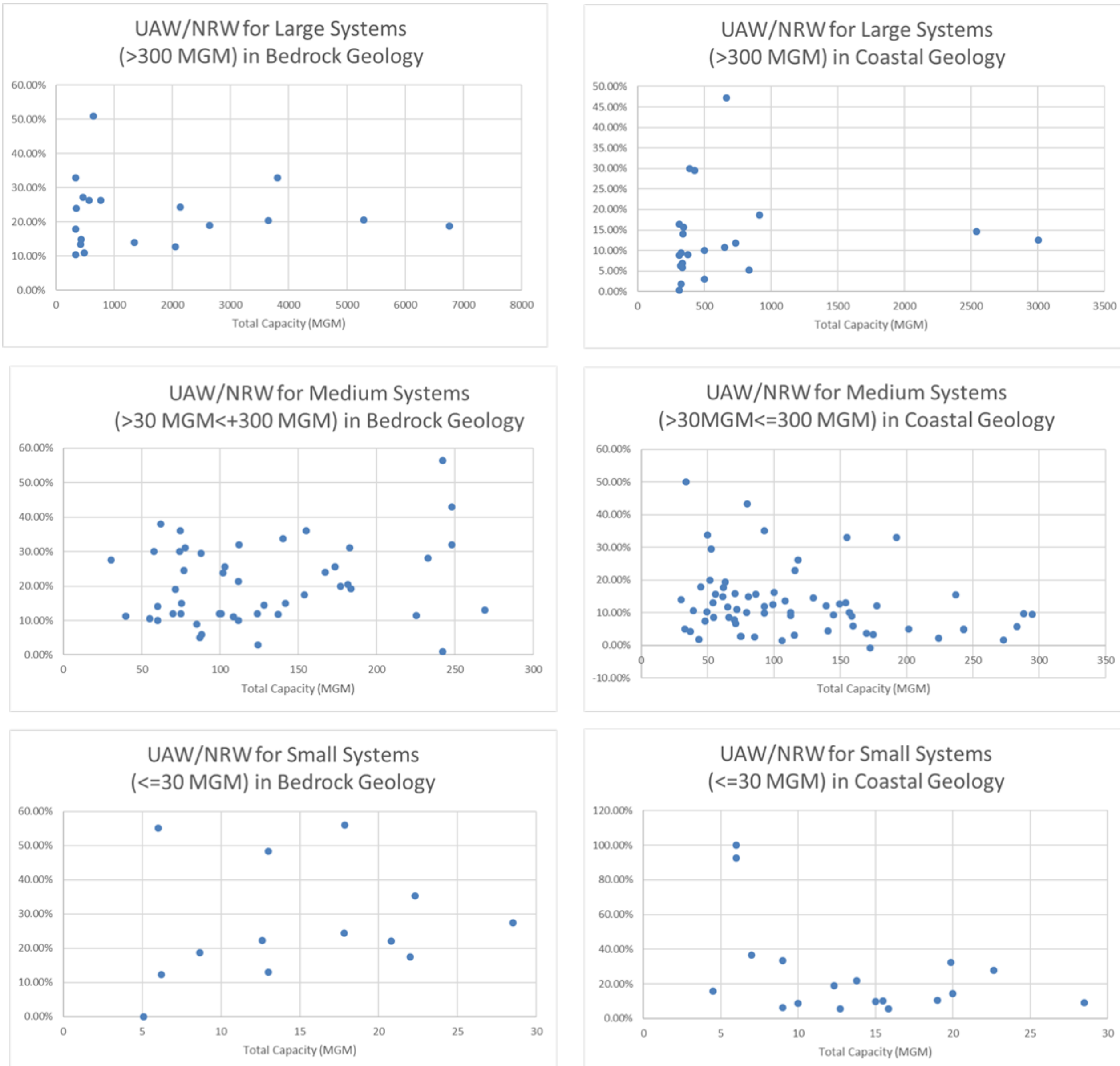


Figure 4-5. Water Losses for PCWS Systems (Scattergram)

The results are shown in a different manner in **Figure 4-6**, which provides "box and whisker plots" for the PCWS systems by size and whether they are in bedrock or coastal plain geology. The boxes show the range of results from 25th to 75th percentile, with the whiskers indicating the range of all but the outlier results, which are shown as points above and below the whiskers.

Given their outsized impacts, it is worth noting that the largest PCWS systems comprising 80% of the total firm capacity for this group of utilities had a similar range of UAW, from 3% to 52% with a median of 13%. For the larger systems, many of the lowest values are in Coastal Plain systems, which supports anecdotal information from water utility managers that water losses will often be lower in well-maintained systems that have limited topographic relief, allowing for lower pressure zones. Many of the highest results, not surprisingly, are in older urban and inner suburban areas, and in systems with significant topographic relief that requires higher water pressure to provide service to higher elevation areas.

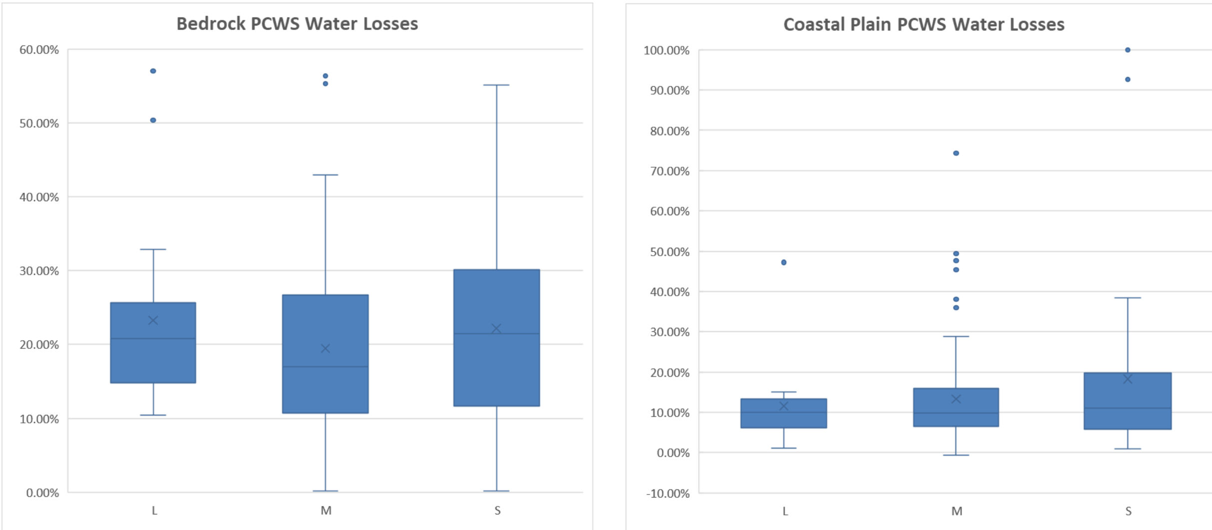


Figure 4-6. Water Losses for PCWS Systems (Box and Whisker Plots)

Table 4-17 provides three simple statistics for each grouping of systems: the mean (average), the median (50^{th} percentile), and the median excluding outliers. The results across all system sizes indicate a very clear distinction between utilities in coastal geology and bedrock geology, with the median (without outliers) UAW/NRW being at least 9% lower for all three sizes. Therefore, the model assigns UAW levels to systems for which UAW/NRW are not available based on the median (no outliers) column, as shown in the final column.

Very small systems (generally, self-supplied facilities) are initially assigned 10%, while mobile home parks and similar small development (e.g., very small municipal or investor-owned systems) are initially assigned 22% in bedrock areas and 11% in the coastal plain. No data are available to know whether these assigned water losses are high or low, but by comparing demands based on per capita times population, some assessment is possible as to whether the actual demands indicate higher or lower water losses. However, on a statewide, county and often municipal or watershed level, the total demands from such facilities are almost uniformly a very small component of total demands.

Table 4-17. Water Loss Statistics by System Size and Geology

Category	**Mean**	**Median**	**Median (no outliers)**	**Nominal 2010 UAW (PCWS Systems Lacking UAW/NRW Estimates)**
Large Systems-Bedrock Geology	23.27%	20.80%	20.40%	20%
Large Systems-Coastal Geology	11.60%	9.99%	9.99%	10%
Medium Systems-Bedrock Geology	19.46%	17.00%	16.65%	17%
Medium Systems-Coastal Geology	13.27%	9.81%	9.97%	10%
Small Systems-Bedrock Geology	22.19%	21.45%	22.30%	22%
Small Systems-Coastal Geology	18.28%	11.00%	11.00%	11%
Very Small Systems				10%

The water demand model uses the values in the last column where no other recent information is available.

Residential Demands

Based on the analyses discussed in Per Capita Residential Water Demands by Housing Category, residential per capita rates were estimated for all PCWS systems. The following steps were used:

1. For each case study PCWS system, using the results from that specific system, multiply the residential per capita rate for each land classification by the population associated with that area, as estimated through the dasymetric analysis.
2. For all other PCWS systems, multiply the relevant derived residential per capita rate for each land classification (Coastal Plain, Piedmont, Highlands/Ridge & Valley) and housing density (High, Medium and Low) by the population associated with that area, as estimated through the dasymetric analysis.
3. Compile all resulting residential demands for the PCWS service area.
4. Add seasonal demand increases related to tourism for systems with a high proportion of beach communities.

Seasonal Demand Increases Due to Tourism

Seasonal shifts in demand have two components. First, year-round users generally increase their demands during the summer months for outdoor water uses. This increased summer demand by regular customers is incorporated into the residential per-capita demand calculations for all systems.

Second, coastal communities, and especially those with large areas (relative to total municipal land area) on the Atlantic Ocean or back bays, often experience major increases in demand due to tourism, including both day users and those who rent houses, apartments and hotel/motel rooms for multi-day vacations. Seasonal visitors may greatly outnumber year-round residents. Commercial water demands will also increase for all businesses that cater to tourists.

The demand model addresses this complication in two ways. First, for systems that provided residential water demand data, the demands of year-round users were compared to the demands of all users, providing a measure of how much of the demand is attributable to seasonal users. In general, little difference was detected. Second, where water allocation permit reports are available for specific systems (i.e., where the PCWS systems rely entirely on their own supplies), the model includes a comparison of the ratio of summer to non-summer total water withdrawals to the same ratio based on modeled demands for year-round residents. The difference is attributed to seasonal users. This ratio is then used as a multiplier for modeled annual demands to account for seasonal demands related to tourism.

All PCWS systems that have major coastal residential areas and their own water supply sources (as identified through the Water Allocation Permit database) were identified. Monthly system water demands for the years 2015 and 2016 were compiled to determine the ratio between total system demands in the tourism season (May through September, with May being added due to the Memorial Day weekend and clear distinctions between April and May in the system data) and the non-tourism season. These ratios were compared to the ratio of Summer to Non-Summer demands for year-round residents. Where the first ratio is clearly greater than the second, that increased demand was added to the model for those systems only. **Table 4-18** shows the results for the PCWS systems with available water allocation permit results.

Table 4-18. Seasonal Demand Analysis for Coastal PCWS Systems

PWSID #	WA PI #	County	PCWS System Name	Primary Beach System	Pop. per mi2	Water Alloca-tion Report Ratio	Model Ratio (Year-round users)	Increased Annual Demand Due to Seasonal Users (%)
119002	5206X	Atlantic	New Jersey American Water - Atlantic	N	2,123	144.4%	156.8%	-12.4%
505002	5240	Cape May	Lower Township MUA	N	824	158.8%	150.3%	8.5%
516001	5124	Cape May	Woodbine MUA	N	308	152.3%	161.6%	-9.3%
1507005	5000X	Ocean	Suez Toms River	N	2,253	135.0%	149.7%	-14.7%
1516001	5037	Ocean	Little Egg Harbor	N	424	149.1%	142.5%	6.6%
1518005	5043	Ocean	Manchester Township	N	528	187.9%	138.9%	49.0%
102001	5306	Atlantic	Atlantic City MUA	Y	3,681	130.9%	118.6%	12.3%
103001	5322	Atlantic	Brigantine Water Dept	Y	1,479	229.2%	126.4%	102.8%
116001	5108	Atlantic	Margate City Water Dept	Y	4,490	270.7%	120.6%	150.1%
122001	5118	Atlantic	Ventnor City Water & Sewer Dept	Y	5,457	153.6%	118.5%	35.1%
502001	5210	Cape May	Cape May Water and Sewer	Y	1,501	226.4%	127.5%	99.0%
508001	5324X	Cape May	New Jersey American Water - Ocean City	Y	1,848	333.1%	126.4%	206.7%
509001	5133	Cape May	Sea Isle City Water Dept	Y	974	342.3%	118.8%	223.5%
510001	5182	Cape May	Stone Harbor Water Dept	Y	620	452.8%	119.5%	333.3%
514001	5057	Cape May	Wildwood City Water Dept	Y	4,082	225.8%	124.7%	101.1%
1327001	5162	Monmouth	Manasquan Borough Water Dept	Y	4,263	168.9%	144.9%	24.0%
1348001	5089	Monmouth	Spring Lake Borough	Y	2,251	460.8%	151.4%	309.4%
1501001	5205	Ocean	Barnegat Light Water Department	Y	785	319.8%	150.0%	169.8%
1503001	5174	Ocean	Beach Haven Water Department	Y	1,196	270.9%	130.0%	140.9%
1505003	5288	Ocean	Shore Water Company	Y	515	215.6%	118.5%	97.1%
1515001	5136	Ocean	Lavallette Water Dept	Y	2,319	222.9%	125.3%	97.6%
1517002	5112	Ocean	Long Beach Township	Y	561	317.1%	128.4%	188.6%
1520001	5259	Ocean	Ocean Township MUA - Pebble Beach	Y	1,902	193.1%	157.2%	35.9%
1525001	5150	Ocean	Point Pleasant Beach Borough	Y	3,270	196.4%	146.6%	49.8%
1527001	5120	Ocean	Seaside Park Borough	Y	2,429	135.3%	118.5%	16.7%
1528001	5163	Ocean	Ship Bottom Water Department	Y	1,621	224.3%	137.2%	87.2%
1531001	5164	Ocean	Surf City Water Dept	Y	1,617	301.3%	150.0%	151.3%

The results are plotted in **Figure 4-7**, to indicate the relationship between population density and the increased demands due to tourism. While not uniformly true, systems with the highest year-round population densities showed more limited effects of tourism demands, and coastal systems with limited beachfront showed lower effects than systems with a relatively large proportion of beachfront area.

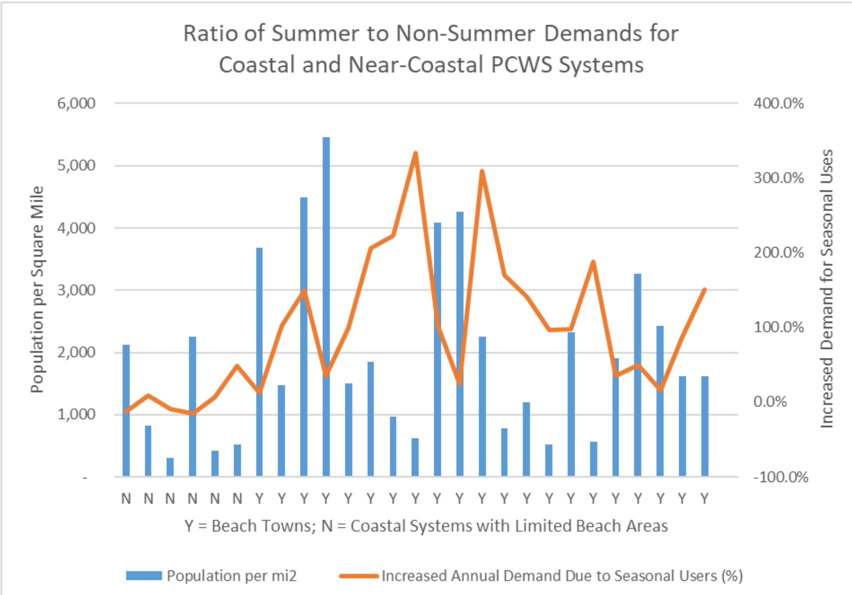


Figure 4-7. Water Demands Effects of Tourism for Coastal and Near-Coastal PCWS Systems

Eight coastal PCWS systems of significant size were identified where a seasonal factor could not be developed. Cape May Point Borough, Lake Como Water, and the Ortley Beach and Pelican Island systems of New Jersey American Water do not have their own water allocation permit. Avon by the Sea and Belmar do have water allocation permits, but use their wells only during the summer season as a supplement to an external source. New Jersey American Water – Coastal North uses a combination of internal and external year-round sources. In several cases, the lack of service area delineations also prevented calculation of demands using the model, specifically for Seaside Heights. **Table 4-19** lists these systems and the basis for not including them in the analysis. In each case, the seasonal demand increase for the system was based on the results for systems in **Table 4-18** above, with the exception of New Jersey American Water – Coastal North, which has a very large non-beach community service area in addition to the beach communities it serves, and therefor was considered more like the New Jersey American Water – Atlantic system, which did not show a pattern of greatly increased seasonal demands.

Table 4-19. Shore Systems Lacking Seasonal Demand Factors

PWSID #	WA PI #	County	PCWS System Name	Primary Shore System?	Analytical Problem/ Alternative Used
115001	NA	Atlantic	Longport Water Dept	Y	No Water Allocation Permit Margate used
501001	NA	Cape May	Avalon Water and Sewerage Utilities	Y	No Water Allocation Permit Sea Isle City used
503001	NA	Cape May	Cape May Point Borough Water Department	Y	No Water Allocation Permit Manasquan used
511001	NA	Cape May	New Jersey American Water - Strathmere	Y	No Water Allocation Permit Ocean City used
1305001	5132	Monmouth	Avon by the Sea Water Department	Y	No winter withdrawals Spring Lake Borough used
1306001	5138	Monmouth	Belmar Borough	Y	No winter withdrawals Spring Lake Borough used

PWSID #	WA PI #	County	PCWS System Name	Primary Shore System?	Analytical Problem/ Alternative Used
1344001	NA	Monmouth	Sea Girt Water Dept	Y	No winter withdrawals Spring Lake Borough used
1345001	5062X	Monmouth	New Jersey American Water - Coastal North	N	Mixed year-round water sources No seasonal factor required
1347001	NA	Monmouth	Lake Como Water Department	Y	No winter withdrawals Spring Lake Borough used
1507007	NA	Ocean	New Jersey American Water - Ortley Beach System	Y	No Water Allocation Permit Lavallette used
1507008	N/A	Ocean	New Jersey American Water - Pelican Island	Y	No Water Allocation Permit Lavallette used
1526001	5093	Ocean	Seaside Heights Borough	Y	No model demand projection Seaside Park used

Commercial and Industrial Demands

A model to estimate 2040 water demands requires a method for estimating how Commercial demands will increase or decrease based on population changes. Industrial demands are assumed to remain stable. For both categories, system-specific information on the relative Residential, Industrial and Commercial demands is not routinely collected by any agency or entity. Assumptions are therefore required for the model.

The first general assumption is that population is linked to Commercial demands in at least two ways. Commercial development in the form of offices and non-industrial production provides jobs that support populations, and increased populations support retail commercial employment.

Many factors complicate the analysis.

- First, a close correlation between Residential and Commercial demands is more likely in larger water supply service areas, where there is a reduced potential for Commercial development outside the service area to be both a source of jobs and provider of services to residents within the service area. However, in areas where there are many contiguous medium-sized systems, it is reasonable to expect that the externalities will work in both directions, reducing but not avoiding error.

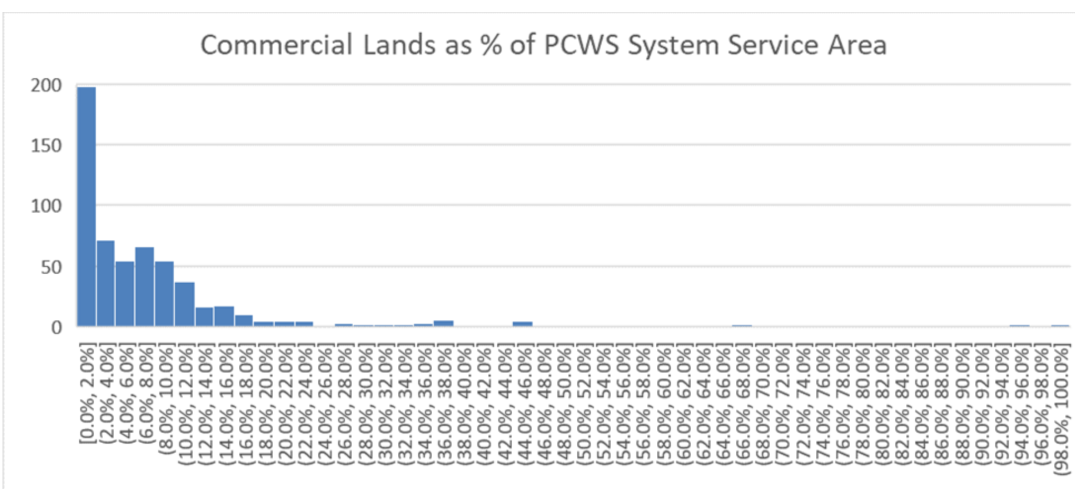


Figure 4-8. Percentage of PCWS Service Area in Commercial Land Uses

- Second, many water supply service areas have no or very little Commercial land area, with 156 systems having none. In **Figure 4-8**, above, nearly 200 PCWS systems have less than 2 percent of their service area in commercial lands, and roughly 440 (75% of all systems) have less than 10 percent. Where Commercial lands are minimal, PCWS system population change would affect Commercial demand outside the service area. The model cannot capture this effect. However, most PCWS systems with minimal or no Commercial land area are small and will experience minimal population change. Therefore, this factor is unlikely to cause major concerns regarding Commercial demands. By comparison, 539 of the 585 PCWS systems have less than 10% Industrial area, and over 300 have none.

- Third, some areas are regional centers of government, jobs, retail commercial, industry, etc. These areas can have much larger Commercial and Industrial water demands relative to residential demand. The question is whether relative demands differ significantly between urban core areas, typical suburban areas, and PCWS systems that serve a mix of the two. Of the systems that provided detailed customer data, Newark is a good example of an urban core configuration (with the highest Commercial and Industrial demand and the lowest residential demands of the group), Mount Laurel and Ridgewood are good examples of suburban areas (with negligible Industrial demand and relatively little Commercial land, and very low Commercial demand in Ridgewood), and Suez-Haworth (aka the Hackensack System) and NJ American-Raritan System as good examples of mixed areas (with significant Industrial and Commercial demands but much less than Newark).

- Fourth, the current location of jobs by municipality and census tract is not clear. Rutgers did not have the opportunity in this project to evaluate whether it would be feasible to estimate job locations (and therefore water demand) by geographic area, for example using the tax assessor data (e.g., building floor area) and commercial development type using the NJDEP Land Use/Land Cover data. The water intensity of commercial, institutional and public facility development can vary widely, as can industry. The model cannot account for these differences.

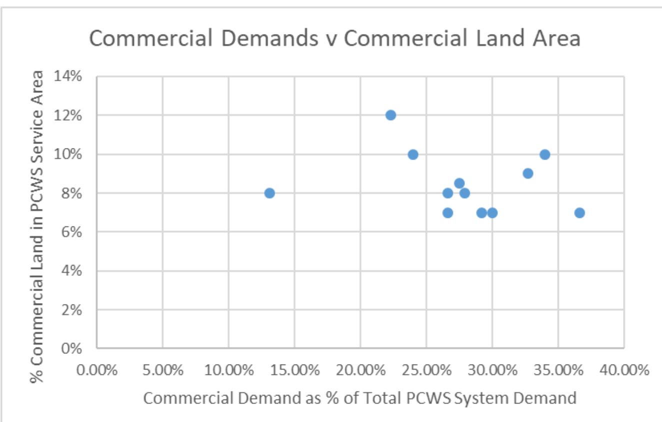
- Fifth, water purveyors may not all classify water customers in the same manner. Rutgers did not evaluate whether the purveyor classification of commercial and industrial customers matched the NJDEP Land Use/Land Cover for those uses. We did identify situations where a relatively small percentage of residential customers were located in areas mapped as commercial and industrial within the LULC mapping.

- Sixth, the nature, job-intensity and trends for commercial development into the future all appear to be changing, making employment forecasts very difficult statewide, much less on a PCWS basis. Warehouse-based "order fulfillment" centers are generating many thousands of jobs, while "bricks and mortar" stores are struggling or vacant in many places. By 2040, robotics, such as autonomic delivery of purchases to homes, is expected to make major incursions into the job marketplace, further affecting employment and job locations (Economist, 2017). For this reason, any estimates of commercial demands over decades of time is essentially a guess. Industrial activity in New Jersey has long been toward a loss of water-intensive and job-intensive industry; what the future will bring is highly uncertain.

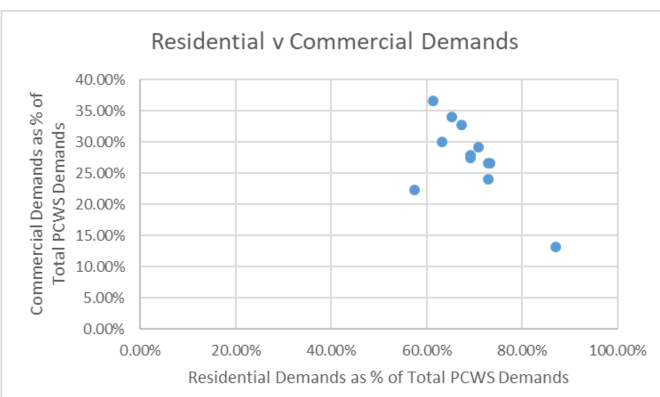
For these reasons, the best assumption for planning purposes is a continuation of existing relationships, which should be periodically tested over time to determine how they may have changed. The question, then, is how to extrapolate from the systems with available data to those for which data are not available.

Approach for Commercial Demands

1. For PCWS systems with minimal or no commercial land areas, the Commercial water demand will be assumed as zero.
2. For systems with significant commercial land areas, the relationship of Commercial water demands to other factors is less clear than even for Industrial demand. (Note that for each evaluation below, Ridgewood is a clear outlier.) As can be seen in **Figure 4-9(a)** showing Commercial demands relative to Commercial land area, the systems tend to be bunched rather than showing any linear relationship, indicating that area alone is not determinative. Likewise, in **Figure 4-9(b)** the relationship between Residential and Commercial demands is also bunched, but in this case there is a clear tradeoff between the two that makes sense given that most systems have little industrial demand and therefore an increase in one percentage causes a decrease in the other. As discussed on the first page, nearly 200 PCWS systems have less than 2 percent commercial lands (considered as minimal or no Commercial demand in the model). Finally, as shown in **Figure 4-9(c)**, Commercial demands perhaps have a relationship with the percentage of residential land (indicated as a hand-drawn orange line), though most results are clustered and there are three outliers to the upper right (NJ American-Delaware and Passaic Systems) and lower area (Newark).



(a)



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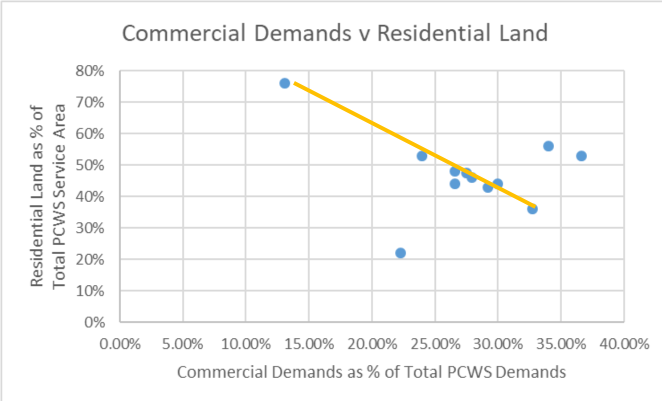

(c)

Figure 4-9. Generalized Relationship of Commercial Demands to: (a) Commercial Land Area, (b) Residential Demands, (c) Residential Land

Based on the available information, the modeling approach to Commercial demands is to apportion system water demand between Residential and Commercial demands at a ratio of 2.5:1 (the median for the case study systems), in systems where Commercial land area is more than 6 percent of the service area, and a ratio of 5:1 for less than 6 percent. This ratio would apply to the portion of water demand not assigned to Industrial demands and water losses.

Approach for Industrial Demands

1. Most PCWS systems have very little or no industrial land areas, and for those systems the industrial demand will be assumed as zero.
2. The case PCWS systems with more than negligible Industrial water demands have a relationship with industrial land area as shown in **Figure 4-10**. While there are few points for a statistical analysis, a correlation analysis generates a value of 0.907. A general relationship is hand-drawn to suggest a rough relationship between demands and land area as a percentage for the PCWS systems, from 1% demand at 2% land area, to Newark's value of 20% demand in 10% land area, indicating a 2.375% increase in industrial demand for every 1% increase in industrial land area, as shown in the following table. This relationship is used in the model as an approximation for systems that lack Industrial demand data and yet have greater than 2% Industrial land area, as shown in **Table 4-20**.

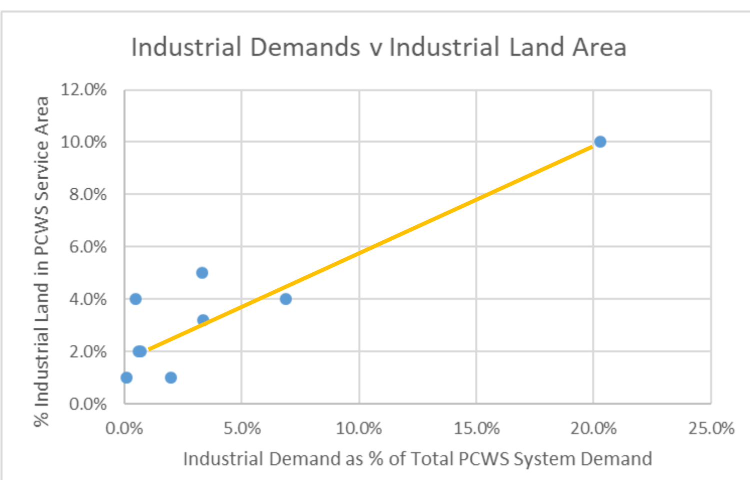

Figure 4-10. Generalized Relationship of Industrial Demands and Land Area

Table 4-20. Model Assumptions for Industrial Water Demands

Industrial Demand Extrapolations			
Demand	**Land Area**	**Demand**	**Land Area**
1.0%	2.0%	12.9%	7.0%
3.4%	3.0%	15.3%	8.0%
5.8%	4.0%	17.6%	9.0%
8.1%	5.0%	20.0%	10.0%
10.5%	6.0%		

Comparison of Model Estimates to Reported System Demands

The totals of water losses, residential demands, commercial demands and industrial demands for each PCWS system are then compared to the actual system water demands provided by NJDEP in the Water Supply Deficit/Surplus Analysis. This comparison allows for identification of systems where local conditions are significantly different from modeled results. Differences of roughly +/- 20 percent are to be expected given the assumptions and the use of datasets that were not developed for this purpose. However, in some cases the differences are quite large. **Table 4-21** provides a review of the resulting demands and differences for the systems comprising 80 percent of total PCWS system demands. Amounts highlighted in the last column indicate a large difference.

Table 4-21. Comparison of Model and Reported PCWS System Demands (Largest Systems)

PWSID #	County	Name	Baseline Model Demand (MGD)	Baseline-D/S Demand (MGD)	Baseline-D/S Demand (%)
102001	Atlantic	Atlantic City MUA	4.379	-7.193	-62.2%
119002	Atlantic	New Jersey American - Atlantic	11.229	-1.407	-11.1%
217001	Bergen	Fair Lawn Water Department	3.504	-0.282	-7.4%
238001	Bergen	Suez New Jersey - Haworth & Franklin Lakes (PWSID 022001)	106.756	-12.559	-10.5%
251001	Bergen	Ridgewood Water Department	9.151	1.005	12.3%
313001	Burlington	Evesham Township	3.835	-0.212	-5.2%
323001	Burlington	New Jersey American - Mount Holly	3.237	-0.842	-20.6%
324001	Burlington	Mount Laurel Township	4.465	-0.092	-2.0%
327001	Burlington	New Jersey American - Western Division	28.581	-2.290	-7.4%
408001	Camden	Camden City Water Department	10.033	-0.973	-8.8%
415002	Camden	Aqua New Jersey - Blackwood System	4.145	0.036	0.9%
424001	Camden	Merchantville Pennsauken Water Commission	5.248	-0.714	-12.0%
514001	Cape May	Wildwood City Water Department	2.300	-2.017	-46.7%
614003	Cumberland	Vineland City Water and Sewer Utility	5.713	-2.655	-31.7%
701001	Essex	Belleville Township Water Department	3.546	-0.259	-6.8%
702001	Essex	Bloomfield Water Department	8.353	0.921	12.4%
705001	Essex	East Orange Water Commission	9.442	2.075	28.2%
706001	Essex	Essex Fells Borough	0.308	-3.736	-92.4%
710001	Essex	Livingston Township Water Division	3.459	-0.604	-14.9%
712001	Essex	New Jersey American - Passaic Basin	37.047	-4.689	-11.2%
713001	Essex	Montclair Water Department	4.003	-1.510	-27.4%
714001	Essex	Newark Water Department	74.295	-10.458	-12.3%
818004	Gloucester	Washington Township	4.334	-0.362	-7.7%

PWSID #	County	Name	Baseline Model Demand (MGD)	Baseline-D/S Demand (MGD)	Baseline-D/S Demand (%)
901001	Hudson	Bayonne City Water Department	11.568	2.637	29.5%
905001	Hudson	Hoboken Water Services	4.905	0.249	5.4%
906001	Hudson	Jersey City MUA	38.668	-8.751	-18.5%
907001	Hudson	Kearny Town Water Department	7.109	-3.201	-31.1%
1103001	Mercer	Aqua New Jersey - Hamilton Square	3.037	-1.001	-24.8%
1111001	Mercer	Trenton Water Works	20.795	-5.978	-22.3%
1204001	Middlesex	East Brunswick Water Utility	4.994	-2.236	-30.9%
1205001	Middlesex	New Jersey American - Edison	8.476	2.590	44.0%
1209002	Middlesex	Old Bridge Township MUA	4.755	-4.341	-47.7%
1213002	Middlesex	Monroe Township Utility Department	3.131	-1.746	-35.8%
1214001	Middlesex	New Brunswick Water Department	15.930	-0.682	-4.1%
1215001	Middlesex	North Brunswick Water Department	6.504	1.083	20.0%
1216001	Middlesex	Perth Amboy Department of Municipal Utilities	8.541	2.546	42.5%
1219001	Middlesex	Sayreville Borough Water Department	3.658	-2.715	-42.6%
1221004	Middlesex	South Brunswick Township Water Company	4.501	-1.550	-25.6%
1225001	Middlesex	Middlesex Water Company	28.191	-23.954	-45.9%
1316001	Monmouth	Freehold Township Water Department	1.680	-2.559	-60.4%
1326001	Monmouth	Gordons Corner Water Company	4.198	-0.898	-17.6%
1328002	Monmouth	Marlboro Township MUA	2.958	-2.119	-41.7%
1339001	Monmouth	Shorelands Water Company	3.397	-1.683	-33.1%
1345001	Monmouth	New Jersey American - Coastal North	40.711	-6.858	-14.4%
1424001	Morris	Southeast Morris County MUA	7.359	-2.196	-23.0%
1429001	Morris	Parsippany - Troy Hills	5.935	-0.600	-9.2%
1506001	Ocean	Brick Township MUA	7.259	-2.493	-25.6%
1507005	Ocean	Suez Toms River	10.681	-1.523	-12.5%
1514002	Ocean	Lakewood Township MUA	2.936	-0.980	-25.0%
1605002	Passaic	Passaic Valley Water Commission	53.749	-48.166	-47.3%
1614001	Passaic	Wayne Township Division of Water	6.133	-1.664	-21.3%
1808001	Somerset	Franklin Township Department Public Works	5.617	-1.011	-15.3%
2004001	Union	Liberty Water Company	16.212	2.852	21.3%
2004002	Union	New Jersey American - Raritan System	107.302	-30.612	-22.2%
2013001	Union	Suez Rahway	5.374	0.059	1.1%

Possible issues for a few of the systems with larger differences are suggested here. Generic uncertainties associated with the model are addressed in the following section.

- **102001 Atlantic City MUA**: The Commercial demands are estimated based on other systems, but Atlantic City is unique in the high demands associated with casinos. In addition, the 2016 Annual Report from ACMUA indicates that NJ American Water-Atlantic System had been a bulk purchase customer of at least 1.5MGD through November 16, 2016. ACMUA reports 10.843 MGD average internal demand in 2016, of which 8.8486 MGD is billable, or 81.16%.
- **706001 Essex Fells Borough**: The NJDEP Depletive/Surplus Capacity analysis for this system notes a lack of sufficient information for assessment of the capacity, which makes it difficult to compare modeled results to actual demands.

- **901001 Bayonne City Water Department**: The modeled results here are unusual in that they overestimate demands, which may be associated with the very large estimated Industrial demand (4.694 MGD of a total demand of 11.568 MGD).
- **1111001 Trenton Water Works**: The water loss rate for Trenton is from 2008, among the oldest used in the analysis. However, even a doubling of the 14% water loss would be insufficient to match the D/S demands from NJDEP. An underestimation of Commercial and Industrial uses is possible, as Trenton Water Works serves both the city and surrounding municipalities.
- **2004002 New Jersey American - Raritan System**: NJDEP lists the highest annual demand as 137.913 MGD, but New Jersey American indicates that this system has roughly 102 MGD in metered sales and non-revenue water, with the remainder to Passaic system, bulk sales. The model results closely match the 102 MGD value.

Sources of Uncertainty for Baseline Water Demand

As discussed in the prior sections, there are many sources of uncertainty in the identification of appropriate values for application to systems for which data are not available. These uncertainties are summarized here by demand category.

- **Residential Demands**: Residential demands are based on population as derived through the dasymetric analysis, and per capita demand information derived from the case PCWS systems. As discussed in Sources of Population Uncertainty, the dasymetric analysis relies heavily on the NJDEP 2012 Land Use Land Cover dataset, which characterizes residential development in broad classes with ranges of housing densities. The dasymetric analysis therefore has inherent uncertainties, and these uncertainties are transmitted through to the per capita residential demands, especially for the smaller systems, because population is the denominator in calculating per capita demands. These per capita demand values are then used as surrogate demand estimates for PCWS systems that were not case studies, introducing another uncertainty in that the target systems inevitably will be different from the case study systems. In addition, per capita demand values could not be developed for some categories of development, and so values from other categories were used in their place. Despite these limitations, the results are far more appropriate and relevant than using a single, statewide per capita value for residential demands. Just having information on the differences between high, medium and low density residential per capita uses, and between summer and non-summer uses, is a valuable step forward.
- **Commercial and Industrial Demands**: As discussed in Commercial and Industrial Demands, there are many inherent uncertainties regarding commercial and industrial demands. In total, these uncertainties are likely to be a major factor in discrepancies between model and actual demands. Except where demands were provided by case PCWS systems, the commercial and industrial demands were based on the proportion of these land uses within a service area, but the water intensity of these customers can vary widely. This variation is perhaps most significant for industrial demands, as some industries are very water intensive while others are not. However, few PCWS systems have significant concentrations of industrial lands. Commercial demands can vary widely also, such as between a one-story retail store and a high-rise office building. Both may have the same land area but the demands will differ greatly. Unfortunately, there seems to be no pattern in the difference between modeled and actual (per the NJDEP Water Supply Deficit/Surplus

Capacity Analysis) water demands, on one hand, and the percent commercial land area, on the other. **Figure 4-11** is a simple scattergram showing this relationship. The model overestimates and underestimates demands roughly equally across all ranges of commercial land density, with perhaps more of a tendency to underestimate. However, this pattern does not provide the basis for a modified equation that would correct for the differences.

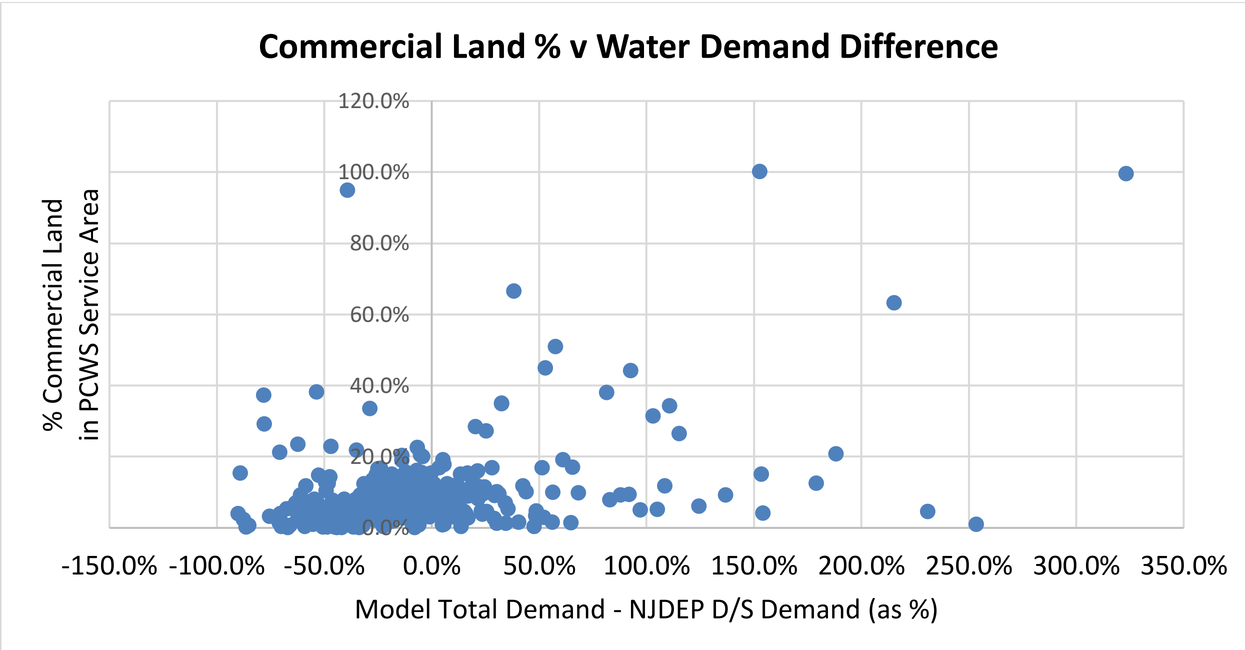

Figure 4-11. Comparison of Demand Differences to Commercial Land Areas

- **Water Losses**: Water loss information was available for 228 of the 584 PCWS systems (39%), many of which are large or medium systems. However, water loss information is missing for most systems including several major and many minor systems, and the estimates provided are from two different protocols. For the 61 percent of systems without water loss estimates, regional median results from the available information were used. There is no way to know the extent to which these applied values are appropriate for each system, and therefore water losses can be a major source of error in the model. In addition, water loss rates change from year to year, depending on the improvement or decline of delivery infrastructure and the level and pattern of demands. The model uses a single water loss rate for each system, which introduces additional uncertainty into the water loss estimates.
- **Comparison to Reported Current Demands**: Another source of uncertainty in the model is the current system demand used. NJDEP's Water Supply Deficit/Surplus Analysis data base provides the highest annual, monthly and daily demands for each PCWS system in the previous five calendar years. This report uses the annual demands as an appropriate comparison to annual demands calculated in the model. However, peak years can have a variety of causes, from a major but temporary water loss problem to a dry year without drought restrictions, and may or may not represent the most appropriate base year for demand evaluations. Other options include a multi-year average such as the NJ Water Tracking database, which was also used, or the highest non-drought year. However, various systems have different attributes, and so the selection of a reasonable base year may be different for each system. The Water Supply Deficit/Surplus Analysis results were selected

for simplicity of analysis and completeness of the database, with the NJWaTr database as an auxiliary point of comparison.

Uncertainties of this type can be overcome by more complete information, but achieving this completeness has a significant expense. As for all modeling, some level of uncertainty is accepted as a necessary aspect of the process. For water resources planning, the water demand projections serve as a means of identifying potential concerns regarding whether future demands can be met by existing or anticipated supplies without unacceptable environmental, social and economic risks. Where concerns are raised, more detailed information can be developed to address the specific issue. This approach is far more cost-effective than trying to achieve a high degree of accuracy in the statewide model.

5. Water Demand Projections

This chapter provides the methodology and results regarding water demand projections to the year 2040. Uncertainty is inherent in projections, especially over extended periods as for this project. Therefore, scenarios are used for water demand trends, and are linked with the population trend scenarios discussed previously. It is recognized that each utility service area will have unique issues, some of which can be assessed within a study of this sort but some of which cannot, either because the issues are not yet manifest or because insufficient information is available to determine the net effects of these issues. The results of this study are useful for long-term planning purposes but should not be used as the sole basis for long-term capital projects to supply additional water, where such needs are indicated. Rather, any major capital projects should be based on a more detailed analysis to amplify on the results of this study. A literature survey was developed in support of this project to indicate demand trends (past and projected) and demand projection methods and models.

Water Demand Trends

According to NJGWS studies, New Jersey's total annual average potable water demands have stayed essentially flat since 1990 while the population has increased by 15 percent. However, consumptive water uses per capita appear to have increased slightly (though apparently not strongly enough to be statistically significant), indicating a shift in relative demand from indoor to outdoor uses. The question is how to plan for future residential water demands. The target year of 2040 is over 22 years from now, which is approximately one human generation and multiple generations regarding some types of plumbing fixtures and most appliances.

During this period, many homes and commercial buildings will be extensively modified, and industrial water demands may go through fundamental changes. Water demand rates are expected to shift significantly. Modeling approaches for future water demands vary widely, ranging from single-utility models for relatively short timeframes (e.g., 5 to 10 years), to multi-system models for long-range planning. Some rely on very simple equations while others use more complex techniques such as artificial neural network analysis or multiple regression. This project recognizes that all long-range models have considerable uncertainty and therefore that a multi-scenario approach to planning provides more useful information, as suggested by Dziegielewski and Chowdhury (2012).

The implementation of water conservation and efficiency measures must be considered in this study. In general, conservation is a result of user behaviors, while efficiency is a result of new technology. National and international trends and examples for water demands are useful in helping to examine recent New Jersey trends and possible scenarios. Information is provided below regarding the literature survey, New Jersey's current water conservation requirements, New Jersey overall demand trends and issues regarding water losses. The following section then provides the scenarios used for demand trends in this study. The final section provides results for the largest 37 systems which meet 80 percent of all PCWS customer demands.

Literature Survey for Residential Demands

The literature is replete with examples of water utilities that have experienced declining per capita demands. Some utilities have achieved a reduction in total demands despite major population increases (Goodyear, 2014; Johnson Foundation at Wingspread, 2012), and nationally the per capita use declined roughly 20% from 1980 to 2000 (Gleick, 2003; Hughes et al., 2014). Other utilities with a more stable or even declining customer base are seeing net reductions in demands (Black & Veatch, 2016; CDM, 2010; Coomes, et al., 2009).

Discussion in the literature for this country suggests a minimum water demand rate of roughly 35 gpcd for indoor uses, reflecting the full use of current water-efficient technology and water conservation behaviors. The British Code for new homes targets 33 gpcd (125 liters per capita per day) with even less for various types of "sustainable homes", down to a low of 21 gpcd (80 lpcd) (UKDCLG, 2009). Vickers et al. (2013) suggest that "50 gpcd can often be a realistic goal and water efficiency benchmark for many given current plumbing, appliance, and landscape water conservation standards and practices." Note that this value of 50 gpcd is a high-efficiency scenario that includes outdoor water demands, not just indoor demands. They further suggest that most conservation will be possible in households with the highest per capita demands, which makes implicit sense.

Outdoor water uses for low and medium density development may increase as summer average and peak temperatures increase through global warming (Arbues et al 2002; Corbella and Pujol 2009), to address increased soil moisture deficits caused by the rising temperatures (Dawadi and Ahmad 2013; Dziegielewski and Chowdhury 2012). These increased needs may overcome potential improvements in lawn irrigation practices. Therefore, where the current ratio of Summer to Non-Summer use is lower than the statewide median for low and medium density development, Summer use may increase toward the median ratio. The projected Summer uses for high density development are less likely to change from current levels, as they have limited outdoor uses (Rockaway et al. 2011) and minimal differences between Summer and Non-Summer demands.

Increased water use efficiency and routine water conservation behavior for both indoor and outdoor demands is likely; that is, reductions in demand through improved plumbing fixtures, appliances and lawn irrigation systems along with day-to-day water conservation behavior that limit wasteful water use. Drought conservation behaviors are <u>not</u> included in the assumptions. We can assume an ongoing replacement of old plumbing fixtures, appliances and irrigation systems with new units that meet or improve upon current federal and state requirements, WaterSense and Energy Star standards, etc. These trends are ongoing, as noted for Rockland County (Black & Veatch 2016), where demands have declined from 70 gpcd in 2000 to roughly 57 gpcd in 2014; market penetration of efficient plumbing fixtures and appliances varied considerably, from roughly 75 percent for low-flow faucets to roughly 25 percent for high-efficiency clothes washers.

Recent trends will drive the most probable scenario toward the conservation scenario. Water rates (and sewer rates) have been increasing faster than the Consumer Price Index for many years (Beecher and Chestnutt 2012). Demands are relatively inelastic relative to price, but there still is some elasticity (Alliance for Water Efficiency 2014; Arbues et al 2002). Water price elasticity suggests a long-term impact of roughly -0.4 (i.e., a 4 percent reduction in response to a 10 percent price increase), though lower elasticities exist for low-income households, as they already tend to have low water demands (and will be concentrated in high-density portions of water service areas), and very high incomes may show little or no response because water costs are such a small part of their household budget (Corbella and Pujol 2009; Dawadi and Ahmad 2013; Grafton et al. 2011; Polebitski and Palmer, 2010; Seattle Public Utilities 2013; Whitcomb 2005). Since the Great Recession, new housing in already-developed areas has significantly exceeded development in suburban and exurban "green field" locations. Evans (2016) notes that "Places that are at least 90 percent built-out accounted for a full two-thirds of statewide population growth (66.4 percent) from 2008 to 2015, after having accounted for only 3.6 percent of statewide growth from 2000 to 2008." Water use technology has been and is likely to continue improving, though perhaps not at the same rate of improvement as in the past decades (Rockaway et al. 2011). Finally, existing housing is aging and so retrofit projects will continue to result in the use of new technology.

New Jersey Water Conservation Requirements

New Jersey implements the federal Energy Policy Act requirements for indoor water fixtures:

- Toilets: 1.6 gallons per flush (gpf)
- Urinals: 1.0 gpf
- Showerheads: 2.5 gallons per minute (gpm) at 80 pounds per square inch of water pressure (psi); 2.2 gpm at 60 psi
- Faucets: 2.5 gpm at 80 psi; 2.2 gpm at 60 psi

In addition, New Jersey law at N.J.S.A. 52:27D-123.13 requires that new automatic lawn sprinkler systems "shall be equipped with an automatic rain sensor device or switch that will override the irrigation cycle of the automatic lawn sprinkler system when adequate rainfall has occurred."

The Water Supply Allocation Rules at N.J.A.C. 7:19-6.4 includes a threshold of 15% "unaccounted for water" (UAW) which is defined simply as water that is withdrawn from a water supply source and not measured as being delivered to a customer. This definition lacks the precision of real and apparent water losses as discussed in the Non-Revenue Water and Water Losses section of this report. Under this rule, those purveyors serving a population of more than 500 persons that have the highest levels of UAW are considered "provisionally delinquent" and must take corrective action to eliminate leaks and other UAW, with an annual review. This approach may be changed in response to the Water Quality Accountability Act of 2017.

The Water Supply Allocation Rules at N.J.A.C. 7:19-6.5 require that all PCWS systems submit a Water Conservation and Drought Management Plan with each water allocation permit renewal or major modification, mostly aimed at water conservation during dry and drought periods, but also including leak reduction programs and water rate structures that provide incentives for water conservation. There are no specific standards against which these plans are measured. Given that permit renewals are now every 10 years, the Water Conservation and Drought Management Plans can easily be outdated by the time of renewal, if no major modification is sought in the interim.

New Jersey Water Demand Trends

According to NJGWS studies, New Jersey's average water demands have stayed essentially flat since 1990 (see **Figure 5-1**) while the population has increased by 15 percent. However, consumptive water uses have apparently increased (see **Figure 5-2**), indicating a possible shift in relative demand from indoor to outdoor uses.

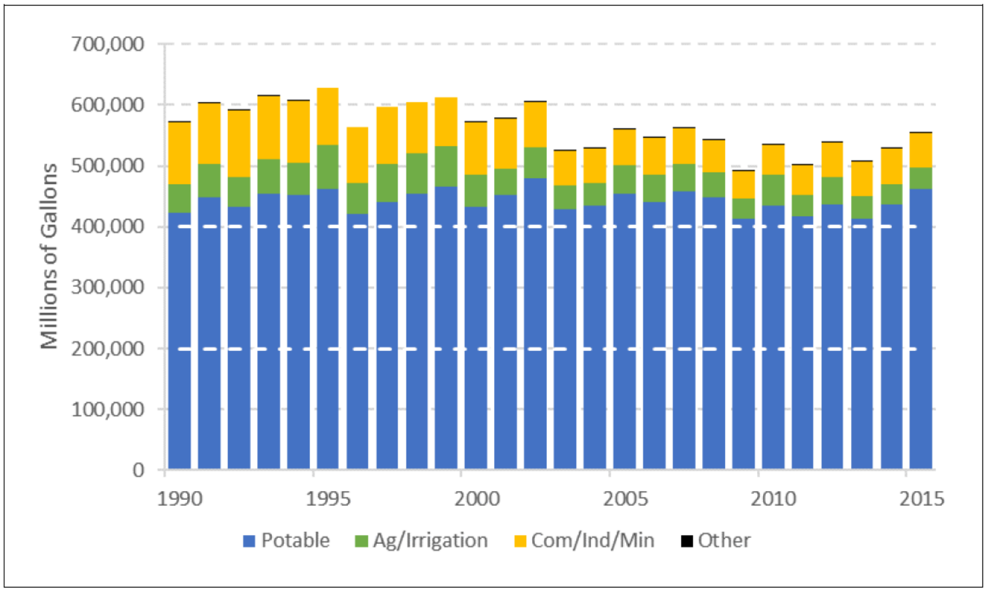

***Figure 5-1*. New Jersey Water Demands by Use Sector, 1990 to 2015, Excluding Power Generation (from New Jersey Water Supply Plan 2017-2022, Figure 2.3)**

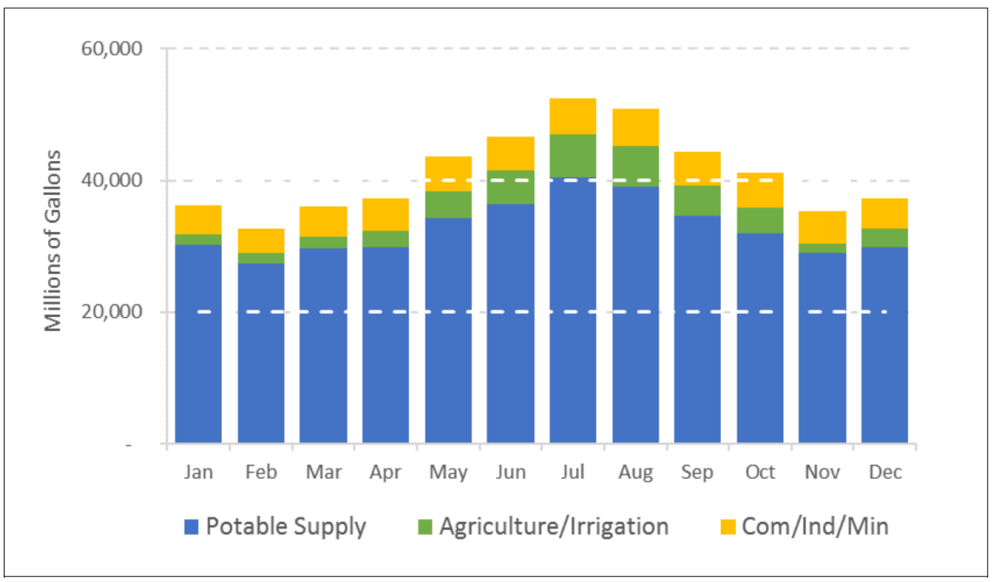

Figure 5-2. New Jersey Consumptive Water Losses 1990 to 2011 by Use Sector, 1990 to 2015, Excluding Power Generation
(from New Jersey Water Supply Plan 2017-2022, Figure 2.6)

The question is how to plan for future residential water demands. The target year of 2040 is over 22 years from now, which is an entire human generation, less than a generation regarding housing stock, but multiple generations regarding some types of plumbing fixtures and all appliances. Therefore, water demand rates are expected to shift significantly.

Another factor is the rate of water losses. As seen in **Figure 5-3**, below, New Jersey's population grew most quickly during the periods from:

- 1890-1930 – a time of mostly urban and inner-ring suburban growth when cast iron pipes were commonly used for water supply mains; and

- 1950-1970 – a time when nearly the urban areas that grew extensively in prior periods lost roughly 700,000 residents to the outer suburban areas (see **Figure 5-4** for an example of Newark), for a total suburban and exurban growth of roughly 3 million.

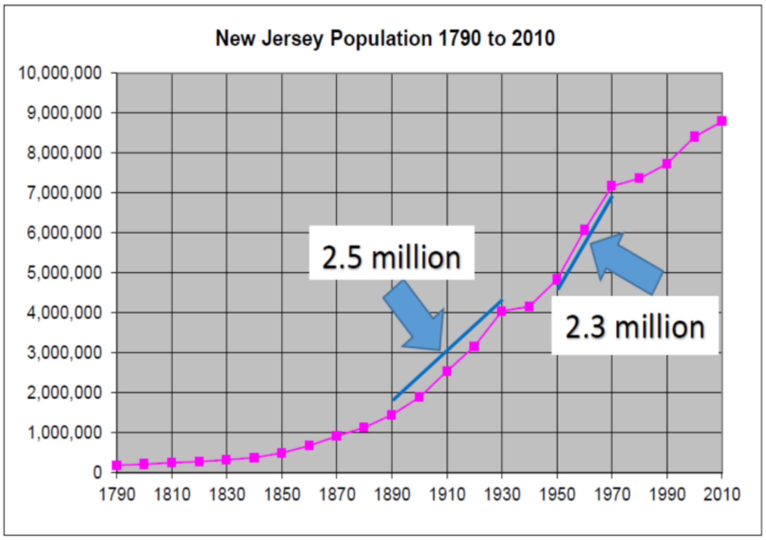

Figure 5-3. New Jersey Population and Major Growth Periods

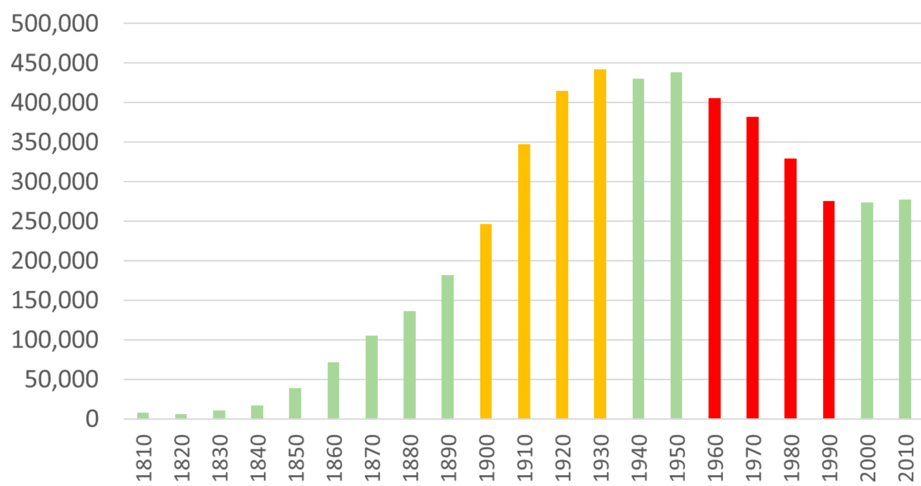

Figure 5-4. Newark Population and Major Growth and Loss Periods (orange for pre-war growth and red for post-war decline)

These population surges mark times when significant new water infrastructure was created. The water mains from both the early 1900s era of urban growth and the post-war suburbanization period are at or beyond their anticipated average lifespan, based on estimates from the American Water Works Association (AWWA 2012), as shown in **Figure 5-5**. **Figure 5-6** provides an indication of housing unit age, where all areas in red (69% of all New Jersey housing, according to the American Community Survey) have an average house construction date of before 1990.

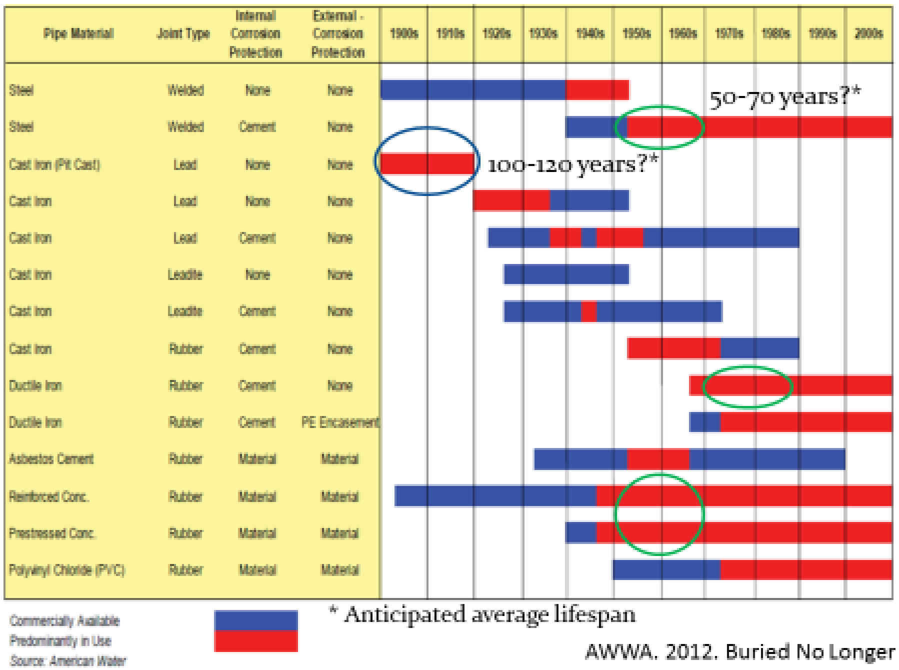

Figure 5-5. Historic Production and Use of Water Pipe by Material, With Selected Estimated Ages (adapted from AWWA, 2012)

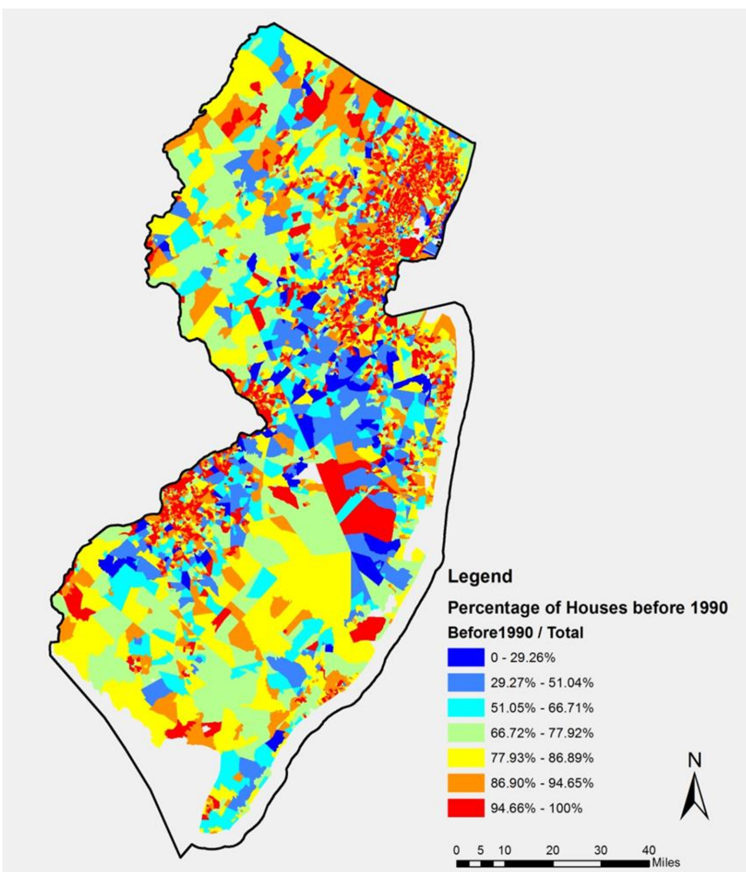

Figure 5-6. Percentage of Houses Built Prior to 1990 by Census Block (data from American Community Survey, U.S. Bureau of the Census)

Table 5-1 provide the median results for residential demands in the case study PCWS systems, which have considerable variation around the medians. The section on Residential Annual Average, Non-growing Season and Growing Season Demands provides detailed results. Given the large differences between utility service area sizes, use of the weighted average demands is more appropriate for use in modeling work.

Table 5-1. Residential Water Demands for Case PCWS Systems

Metric	Density	Median (gpcd)	Weighted Average (gpcd)
Average Annual Per Capita Per Day	high	41.67	49.89
	medium	53.51	60.79
	low	75.31	87.10
Total Summer Use Per Capita Per Day	high	45.32	52.96
	medium	67.26	78.23
	low	88.14	128.51
Average Non-Summer Use Per Capita Per Day	high	39.10	46.23
	medium	49.62	52.09
	low	58.42	62.93
Ratio of Summer Use to Non-Summer Use (Per Capita Per Day)	high	1.10	1.15
	medium	1.31	1.50
	low	1.32	2.04

Water Demand Trend Scenarios

Water demands will be affected by trends in several components of demand and delivered water. Residential demands are likely to change, and will change in different ways depending on current demands, housing type, landscaping trends, location within the state, and so on. Commercial demands shifted greatly over the last few decades with office complex development and the growth of big-box stores, and now will be changing again with redevelopment of office campuses and a shift to online retail sales. Industrial demands have also changed with a reduction in manufacturing sites and a reduction in water-intensive industries. Finally, water losses are an increasing focus of regulation and practice, and will be affected by the 2017 passage of the Water Quality Accountability Act that requires asset management programs for water purveyors. This section addresses the demand scenarios for these components.

Residential Demand Scenarios

This report uses a two-scenario approach. The first scenario involves no change in current per capita annual, Summer and Non-Summer demands. Where population increases, water demands would be projected to increase proportionally, and vice versa. Therefore, the scenario uses water demand rates appropriate to each area's development density, geographic location, housing age, topography and precipitation quintile.

The second scenario assumes increased water use efficiency and routine water conservation behavior for both indoor and outdoor demands; that is, reductions in demand through improved plumbing fixtures, appliances and lawn irrigation systems along with day-to-day water conservation behavior that limits wasteful water use. Drought conservation behaviors are not included in the assumptions. This scenario will assume an ongoing replacement of old plumbing fixtures, appliances and irrigation systems with new units that meet or improve upon current federal and state requirements, WaterSense and Energy Star standards, etc.

This scenario assumes that indoor per capita demands will trend toward but not go below 35 gpcd. The more that current demand rates exceed 50 gpcd, the more demands will be assumed to decline by 2040. Areas with existing rates near the minimum rate will be assumed to decline minimally. No change will be projected where existing rates are already below the 35 gpcd rate. In summary, the two scenarios are as follows:

1. Static Per Capita Demands
Annual, Summer and Non-Summer per capita demands are assumed to not change. Baseline demand rates are as calculated (for systems that provided data for the case studies) or extrapolated (for all other systems). Multiply population change (positive and negative) by baseline demand rates and add or subtract from existing demands.

2. Conservation Scenario
Assume that 2040 per capita indoor and outdoor residential water demands reflect reductions in demands due to water-efficiency technology and standard water conservation behaviors. Annual, Summer and Non-Summer demands all will be calculated as declining to the weighted averages in **Table 5-2**, where current levels are higher.

Table 5-2. Weighted Average Residential Demands and Seasonal Ratios

Metric	Residential Density	Weighted Average (gpcd)	Metric	Residential Density	Weighted Average (gpcd)
Average Annual Per Capita Per Day	high	49.89	Average Non-Summer Use Per Capita Per Day	high	46.23
	medium	60.79		medium	52.09
	low	87.10		low	62.93
Total Summer Use Per Capita Per Day	high	52.96	Ratio of Summer Use to Non-Summer Use (Per Capita Per Day)	high	1.15
	medium	78.23		medium	1.50
	low	128.51		low	2.04

Where current demands are lower than the current weighted average, they will be reduced by 5 percent over the projection period, but not below 35 gpcd, while per capita demands at or below 35 gpcd will be assumed to remain stable. The values used in this scenario are key assumptions. There is no "magic number" for either value, as we cannot predict with any certainty the technology of water use efficiency or its penetration into the market, especially given the advent of "smart technology" for the home that could allow for micromanagement of home appliances.

These rules will be applied directly to the calculated residential demands for the case PCWS systems. For all other systems, the results for the two scenarios are provided in **Table 5-3**.

Table 5-3. 2040 Residential Demand Scenarios

	2010 and 2040 Static			2040 – Conservation		
Residential Density	**CP**	**PM**	**HL**	**CP**	**PM**	**HL**
High Density (HD) Annual	47.92	58.46	42.04	45.52	49.89	39.94
Medium Density (MD) Annual	59.04	61.2	53.52	56.09	60.79	50.84
Low Density (LD) Annual	93.27	73.95	61.09	87.10	70.25	58.04
High Density (HD) Summer	53.49	62.61	42.47	52.96	52.96	40.35
Medium Density (MD) Summer	75.88	76.62	59.42	72.09	72.79	56.45
Low Density (LD) Summer	141.05	108.92	81.75	128.51	103.47	77.66
High Density (HD) Non-Summer	45.13	56.27	41.82	42.87	46.23	39.73
Medium Density (MD) Non-Summer	50.59	53.17	50.62	48.06	52.09	48.09
Low Density (LD) Non-Summer	69.36	56.61	50.84	62.93	53.78	48.30

* CP=Coastal Plain; PM=Piedmont; HL=Highlands/Ridge & Valley

Commercial and Industrial Demands

As with Residential demands, two scenarios are used in the model for 2040 Commercial demands. Commercial demands are assumed to track residential demands over time, as business development is dependent upon a population base that provides both workers and consumers. Therefore, the 2040 No Conservation scenarios will change Commercial demands from their 2010 estimates in proportion with population changes, either higher or lower. However, conservation measures will also affect commercial demands. The 2040 Conservation scenarios will assume a ten percent reduction in Commercial demands due to conservation.

Industrial demands are assumed to be flat through the entire period. It is more likely that industrial demands will decrease over time due to continued water conservation, process changes and the loss of manufacturing capacity in the state. However, there is no method available to project such demand changes either statewide or by PCWS system. The following 21 PCWS systems have over 640 acres (one square mile) of industrial land use (**Table 5-4**), where significant demand changes would likely have a much larger impact on total demands. There are 60 systems with over 200 acres of industrial land.

Table 5-4: PCWS Systems with Major Industrial Land Uses

PWSID #	County	PCWS System Name	Industrial Land (ac)	Percent Industrial
2004002	Union	New Jersey American Water Company - Raritan System	7325.4	3.8%
238001	Bergen	Suez New Jersey - Haworth & Franklin Lakes (PWSID 022001)	4033.7	4.4%
1302001	Monmouth	Allentown Water Department	3674.1	10.2%
714001	Essex	Newark Water Department	2061.8	10.0%
327001	Burlington	New Jersey American Water Company - Delaware Division	1749.7	3.2%
1221004	Middlesex	South Brunswick Township Water Company	1668.0	6.6%
1605002	Passaic	Passaic Valley Water Commission	1565.1	10.3%
820001	Gloucester	West Deptford Township Water Department	1133.1	9.8%
1111001	Mercer	Trenton Water Works	1132.3	3.3%
1345001	Monmouth	New Jersey American Water Company - Coastal North	999.5	1.1%
424001	Camden	Merchantville Pennsauken Water Commission	961.1	9.7%
1205001	Middlesex	New Jersey American Water Company - Edison	957.0	24.2%
906001	Hudson	Jersey City MUA	947.5	9.7%
614003	Cumberland	Vineland City Water and Sewer Utility	914.5	4.1%
901001	Hudson	Bayonne City Water Department	881.5	23.7%
1808001	Somerset	Franklin Township Department Public Works	743.7	2.5%
1216001	Middlesex	Perth Amboy Department of Municipal Utilities	729.5	23.9%
809002	Gloucester	New Jersey American Water Company - Logan System	689.1	18.6%
707001	Essex	Fairfield Township Water Department	683.7	16.9%
2004001	Union	Liberty Water Company	668.9	12.8%
907001	Hudson	Kearny Town Water Department	653.1	13.3%

Water Loss Projections

Too many variables exist to authoritatively project water loss rates decades into the future. Instead, the 2040 demands model will use two scenarios. One is that all systems achieve the current median values shown in **Figure 5-7**, as listed in **Table 5-5** below. The other is that systems achieve water loss rates roughly equivalent to the better systems, based on recent reporting. The two box and whisker plot sets reflect the current water loss rates for all reporting systems, as previously shown in the section on Non-Revenue Water and Water Losses.

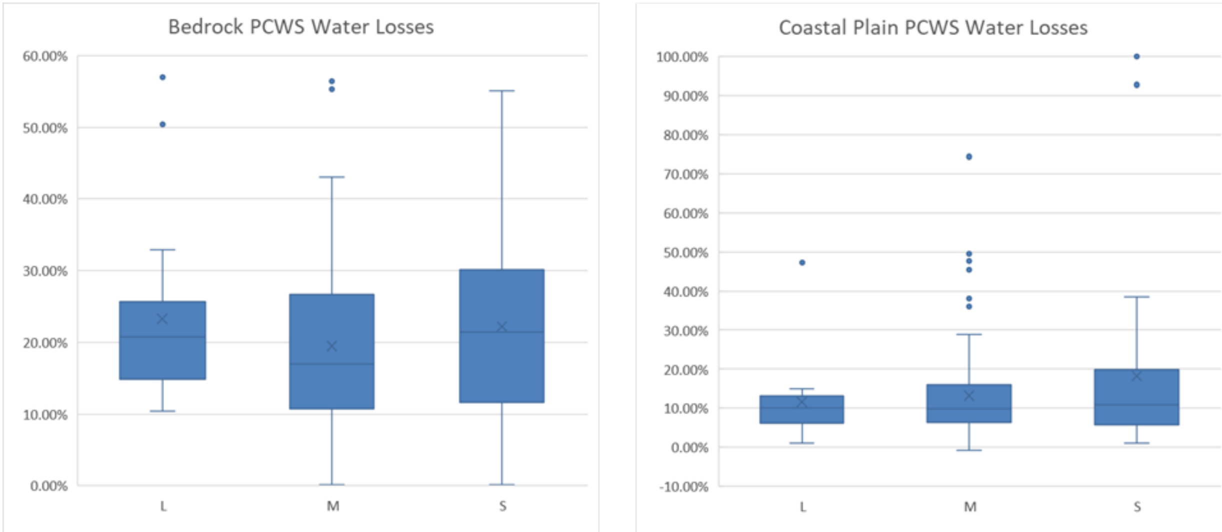

Figure 5-7. Water Losses for PCWS Systems (Box and Whisker Plots)

The bedrock systems (Piedmont, Highlands, Valley & Ridge) show far more variability than the coastal plain systems. While the 25th percentile values vary somewhat within each group, they are still generally at 11-15 percent for bedrock systems and 5-7 percent for coastal plain. Based on these results, the second scenario will use an "Optimum System" approach of 15 percent for bedrock systems and 5 percent for coastal plain systems. A critical point here is that the water losses are based on the most recent reported values of non-revenue water or unaccounted-for water, while the demands are based on multi-year averages. As pointed out in prior sections, in actual practice water loss rates change from year to year, but the pattern cannot be known for the future in so many systems. Therefore, the model uses a single value, and therefore water loss estimates should be considered general estimates, incorporating substantial uncertainty.

Table 5-5. Water Loss Scenarios for 2040 Demands

Category	**Nominal 2040 Water Losses**	**"Optimum System" 2040 Water Losses**
Large Systems-Bedrock Geology	20%	15%
Large Systems-Coastal Geology	10%	5%
Medium Systems-Bedrock Geology	20%	15%
Medium Systems-Coastal Geology	10%	5%
Small Systems-Bedrock Geology	22%	15%
Small Systems-Coastal Geology	13%	5%

Application of 2040 Population Forecasts to PCWS Service Areas

PCWS systems often do not serve all of one municipality, or just one municipality. Therefore, municipal population projections are not synonymous with PCWS service area population projections. The creation of a model for projections PCWS water demands to 2040 required several steps:

1. Determine the portion of each municipality and Census block that is not currently developed or environmentally constrained (e.g., preserved lands, wetlands, flood plains). For entirely developed municipalities, it is assumed that all population growth will be through increased density of existing residential areas and through redevelopment of other developed areas.

2. Using the dasymetric analysis and PCWS service areas, determine the portion of each municipality's 2010 population that is associated with each PCWS system serving that municipality, and also the portion of the municipal population that is not associated with a PCWS system.
3. Ascribe municipal population changes through 2040 to each PCWS system serving the municipality, using population proportions from the 2010 evaluation for High and Medium density residential development. No new population was assigned to Low density development unless the service area was essentially all in that classification. The assumption is that new development will occur in somewhat to much denser forms, based on the increasingly limited land area in New Jersey for low density development, the increase in development within developed areas, the need for density regarding affordable housing requirements, and general needs for density to meet development profitability objectives.
4. Aggregate the population changes for each PCWS system. Multiple scenarios will be used, based on different assumptions regarding population trends.

As a check on the results of this analysis, the 2010 and projected 2040 municipal populations were compared to all PCWS systems with 2010 populations of 2,000 or more, where the PCWS system provided service to all or most of one municipality or a defined set of municipalities, making the population comparisons feasible. In all cases, the populations matched well in both years. As discussed in the section on PCWS Service Areas, Populations and Land Use, and particularly Sources of Population Uncertainty, greater discrepancies between actual and dasymetric populations are likely as service area sized diminish.

2040 Water Demands by PCWS

This report uses multiple scenarios in sets of two.

Table 5-6. 2040 Water Demand Scenarios

	Demand Scenario	Water Losses
	Direct Extrapolation Scenarios (Set 1)	
Scenario 1	Population Percent Change X Water Supply Deficit/Surplus Analysis (Current Peak Demands) with no change to other factors	
Scenario 2	Population Percent Change X NJWaTr database (Current Average Demands) with no change to other factors	
	No Conservation Scenarios (Set 2)	
Scenario 3	Modeled Demand with Constant Per Capita	Current State Median
Scenario 4	Modeled Demand with Constant Per Capita	Current 25th Percentile
	Conservation Scenarios (Set 3)	
Scenario 5	Modeled Demand with Decrease Per Capita	Current State Median
Scenario 6	Modeled Demand with Decrease Per Capita	Current 25th Percentile
	No Conservation Extrapolation Scenarios (Set 4)	
Scenario 7	Current Peak Demands X Percent Change (2010-2040) from Scenario 3	Current State Median
Scenario 8	Current Peak Demands X Percent Change (2010-2040) from Scenario 4	Current 25th Percentile
Scenario 9	Current Average Demands X Percent Change from Scenario 3	Current State Median

Scenario 10	Current Average Demands X Percent Change from Scenario 4	Current 25th Percentile
	Conservation Extrapolation Scenarios (Set 5)	
Scenario 11	Current Peak Demands X Percent Change (2010-2040) from Scenario 5	Current State Median
Scenario 12	Current Peak Demands X Percent Change (2010-2040) from Scenario 6	Current 25th Percentile
Scenario 13	Current Average Demands X Percent Change (2010-2040) from Scenario 5	Current State Median
Scenario 14	Current Average Demands X Percent Change (2010-2040) from Scenario 6	Current 25th Percentile

Set 1 (scenarios 1 and 2) assumes that annual demands will change in direct proportion to population changes, i.e., that a 5 percent increase in population will drive a 5 percent increase in total demands. This is the most simplistic approach and unlikely to be accurate over a 20-plus year period. The scenarios extrapolate from the current peak annual system demands (from the NJDEP Water Supply Deficit/Surplus Analysis) and average annual system demands (from the NJDEP NJ Water Tracking, or NJWaTr, data set).

Set 2 (Scenarios 3 and 4), called the No Conservation Scenarios, applies the water demand model described in the section Extrapolation to Other PCWS Systems. The model assumptions regarding per capita residential demand rates (gpcd) are from **Table 5-3** as applied to the 2010 and 2040 population to generate residential demands, thus assuming the per capita rates do not change. The scenarios use water demand rates appropriate to each area's development density (High, Medium, Low) and geographic location (Coastal Plain, Piedmont, Highlands/Valley & Ridge). Three other factors – housing age, topography and precipitation quintile – were not used, as insufficient demand data were available to assess their effects on residential demands. Commercial demands are assumed to vary with residential demands (and, therefore, population), while industrial demands are assumed to remain stable. However, 2040 water losses are assumed to be either the current median water loss (Nominal Rate, Scenario 3) or a more aggressive Optimum Rate (Scenario 4) for the relevant purveyor group size (Large, Medium, Small) and service area geology (Bedrock, Coastal Plain).

Set 3 (Scenarios 5 and 6), called the 2040 Conservation Scenarios, is similar to the second, but assumes that higher-than-weighted-average residential rates will decline over time, as discussed in the section on Residential Demand Scenarios. Commercial and industrial demands and water losses are treated in a manner to Scenarios 3 and 4.

Set 4 (Scenarios 7 through 10) uses the percentage (not absolute) changes in demands from 2010 to 2040 from Scenarios 3 and 4 (No Conservation) to extrapolate from the known peak annual system demands (from the NJDEP Water Supply Deficit/Surplus Analysis, Scenarios 7 and 8) and average annual system demands (from the NJDEP NJ Water Tracking, or NJWaTr, data set, Scenarios 9 and 10). This approach is different from the first set of scenarios in that the percent changes are in modeled demands, not population, and therefore reflect more realistic expectations regarding water conservation and efficiencies. Each pair of scenarios tests the effects of the two water loss options.

Set 5 (Scenarios 11 through 14) again uses percentage changes in demands from 2010 to 2040, but this time from the Conservation Scenarios 5 and 6, in the same manner as the fourth set.

As noted, Set 1 is simplistic and unlikely to be realistic. It can be used as a marker for higher demands than are likely to occur. Sets 2 and 3 have more realistic expectations for changes in residential and commercial demands, and for improvements in water losses, but are constrained by assumptions made regarding residential, commercial and industrial demands. In many cases, these assumptions have resulted in estimated 2010 demands that match neither peak nor average total system demands. Therefore, the model demands are more valuable as indicators for the direction and magnitude of water demand changes than of the actual demands themselves.

Set 4 combines the strength of a known starting point (either peak or average total system demands). Set 4, however, assumes no change in per capita residential demands, an assumption worth testing but at odds with national experience, ongoing improvements in household appliances and water fixtures, applicable water conservation laws, and energy costs. Set 5 provides a more nuanced evaluation of changing residential and commercial demand rates and the potential for savings from water losses. **As such, the Set 5 scenarios are recommended for planning use**, with the second and third sets being useful to understand the basis for changing system demands from 2010 to 2040. While the absolute values in the second and third sets may not be correct, the pattern of changes is generally defensible.

The scenarios do not incorporate possible shifts in population projections as discussed in the section Evaluation of Sensitivity to Variations in Critical Variables, but rather use the Metropolitan Planning Organization projections as discussed in Statewide and Regional Population Projections. Alterations in population trends (i.e., fertility, mortality, migration) may affect water demands in specific PCWS systems, but there is no mechanism available for this project to assess such population changes at the PCWS service area level. Further, the uncertainties regarding population are in most cases likely to be less than the uncertainties regarding water demands, especially regarding water loss rates. Therefore, individual PCWS systems and those managing water supplies on a regional or statewide basis should be aware of the implications for population trends, and periodically track them.

Recommended Projections from Current Demands

Table 5-7 on provides the results of the Set 5 scenarios for the 37 PCWS systems that provided 80 percent of total average PCWS demands (NJWaTr database)during the period 2008-2015. The results for all 584 systems is provided on a separate MS-Excel spreadsheet, 'NJDEP 2040 Demands Model 2017.10.xlsx'. This set of scenarios is recommended for use in further planning work within the NJ Statewide Water Supply Plan.

For the 37 largest systems, the total of all recent peak demands from the Water Supply Deficit/Surplus analysis is 919.229 MGD, of a total for all systems of 1238.906 MGD. It is important to recognize that the peak years can differ among the systems, occurring any time from 2012 through 2016, and as of the close of 2017 the year 2012 peaks will drop from the analysis and 2017 will be added.

For the 37 largest systems, the total of all 2008-2015 average demands was 702.879 MGD, of a total for all systems of 983.892 MGD. The average demands for all systems are 79.4 percent of the peak demands for all systems.

For the 37 largest systems, the total 2040 demands are higher than recent average demands for the first scenario, that of No Conservation and Nominal Water Losses, at 726.174 MGD. The No Conservation scenario but with Optimum Water Losses is 684.463 MGD, a reduction of 5.75 percent from the first, and a reduction of 2.62 percent from the 2008-2015 average.

Finally, the Conservation scenarios with Nominal and Optimum Water Losses result in demands for the 37 largest systems of 680.541 MGD and 641.464 MGD, respectively. The Conservation scenarios results in a drop of 6.28 percent from each of the No Conservation scenarios. The difference between the No Conservation/Nominal Water Loss and Conservation/Optimum Water Loss scenarios is 11.67 percent. Based on these projections, modeled customer conservation and water loss reductions have roughly equal effects on reducing water demands. These overall results mask significant variability, however, as seen on **Table 5-7**. Of the 37 systems, 26 systems show flat or declining demands (-71.9 MGD in total), while eleven show increasing demands (10.5 MGD in total). Of the systems with increasing demands, several are within regions with highly interconnected water supply infrastructure (e.g., Jersey City, Liberty – serving Elizabeth City, Bayonne, Franklin Township-Somerset, and South Brunswick), while others do not have the same level of interconnectedness.

Table 5-7. 2040 Water Demand Projections from 2008-2015 Average Demands for Major PCWS Systems

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet				NJWaTr	2040 No Conservation Scenario		2040 Conservation Scenario	
PWSID #	**County**	**Name**	**D/S Peak Annual Demand (MGD)**	**2008-2015 Average Demand (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**
0238001	Bergen	Suez New Jersey - Haworth & Franklin Lakes (PWSID 022001)	119.315	112.557	124.097	116.797	107.219	100.912
2004002	Union	New Jersey American Water - Raritan System	137.913	97.057	103.994	97.876	101.713	95.730
0714001	Essex	Newark Water Department	84.753	55.247	49.742	46.816	45.585	42.903
1605002	Passaic	Passaic Valley Water Commission	101.915	51.051	44.491	41.873	42.387	39.894
1345001	Monmouth	New Jersey American Water - Coastal North	47.568	37.114	39.483	37.405	36.365	34.451
0712001	Essex	New Jersey American Water - Passaic Basin	41.736	36.508	36.909	34.738	35.490	33.403
0906001	Hudson	Jersey City MUA	47.419	31.100	37.473	35.269	34.518	32.487
0327001	Burlington	New Jersey American Water - Delaware Division	30.872	28.847	31.300	29.653	30.308	28.713
1225001	Middlesex	Middlesex Water Company	52.145	24.977	24.346	22.914	23.295	21.925
1111001	Mercer	Trenton Water Works	26.773	23.930	26.121	24.584	24.832	23.371
2004001	Union	Liberty Water Company	13.360	13.229	15.671	14.749	14.466	13.615
1507005	Ocean	Suez Toms River	12.204	12.778	15.272	14.469	14.527	13.763
0119002	Atlantic	New Jersey American Water - Atlantic	12.635	12.007	16.402	15.538	15.965	15.125
0102001	Atlantic	Atlantic City MUA	11.571	11.004	7.799	7.389	7.550	7.153
1214001	Middlesex	New Brunswick Water Department	16.612	10.864	7.947	7.479	7.464	7.025
0408001	Camden	Camden City Water Department	11.006	10.435	5.616	5.320	5.499	5.209
0901001	Hudson	Bayonne City Water Department	8.932	8.759	10.452	9.838	9.823	9.245
1424001	Morris	Southeast Morris County MUA	9.555	8.374	7.811	7.352	7.536	7.093
0614003	Cumberland	Vineland City Water and Sewer Utility	8.368	8.072	9.833	9.316	9.467	8.969
0705001	Essex	East Orange Water Commission	7.367	7.876	6.242	5.875	5.634	5.303
0251001	Bergen	Ridgewood Water Department	8.146	7.818	6.082	5.725	5.967	5.616
0702001	Essex	Bloomfield Water Department	7.431	7.630	5.552	5.225	5.188	4.883
1614001	Passaic	Wayne Township Division of Water	7.797	7.459	8.641	8.133	8.431	7.935
1204001	Middlesex	East Brunswick Water Utility	7.231	7.013	7.336	6.950	7.084	6.711

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet				**NJWaTr**	**2040 No Conservation Scenario**		**2040 Conservation Scenario**	
PWSID #	**County**	**Name**	**D/S Peak Annual Demand (MGD)**	**2008-2015 Average Demand (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**	**Nominal Water Loss Scenario (MGD)**	**Optimal Water Loss Scenario (MGD)**
1429001	Morris	Parsippany - Troy Hills	6.535	6.292	6.205	5.840	5.983	5.631
1209002	Middlesex	Old Bridge Township MUA	9.096	6.058	6.881	6.519	6.577	6.231
0424001	Camden	Merchantville Pennsauken Water Commission	5.962	6.040	6.006	5.690	5.843	5.535
1808001	Somerset	Franklin Township Department Public Works	6.628	6.015	7.082	6.665	6.720	6.324
1205001	Middlesex	New Jersey American Water Company - Edison	5.887	6.004	6.589	6.201	6.401	6.024
0907001	Hudson	Kearny Town Water Department	10.310	5.470	5.917	5.569	5.591	5.262
1221004	Middlesex	South Brunswick Township Sewer & Water Dept	6.052	5.309	7.965	7.496	7.635	7.186
2013001	Union	Suez Rahway	5.315	5.247	4.421	4.161	4.229	3.980
1215001	Middlesex	North Brunswick Water Department	5.421	5.185	5.311	4.999	5.057	4.759
1506001	Ocean	Brick Township MUA	9.752	5.118	6.015	5.699	5.793	5.488
1216001	Middlesex	Perth Amboy Department of Municipal Utilities	5.994	5.079	5.124	4.823	5.026	4.730
1326001	Monmouth	Gordons Corner Water Company	5.096	4.760	5.029	4.765	4.777	4.526
0324001	Burlington	Mount Laurel Township	4.557	4.596	5.017	4.753	4.596	4.354
TOTALS (Largest 37 PCWS Systems, representing 80 percent of total 2010 statewide demands)			**919.229**	**702.879**	**726.174**	**684.463**	**680.541**	**641.464**
TOTALS (All PCWS Systems) NB: Many very small systems lack available information on current and therefore projected demands			**1250.478**	**994.896**	**1045.664**	**985.4604**	**986.391**	**929.615**

6. Recommendations for Further Evaluation

Through this project, New Jersey now has a great deal of new information regarding residential water demands and how they vary based on housing density and geographic location. A new approach to projecting water demands is possible with this information, but the results still have significant uncertainties for the reasons discussed in the report.

To improve demand projections, the following steps (or actions) are recommended:

1. Reconcile the various NJDEP data sets on water demands for use in long-range water supply planning. The Water Supply Deficit/Surplus Analysis was not created for statewide planning purposes, and the NJWaTr data set is not fully compatible with the D/S analysis with regard to PCWS systems and completeness of the data. While both were very useful for the project, improvements to the projections are possible if the data sets are fully compatible.
2. Improve the coverage and quality of water loss estimates from all PCWS systems, or at least all systems that serve a significant population. Information was provided by NJDEP and DRBC, and the NJDEP information includes results using two different methods – the regulatory Unaccounted-for Water method and the AWWA M36 method. Planning can be improved by requiring the AWWA method uniformly and achieving more complete coverage. While annual loss estimates may not be strictly necessary, they are valuable for all medium and large systems to ensure that the PCWS systems become conversant with the AWWA method, to integrate the use of water loss estimates with asset management requirements of the Water Quality Accountability Act, and to help the public understand system success at reducing water losses.
3. Periodic collection of PCWS estimates for the proportion of system water that is Residential, Industrial, Commercial/Institutional, and Water Losses, perhaps every three to five years. The lack of information on Industrial and Commercial/Institutional demands was especially problematic for this project.
4. Continued improvement of the PCWS Service Area mapping. Over the life of this project, the mapping improved considerably, but a variety of small systems are still missing from the map, and some areas appear to have inconsistencies between customer locations provided by the case PCWS systems and the NJDEP mapping of the service areas, with customer data clearly located outside of the NJDEP service area boundaries. Examples of this can be seen in the maps of Appendix D.
5. Refinement of the dasymetric analysis method for small PCWS systems, to achieve better population estimates for these systems than was possible using the current method.

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Appendices

Appendix A. Methodology for 2010 and 2040 PCWS Population Estimates and Per Capita Water Demand Calculations

As discussed in PCWS Service Areas, Populations and Land Use, 2010 populations were estimated for each PCWS system, by residential development density (High, Medium, Low) for each Census block group. These estimates were generated using a Geographic Information System (GIS) approach known as dasymetric analysis. The following methodology was used to generate the population estimates for 2010.

The estimates for 2040 required disaggregation of municipal population projections to one or more PCWS service areas and any non-service areas in the municipality, based on the relative population distribution in 2010 in lieu of a detailed build-out analyses. The analysis also assumed that population increases would be in High and Medium density residential areas, and not in Low density unless the entire service area was all or mostly all Low density. This approach was selected because population increases are generally driven by either or both of increased household size (which would increase internal demands but not external) or increased housing units (which in most areas will be in more dense developments due to the profit profiles of new development). In both cases, per capita demands for the increases will trend to more efficient rates.

For the few areas with projected population decreases, losses were distributed evenly across existing High, Medium and Low Density areas within the PCWS service area, as such losses will often be related to decreasing average household size.

Methodology

Note: Many of the steps in this methodology require carrying out the same processing steps on multiple layers. The Model Builder tool found in ArcMap can be used to automate the duplication of these steps and save time.

Part 1 -Data download & Acquisition

The following data must be acquired for this methodology. All of the data is publicly accessible with the exception of the Water Use Point Layers. GIS layers are color coded "orange" throughout this methodology.

Name	Type	Source	Description
"BlockGroups_2010"	Polygon Shapefile	New Jersey Geographic Information Network (NJGIN)	U.S. Census Block Group delineations from the year 2010.
"Counties_2010"	Polygon Shapefile	New Jersey Geographic Information Network (NJGIN)	U.S. Census County delineations from the year 2010.
"CensusPop_2010"	Excel Table	U.S Census Bureau - American Fact Finder	A table with population values for block groups from the U.S. Census Bureaus' 2010 decennial census.
"LULC_2012"	Polygon Shapefile	New Jersey Department of Environmental Protection (NJDEP)	A comprehensive polygon layer of land use types in the state of New Jersey. The layers are organized by Sub-basins (HU8) and must be individually downloaded and combined.
"NJ_Parcels"	Polygon Shapefile	New Jersey Geographic Information Network (NJGIN)	Delineations of parcels in New Jersey. The layers are organized by County and must be individually downloaded and combined.
Water Use Point Layers	Point Shapefiles	Water Companies	Data from different water companies vary in organization and level of detail. The data used in this study are organized into individual annual layers. Some data used in the study has monthly water use and some has quarterly water use.

Part 2 – Dasymetric Population Distribution

Dasymetric mapping is a method of using an ancillary data source to spatially distribute data that are initially organized by large or arbitrary boundaries, so as to achieve a greater degree of spatial accuracy. Dasymetric mapping is employed in this study to more accurately distribute population within block groups, the smallest available cartographic units with associated U.S. Bureau of Census Decennial population data.

2.1 - Adjusting the Original LULC dataset

The following steps will adjust the original LULC dataset to fit the needs of this dasymetric analysis. The original dataset has 5 categories of residential land use:

- 1110 (High Density or Multiple dwelling)
- 1120 (Single Unit, Medium Density)
- 1130 (Single Unit, Low Density)

- 1140 (Rural Density)
- 1150 (Mixed Residential)

For the purposed of this study, the rural density category is collapsed into the low density category due to the similarity of water uses associated with these two categories. The mixed use category does not have an inherent density associated with it. Furthermore, it is a rarely used category relative to the other residential types; there are only 54 mixed use polygons in the entire statewide layer. For these reasons, mixed use polygons are manually reassigned to an appropriate residential category.

1. Use the ‘Select by Attribute’ function to select polygons from the “LULC_2012” layer that have a “LU12” field value of 1140

    a. Use the ‘Field Calculator’ tool to change the value of the “LU12” field from 1140 to 1130 for all of the selected records.

2. Clear all selections. Use the ‘Select by Attribute’ function to select polygons from the “LULC_2012” layer that have a “LU12” field value of 1150.

    a. Use the ‘Add Data’ tab to add a base map

    b. Use the ‘Field Calculator’ tool to change the value of the “LU12” field from 1150 to either 1110 (high density), 1120 (medium density), or 1130 (density) based on the base map and surrounding residential land use.

       Note: This step uses the judgement of the individual carrying out this analysis. In this study, the vast majority of mixed use residential polygons were reassigned to the medium density category.

    c. Export the resulting layer as a new layer and name it “LULC_2012_Adjusted.”

3. Use the ‘Select by Attribute’ function to select polygons from the “LULC_2012_Adjusted” layer using the following expression:
   LU12 = 1110 OR LU12 = 1120 OR LU12 = 1130

    a. Export the selected polygons as a new polygon layer and name it “LULC_2012_Residential_Adjusted.”

4. Use the ‘Dissolve’ tool to dissolve the “LULC_2012_Adjusted” layer. Use the following fields as dissolve fields:
    - LU12
    - LABEL12

   Name the resulting layer “LULC_Key”

5. Add a new field (Type: Double) to the “LULC_Key” layer and name the field “Key.”

a. Populate the "Key" field based on the LABEL12 field in the following manner:

LABEL12	Key
RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	100
RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	100
RESIDENTIAL, SINGLE UNIT, LOW DENSITY	100
RESIDENTIAL, RURAL, SINGLE UNIT	100
MIXED RESIDENTIAL	100
COMMERCIAL/SERVICES	1
MILITARY INSTALLATIONS	1
INDUSTRIAL	1
AIRPORT FACILITIES	1
INDUSTRIAL AND COMMERCIAL COMPLEXES	1
MIXED URBAN OR BUILT-UP LAND	1
OTHER URBAN OR BUILT-UP LAND	1
ATHLETIC FIELDS (SCHOOLS)	1
STADIUM, THEATERS, CULTURAL CENTERS AND ZOOS	1
CROPLAND AND PASTURELAND	1
AGRICULTURAL WETLANDS (MODIFIED)	1
ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	1
CONFINED FEEDING OPERATIONS	1
OTHER AGRICULTURE	1
PLANTATION	1
EXTRACTIVE MINING	1
***** All Other "LABEL12" Values *****	0

2.2 - Separating the State into Tiers

A 'High Density Residential' LULC polygon in an extremely developed area such as Jersey City is likely to be significantly different from a 'High Density Residential' LULC polygon in a less developed area such as the New Jersey Highlands. In recognition of this discrepancy, New Jersey was broken out into four tiers for the purposes of this study. Individual dasymetric analyses are carried out for each of the four tiers. The four tiers were developed using 2010 Census population density values for New Jersey counties and block groups. The four tiers as designated as follows:

- **Tier 1:** Hudson County
- **Tier 2:** Essex, Union, Bergen, Passaic, Middlesex, Camden, Mercer Counties
- **Tier 3:** Monmouth, Somerset, Morris, Ocean, Gloucester, Burlington, and Atlantic Counties
- **Tier 4:** Cape May, Cumberland, Warren, Hunterdon, Sussex, Salem

6. Join the "CensusPop_2010" table to the "BlockGroups_2010" layer. Use the "GEOID10" field as the join field.

   a. Add a new field (Type:Double) and name it "BGCensusPop"
   b. Use the 'Field Calculator' to populate the "BGCensusPop" field with block group population values from the "CensusPop_2010" table.
   c. Remove the join.

7. Add a new field (Type: double) to the "BlockGroups_2010" layer. Name the field "BGArea_Acres"

a. For the "BGArea_Acres" field use the 'Calculate Geometry' function to calculate the area in US acres.

8. Use the 'Select by Attribute' tool to select polygons from the "Counties_2010" layer using the following expression:
   COUNTYFP10 = '017'
   a. With the selection still active. Clip the "LULC_2012_Residential_Adjusted" layer by the "Counties_2010" layer.

9. Use the 'Intersect' tool to intersect the "BlockGroups_2010" layer and the layer created in the previous step. In the 'Intersect' dialogue box, make sure that the layer created in the previous step is above the "BlockGroups_2010" layer.

10. Add a new field (Type: Text) to the layer created in the previous step and name it "BG_LULC."

    a. Use the 'Field Calculator' to populate the "BG_LULC" field using the following equation:
       [GEOID10]&"_"&[LU12]

    b. Use the 'Dissolve' tool. Use the following fields as dissolve fields.
       - GEOID10
       - LU12
       - BG_LULC
       - BGArea_Acres
       - BGCensusPop

       Name the resulting layer "Tier1_Polys."

11. Clear all Selections. Use the 'Select by Attribute' tool to select polygons from the "Counties_2010" layer using the following expression:
    COUNTYFP10 = '003' OR COUNTYFP10 = '021' OR COUNTYFP10 = '013' OR COUNTYFP10 = '007' OR COUNTYFP10 = '031' OR COUNTYFP10 = '039' OR COUNTYFP10 = '023'
    a. With the selection still active. Clip the "LULC_2012_Residential_Adjusted" layer by the "Counties_2010" layer.

12. Use the 'Intersect' tool to intersect the "BlockGroups_2010" layer and the layer created in the previous step. In the 'Intersect' dialogue box, make sure that the layer created in the previous step is above the "BlockGroups_2010" layer.

13. Add a new field (Type: Text) to the layer created in the previous step and name it "BG_LULC."

    a. Use the 'Field Calculator' to populate the "BG_LULC" field using the following equation:
       [GEOID10]&"_"&[LU12]

b. Use the 'Dissolve' tool. Use the following fields as dissolve fields.
   - GEOID10
   - LU12
   - BG_LULC
   - BGArea_Acres
   - BGCensusPop

   Name the resulting layer "Tier2_Polys."

14. Clear all Selections. Use the 'Select by Attribute' tool to select polygons from the "Counties_2010" layer using the following expression:
    COUNTYFP10 = '001' OR COUNTYFP10 = '015' OR COUNTYFP10 = '025' OR
    COUNTYFP10 = '005' OR COUNTYFP10 = '027' OR COUNTYFP10 = '035' OR
    COUNTYFP10 = '029'

    a. With the selection still active. Clip the "LULC_2012_Residential_Adjusted" layer by the "Counties_2010" layer.

15. Use the 'Intersect' tool to intersect the "BlockGroups_2010" layer and the layer created in the previous step. In the 'Intersect' dialogue box, make sure that the layer created in the previous step is above the "BlockGroups_2010" layer.

16. Add a new field (Type: Text) to the layer created in the previous step and name it "BG_LULC."

    a. Use the 'Field Calculator' to populate the "BG_LULC" field using the following equation:
       [GEOID10]&"_"&[LU12]

    b. Use the 'Dissolve' tool. Use the following fields as dissolve fields.
       - GEOID10
       - LU12
       - BG_LULC
       - BGArea_Acres
       - BGCensusPop

       Name the resulting layer "Tier3_Polys."

17. Clear all Selections. Use the 'Select by Attribute' tool to select polygons from the "Counties_2010" layer using the following expression:
    COUNTYFP10 = '041' OR COUNTYFP10 = '033' OR COUNTYFP10 = '011' OR
    COUNTYFP10 = '009' OR COUNTYFP10 = '019' OR COUNTYFP10 = '037'

    a. With the selection still active. Clip the "LULC_2012_Residential_Adjusted" layer by the "Counties_2010" layer.

18. Use the 'Intersect' tool to intersect the "BlockGroups_2010" layer and the layer created in the previous step. In the 'Intersect' dialogue box, make sure that the layer created in the previous step is above the "BlockGroups_2010" layer.

19. Add a new field (Type: Text) to the layer created in the previous step and name it "BG_LULC."

    a. Use the 'Field Calculator' to populate the "BG_LULC" field using the following equation:
    [GEOID10]&"_"&[LU12]

    b. Use the 'Dissolve' tool. Use the following fields as dissolve fields.
        - GEOID10
        - LU12
        - BG_LULC
        - BGArea_Acres
        - BGCensusPop

    Name the resulting layer "Tier4_Polys."

2.3 - Density Sampling Ratio

The following steps are carried out individually for each of the four tier layers created in the previous section 2.2. When one of these tier layers are used in this section, it will be referred to as "TierX_Polys" as a substitute for "Tier1_Polys," Tier2_Polys," "Tier3_Polys," and "Tier4_Polys."

20. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "LU12Area_Acres"

    a. For the "LU12Area_Acres" field use the 'Calculate Geometry' function to calculate the area in US acres.

    b. Add a new field (Type: Double) and name it "PercentOfBlockGroup"

    c. Use the 'Field Calculator' function to calculate the "PercentOfBlockGroup" field using the following equation:

    ([LU12Area_Acres]/[BGArea_Acres])*100

21. Use the 'Select by Attribute' function to select records from the "TierX_Polys" layer using the following equation:

    PercentOfBlockGroup >= 95

    a. Export the selected records as a new layer.

22. Use the 'Dissolve' tool to dissolve the layer created in the previous step. Use the "LU12" field as the dissolve field. Add the following statistics fields
    - LU12Area_Acres (Statistic Type: SUM)
    - CensusPop (Statistic Type: SUM)

Name the resulting layer "Sampling_Ratio"

23. Add the following fields to the "Sampling_Ratio" layer
    - "Density" (Type: Double)
    - "Density_Sum" (Type: Double)
    - "Sampling_Ratio" (Type: Double)

    a. Use the 'Field Calculator' function to calculate the "Density" field using the following equation:
    [SUM_CensusPop] / [SUM_LU12Area_Acres]

    b. Calculate the sum the "Density" field values of each record. Use the 'Field Calculator' function to populate the "Density_Sum" with that value.

    c. Use the 'Field Calculator' function to calculate the "Sampling_Ratio" field using the following equation:

    [Density] / [Density_Sum]

24. Add a new field (Type: Double) to the "TierX_Polys" layer. Name it "Sampling_Ratio"

25. Join the "Sampling_Ratio" Layer with the "TierX_Polys" layer. Use "LU12" field as the join field.

    a. Use the 'Field Calculator' to populate the "Sampling_Ratio" field of the "TierX_Polys" layer with the "Sampling_Ratio" field values from the "Sampling_Ratio" layer.

    b. Remove the join.

2.4 - Area Ratio

The following steps are carried out individually for each of the four tier layers created in the previous section 2.2. When one of these tier layers are used in this section, it will be referred to as "TierX_Polys" as a substitute for "Tier1_Polys," Tier2_Polys," "Tier3_Polys," and "Tier4_Polys."

26. Use the 'Dissolve' tool to dissolve the "TierX_Polys" layer. Use the "GEOID10" field as the dissolve field. Add the "LU12Area_Acres" as a statistic field (statistic type: SUM).

    Name the resulting layer "LU12Area_SUM"

27. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the new field "BGResidentialArea"

    a. Join the "BlockGroup_LULC" layer with the "LU12Area_SUM" layer. Use the "GEOID10" field as the join field.

   b. Use the 'Field Calculator' to populate the "BGResidentialArea" field of the "TierX_Polys" layer with the "SUM_LU12Area_Acres" field values from the "LU12Area_SUM" layer.

   c. Remove the join

28. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the new field "Area_Ratio"

   a. Use the 'Field Calculator' function to calculate the "Area_Ratio" field using the following equation:
      [LU12Area_Acres] / [BGResidentialArea]

2.5 - Final Ratio

The following steps are carried out individually for each of the four tier layers created in the previous section 2.2. When one of these tier layers are used in this section, it will be referred to as "TierX_Polys" as a substitute for "Tier1_Polys," Tier2_Polys," "Tier3_Polys," and "Tier4_Polys."

29. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "Sampling_x_Area"

   a. Use the 'Field Calculator' function to calculate the "Sampling_x_Area" field using the following equation:
      [Sampling_Ratio] * [Area_Ratio]

30. Use the 'Dissolve' tool to dissolve the "TierX_Polys" layer. Use the "GEOID10" field as the dissolve field. Add the "Sampling_x_Area" field as a statistics field (statistic type: SUM). Name the resulting layer "SamplingAreaDissolve"

31. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "BGSUM_Sampling_x_Area"

   a. Join the "SamplingAreaDissolve" layer to the "TierX_Polys" layer. Use the "GEOID10" field as the join field

   b. Use the 'Field Calculator' function to populate the "BGSUM_Sampling_x_Area" field of the "TierX_Polys" layer with the "SUM_Sampling_x_Area" field values of the "SamplingAreaDissolve" layer.

   c. Remove the join

32. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "Final_Fraction"

   a. Use the 'Field Calculator' function to calculate the "Final_Fraction" field using the following equation:

      [Sampling_x_Area] / [BGSUM_Sampling_x_Area]

33. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "AssignedPopulation"

a. Use the 'Field Calculator' function to calculate the "AssignedPopulation" field using the following equation:

[BGCensus_Pop]*[Final_Fraction]

34. Add a new field (Type: Double) to the "TierX_Polys" layer. Name the field "AssignedDensity_Acres"

a. Use the 'Field Calculator' function to calculate the "AssignedDensity_Acres" field using the following equation:

[AssignedPopulation] / [LU12Area_Acres]

2.6 - Final Dasymetric Layer

35. Use the 'Merge' tool to merge the following layers:
- "Tier1_Polys"
- "Tier2_Polys"
- "Tier3_Polys"
- "Tier4_Polys"

Name the resulting layer "DasymetricPolys"

36. Create a duplicate of the "DasymetricPolys" layer and rename it "DasymetricPolysExploded"

a. Select all of the records in the "DasymetricPolysExploded" layer

b. In the 'Advanced Editing' toolbar, use the 'Explode Multipart Feature' tool to explode the "DasymetricPolysExploded" layer.

Part 3 Assigning Residential Density to Water Use Data Points

The following steps will assign a residential density of High, Medium, or Low to water use data points. This will allow the water use data points to be joined with corresponding population values that are also organized by the same residential categories. Overlaying water use data points with the residential polygons from the 2012 Land Use Land Cover (LULC) dataset results in an unacceptable amount of data loss. To remedy this spatial discrepancy between the data points and the LULC dataset, land uses within parcels are generalized to create a more accurate representation of the predominant land use in each parcel.

3.1 - Preprocessing Steps

The following steps will create the necessary layers to begin generalizing land uses within parcels. The method stars with isolating points that are not overlapped by a residential land use and working off of those points.

1. Use the 'Merge' tool to merge all of the water use point layers into one layer. The result is a comprehensive layer containing all of the geographic locations of the data points.

2. Use the 'Select By Location' function to isolate points from the layer created in the previous step that do NOT intersect with the "LULC_2012_Residential_Adjusted" layer. Export the selected points as a new point layer**.**

3. Use the 'Select By Location' function to isolate polygons from the "NJ_Parcels" layer that intersect with the point layer created in the previous step. Export the selected polygons as a new polygon layer. Name the layer "IntersectingParcels."

    a. Add two new fields to the polygon layer and populate them in the following manner:

Field Name	Type	Calculation Method
ParcelArea_Acres	Double	Calculate geometry → US Acres
Parcel_ID	Double	Field Calculator → [ObjectID]

    b. Use the 'Intersect' Tool to intersect the polygon layer with the "LULC_2012_Adjusted" layer. In the 'Intersect' dialogue box, the polygon layer needs to be above the "LULC_2012_Adjusted" layer.

4. Use the 'Dissolve' Tool to dissolve the polygon layer created in the previous step. In the 'Dissolve' dialogue box, select "LU12","Parcel_ID", and "ParcelArea_Acres" as dissolve fields. This groups all of the density types by parcel while preserving the total parcel area value. Name the resulting layer "Parcels_By_LULC"

    a. Add three new fields to the polygon layer and populate them in the following manner:

Field Name	Type	Calculation Method
Area_Acres	Double	Calculate geometry → US Acres
Percent of Parcel	Double	Field Calculator →([Area_Acres] / [ParcelArea_Acres])*100
Dissolve_Key	Double	Leave empty, populated in the next step

    b. Join the "LULC_Key" layer with the polygon layer created in. Use the "LU12" field as the join field for both the table and the polygon layer. While the table is joined, calculate the "Dissolve_Key" field to be equal to the "Key" field. Remove the join. This step codes the polygons in the following manner:
        i. All residential categories = 100
        ii. Non-residential categories associated with water use = 1
        iii. All other categories = 0

5. Use the 'Dissolve' Tool to dissolve the polygon layer created in the previous step (Parcels_By_LULC). In the 'Dissolve' dialogue box, select "Parcel_ID" as the dissolve field. Select the "Dissolve_Key" field as a statistics field and set the statistic type to SUM. Name the resulting layer "Parcels_Coded"

a. The resulting layer will contain a field named "SUM_Dissolve_Key." The following values may occur in this field:

SUM_Dissolve_Key Value	Interpretation
0	No land uses associated with water.
1-99	One or more non-residential land uses associated with water use.
100 or 200 or 300	One or more types of residential use.
101-199 or 201-299 or 301-399	One or more types of residential use and one or more non-residential land uses associated with water use.

3.2 - Situational Rules

The following steps will generalize the land uses within parcels using the following situational rules:

Situation	SUM_Dissolve_Key Value	Rule
One residential land use	100	Assign the residential land use to the entire parcel
Two or more types of residential land use	200 or 300	Identify which type residential land use covers the greatest percentage of the parcel and assign that residential land use to the entire parcel.
One or more types of residential use and one or more non-residential land uses associated with water use.	101-199 or 201-299 or 301-399	For parcels where a residential land use covers at least 50% of the parcel, assign that residential land use to the entire parcel.

6. Create a relate between the "Parcels_Coded" layer and the "Parcels_By_LULC" layer. Use the "Parcel_ID" field as the common field to relate the two layers. Use the default name of "Relate1."

    a. Use the 'Select by Attribute' function to select polygons from the "Parcels_Coded" layer that have a "SUM_Dissolve_Key" field value of 100.

    b. With the selection still active, open the attributes table of "Parcels_Coded." Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "Parcels_By_LULC" layer.

    c. Export the selected polygons and name the layer "OneResidentialUse."

7. Create a relate between the "OneResidentialUse" layer and the "IntersectingParcles" layer. Use the "Parcel_ID" field as the common field to relate the two layers. Use the default name of "Relate1."

a. Use the 'Select by Attribute' function to select all of the records from the "OneResidentialUse" that have a "Dissolve_Key" field value of 0. Delete the selected records.

b. Select all of the remaining records from the "OneResidentialUse" layer and open the attributes table. Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "IntersectingParcels" layer.

c. Export the selected records from the "IntersectingParcels" layer as a new layer. Name the new layer "Final_OneResidentialUse."

8. Add a new field (Type: Double) named "LU12" to the "Final_OneResidentialUse" layer.

   a. Open the attributes table of the "Final_OneResidentialUse" layer. Join the "OneResidentialUse" layer using the "Parcel_ID" field as the join field.

   b. With the join still active, use the 'Field Calculator' function to populate the "LU12" field from the "Final_OneResidentialUse" layer with the "LU12" field values from the "OneResidentialUse" layer. Remove the join.

9. Clear all selections. Use the 'Select by Attribute' function to select polygons from "Parcels_Coded" layer that have a "SUM_Dissolve_Key" Value of 200 or 300.

   a. With the selection still active, open the attributes table of "Parcels_Coded." Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "Parcels_By_LULC" layer.

   b. Export the selected records as a new layer and name it "MultipleResidentalUses."

10. Use the 'Select by Attribute' function to select all of the records from the "MultipleResidentalUses" that have a "Dissolve_Key" field value of 0. Delete the selected records.

    a. Use the 'Dissolve' Geoprocessing Tool to dissolve the "MultipleResidentalUses" layer. In the 'Dissolve' dialogue box, select "Parcel_ID" as the dissolve field. Select the "PercentOfParcel" field as a statistics field and set the statistic type to MAX. Name the resulting layer "MultipleResidentalUses_Dissolve."

11. Add a new field (Type: Double) named "PercentCode" to the "MultipleResidentalUses" layer.

    a. Open the attributes table of the "MultipleResidentalUses" layer. Join the "MultipleResidentalUses_Dissolve" layer using the "Parcel_ID" field as the join field.

    b. With the join still active, use the 'Field Calculator' function to calculate the "PercentCode" field using the following equation:
    [PercentOfParcel] / [MAX_PercentOfParcel]

c. Remove the join. Create a relate between the "MultipleResidentialUses" layer and the "IntersectingParcels" layer. Use the "Parcel_ID" field as the common field to relate the two layers. Use the default name of "Relate1"

d. Use the 'Select by Attribute' function to select all of the records from the "MultipleResidentalUses" that have a "PercentCode" field value of 1.

e. With the selection still active, open the attribute table of "MultipleResidentalUses" layer. Under the 'Table Options' tab, choose 'switch selection.' Delete the selected records.

f. Select all of the remaining records from the "MultipleResidentalUses" layer and open the attributes table. Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "IntersectingParcels" layer.

g. Export the selected polygons from the "IntersectingParcels" layer as a new layer. Name the new layer "Final_MultipleResidentialUse."

12. Add a new field (Type: Double) named "LU12" to the "Final_MultipleResidentialUse" layer.

    a. Open the attributes table of the "Final_MultipleResidentialUse" layer. Join the "MultipleResidentialUse" layer using the "Parcel_ID" field as the join field.

    b. With the join still active, use the 'Field Calculator' function to populate the "LU12" field from the "Final_MultipleResidentialUse" with the "LU12" field values from the "MultipleResidentialUse" layer. Remove the join.

13. Clear all selections. Use the 'Select by Attribute' function to select polygons from "Parcels_Coded" layer using the following expression:

    (SUM_Dissolve_Key >100 AND SUM_Dissolve_Key <200) OR

    (SUM_Dissolve_Key >200 AND SUM_Dissolve_Key <300) OR

    (SUM_Dissolve_Key >300 AND SUM_Dissolve_Key < 400)

    a. With the selection active, open the attributes table of "Parcels_Coded." Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "Parcels_By_LULC" layer.

    b. Export the selected polygons from the "Parcels_By_LULC" layer as a new layer. Name the new layer "MultiplelUses."

14. Create a relate between the "MultipleUses" layer and the "IntersectingParcels" layer. Use the "Parcel_ID" field as the common field to relate the two layers. Use the default name of "Relate1."

    a. Use the 'Select by Attribute' function to select all of the records from the "MultipleUses" layer using the following expression:

Dissolve_Key =100 AND PercentOfParcel >=50

b. With the selection still active, open the attribute table of the "MultipleUses" layer. Under the 'Table Options' tab, choose 'switch selection.' Delete the selected records.

c. Select all of the remaining records in the "MultipleUses" layer and open the attributes table. Open the 'Related Tables' dropdown menu and select "Relate1." The displayed attributes table should now change to the "IntersectingParcels" layer.

d. Export the selected polygons from the "IntersectingParcels" layer as a new layer. Name the new layer "Final_MultipleUses."

15. Add a new field (Type: Double) named "LU12" to the "Final_MultipleUses" layer.

    a. Open the attributes table of the "Final_MultipleUses" layer. Join the "MultipleUses" layer using the "Parcel_ID" field as the join field.

    b. With the join still active, use the 'Field Calculator' function to populate the "LU12" field from the "Final_MultipleUses" layer with the "LU12" field values from the "MultipleUses" layer. Remove the join.

3.3 - Creating the Final Generalized layer

The following steps will use the generalized parcel layers created using the situational rules and combine them with residential LULC polygons to create a final layer for assigning residential density. Even after this process, there may still be data points that are not overlapped by the final layer and therefore not assigned a residential density.

16. Clear all selections. Use the 'Merge' Tool to merge the "Final_OneResidentialUse" layer, the "Final_MultipleResidentialUse" layer.

17. Use the 'Erase' Tool to erase the "LULC_2012_Residential_Adjusted" layer from the polygon layer created in the previous step.

18. Use the 'Merge' Tool to merge the "LULC_2012_Residential_adjusted" layer and the layer created in the previous step. Name the resulting layer "Final_AssigningDensity."

19. Use the 'Spatial Join' tool spatially join the "Final_AssigningDensity" layer to all of the water use point layers located. In the 'Spatial Join' dialogue box, uncheck the 'Keep All Target Features' option so only data points that are overlaid by the "Final_AsssigningDensity" layer a included in the outputs. The resulting data point layers now contain residential density values in the 'LU12' field.

Part 4 Assigning Population to All Water Use Data Points

The following steps will combine water use data points and population values to create water use per capita values. All of the steps in this part (steps 1 – 14) are carried out for each available year of data.

4.1 - Water Use Per Capita for All Users

The following steps will combine population and water use values and create a polygon layer with water use per capita values for all users.

1. Use the 'Spatial Join' tool to join the "GEOID10" field from the "BlockGroup_2010" layer to the water use point layers with density values that were created in the final step of Part 3.

2. Add a new field (Type:Text) to the new point layer created in the previous step. Name the field "BG_LULC."

    a. Use the 'Field Calculator' function to calculate the "BG_LULC" field using the following expression:
    [GEOID10]&"_"& [LU12]

    b. Use the 'Dissolve' Tool. In the 'Dissolve' dialogue box, make sure the 'Create multipart features' option is checked and select the following fields as dissolve fields:
        i. LU12
        ii. GEOID10
        iii. BG_LULC

    Add the following statistic fields:
        iv. Oct (statistic type: SUM)
        v. Nov (statistic type: SUM)
        vi. Dec (statistic type: SUM)
        vii. Jan (statistic type: SUM)
        viii. Feb (statistic type: SUM)
        ix. Mar (statistic type: SUM)
        x. Apr (statistic type: SUM)
        xi. May (statistic type: SUM)
        xii. Jun (statistic type: SUM)
        xiii. Jul (statistic type: SUM)
        xiv. Aug (statistic type: SUM)
        xv. Sep (statistic type: SUM)
        xvi. Premis_ID (statistics type:COUNT)

    Name the resulting layer "BG_LULC_Points"

3. Use the 'Select By Location' Tool to select polygons from the "DasymetricPolysExploded" layer that intersect with the "BG_LULC_Points" layer. Export the selected polygons as a new polygon layer.

4. Use the 'Dissolve' Tool to dissolve the layer from the previous step. In the 'Dissolve' dialogue box, make sure the 'Create multipart features' option is checked and select the following fields as dissolve fields:
    - LU12
    - GEOID10
    - BG_LULC
    - AssignedDensity_Acres

5. Join the "BG_LULC_Points" layer to the polygon layer created in the previous step.
    a. While the join is still active, export the polygon layer as a new layer.

6. Add the following fields to the polygon layer created in the previous step. Calculate each of the fields using the following methods:

Field Name	**Field Type**	**Calculation Method**
Area_Acres	Double	'Calculate Geometry' US Acres
Assigned_Population_Adjusted	Double	[Area_Acres]*[AssignedDensity_Acres]
AnnualTotal	Double	[SUM_Oct] + [SUM_Nov] + [SUM_Dec] + [SUM_Jan] + [SUM_Feb] + [SUM_Mar] + [SUM_Apr] + [SUM_May] + [SUM_Jun] + [SUM_Jul] + [SUM_Aug] + [SUM_Sep]
AnnualPerCapita	Double	[AnnualTotal] / [Assigned_Population_Adjusted]
AnnualPerCaptiaPerDay	Double	[AnnualPerCapita]/365
SummerTotal	Double	[SUM_Jun] + [SUM_Jul] + [SUM_Aug] + [SUM_Sep]
SummerPerCapita	Double	[SummerlTotal] / [Assigned_Population_Adjusted]
SummerPerCapitaPerDay	Double	[SummerlPerCapita] /122
NonSummerTotal	Double	[SUM_Oct] + [SUM_Nov] + [SUM_Dec] + [SUM_Jan] + [SUM_Feb] + [SUM_Mar] + [SUM_Apr] + [SUM_May]
NonSummerPerCapita	Double	[NonSummerlTotal] / [Assigned_Population_Adjusted]
NonSummerPerCapitaPerDay	Double	[NonSummerPerCapita] /243
AnnualPerPremisID	Double	[AnnualTotal] / [COUNT_Premise_ID]
AnnualPerPremisIDPerDay	Double	[AnnualPerPremisID] /365
SummerPerPremisID	Double	[SummerlTotal] / [COUNT_Premise_ID]
SummerPerPremisIDPerDay	Double	[SummerlPerPremisID] /122
NonSummerPerPremisID	Double	[NonSummerlTotal] / [COUNT_Premise_ID]
NonSummerPerPremisIDPerDay	Double	[NonSummerPerPremisID] /243

a. After all of the fields have been added and populated use the 'Dissolve' tool. Use the "LU12" Field as the dissolve field. Choose the following fields as statistics field and set the statistic type to SUM.
   i. AnnualTotal
   ii. PopTotal
   iii. PremisIDTotal
   iv. SummerTotal
   v. NonSummerTotal
b. Use the "Table To Excel" tool to export layer to Excel spreadsheet. Calculate each of the fields using the following methods:

Field Name	**Field Type**	**Calculation Method**
AnnualPerCapita	Double	AnnualTotal/PopTotal
AnnualPerCapitaPerDay	Double	AnnualTotal/PopTotal/365
SummerPerCapita	Double	SummerTotal/ PopTotal
SummerPerCapitaPerDay	Double	SummerTotal/ PopTotal/122
NonSummerPerCapita	Double	NonSummerTotal/ PopTotal
NonSummerPerCapitaPerDay	Double	NonSummerTotal/ PopTotal/243
AnnualPerPremisID	Double	AnnualTotal/PremisIDTotal
AnnualPerPremisIDPerDay	Double	AnnualTotal/PremisIDTotal/365
SummerPerPremisID	Double	SummerTotal/PremisIDTotal
SummerPerPremisIDPerDay	Double	SummerTotal/PremisIDTotal/122
NonSummerPerPremisID	Double	NonSummerTotal/PremisIDTotal
NonSummerPerPremisIDPerDay	Double	NonSummerTotal/PremisIDTotal/122

4.2 - Water Use Per Capita for 'Year Long' Users

The following steps will combine population and water use values and create a polygon layer with water use per capita values for 'year long' users. This analysis defines year long users as data points with no more than three months of zero water use. Negative values are not considered a water use of zero because they represent a billing adjustment carried out by the water company.

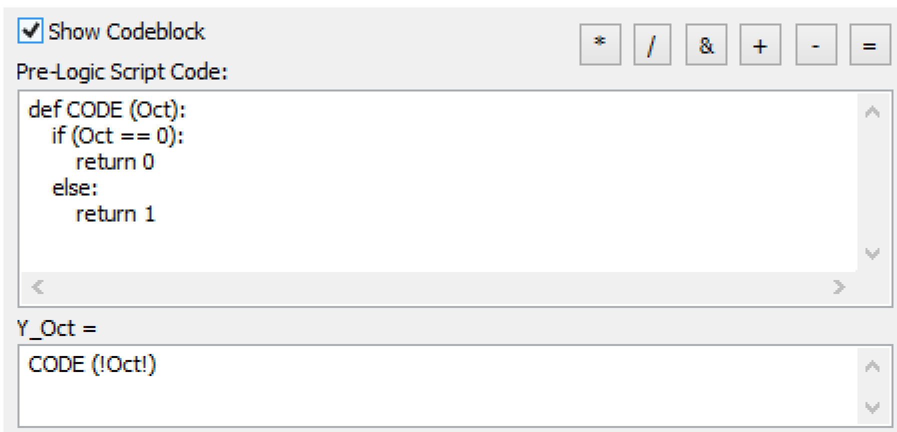
7. Use the 'Spatial Join' tool to join the "GEOID10" field from the "BlockGroup_2010" layer to the water use point layers with density values that were created in the final step of Part 3.

8. Add the following fields (Type Double) to the point layer created in the previous step:
   - Nov_1
   - Dec_1
   - Jan_1
   - Feb_1
   - Mar_1
   - Apr_1

- May_1
- Jun_1
- July_1
- Aug_1
- Sep_1

These fields will be coded with the values 1 or 0, depending on value in the field of the corresponding month. A value of 0 is given if the corresponding month also has a value of 0. A value of 1 is given if the corresponding month has a value that is NOT 0. For example, if a record has an Oct field value of 20, then the Oct_1 field for that record is given a value of 1. However, If a record has an Oct field of 0, then the Oct_1 field is given a value of 0.

The fields can be calculated using python script. The script shown below is used to calculate the "Oct_1" field. To calculate the other fields, "Oct" must be replaced with the name of the other months wherever it appears in the script.



9. After the fields have been coded, add a new field (Type: Double) and name it "YearLongCode."

    a. Use the 'Field Calculator' function to calculate the "YearLongCode"field using the following expression:
    [Oct_1] + [Nov_1] + [Dec_1] + [Jan_1] + [Feb_1] + [Mar_1] + [Apr_1] + [May_1] + [Jun_1] + [Jul_1] + [Aug_1] + [Sep_1]

    b. Use the 'Select By Attribute' Function to select records that have a "YearLongCode" field value greater than 8.

    c. Export the selected records as a new point layer.

10. Add a new field (Type:Text) to the new point layer created in the previous step. Name the field "BG_LULC."

    a. Use the 'Field Calculator' function to calculate the "BG_LULC" field using the following expression:
    [GEOID10]&"_"& [LU12]

b. Use the 'Dissolve' Tool. In the 'Dissolve' dialogue box, make sure the 'Create multipart features' option is checked and select the following fields as dissolve fields:
    i. LU12
    ii. GEOID10
    iii. BG_LU12

    Add the following statistic fields:
    iv. Oct (statistic type: SUM)
    v. Nov (statistic type: SUM)
    vi. Dec (statistic type: SUM)
    vii. Jan (statistic type: SUM)
    viii. Feb (statistic type: SUM)
    ix. Mar (statistic type: SUM)
    x. Apr (statistic type: SUM)
    xi. May (statistic type: SUM)
    xii. Jun (statistic type: SUM)
    xiii. Jul (statistic type: SUM)
    xiv. Aug (statistic type: SUM)
    xv. Sep (statistic type: SUM)
    xvi. Premis_ID (statistics type: COUNT)

    Name the resulting layer "YearLong_BG_LULC_Points"

11. Use the 'Select By Location' Tool to select polygons from the "DasymetricPolysExploded" layer that intersect with the use point layers from the "YearLong_BG_LULC_Points" layer. Export the selected polygons as a new polygon layer.

12. Use the 'Dissolve' Tool to dissolve the layer from the previous step. In the 'Dissolve' dialogue box, make sure the 'Create multipart features' option is checked and select the following fields as dissolve fields:
    - LU12
    - GEOID10
    - BG_LULC
    - AssignedDensity_Acres

13. Join the "YearLong_BG_LULC_Points" layer to the polygon layer created in the previous step.

    a. While the join is still active, export the polygon layer as a new layer.

14. Add the following fields to the polygon layer created in the previous step. Calculate each of the fields using the following methods:

Field Name	Field Type	Calculation Method
Area_Acres	Double	'Calculate Geometry' US Acres
Assigned_Population_Adjusted	Double	[Area_Acres]*[AssignedDensity_Acres]
AnnualTotal	Double	[SUM_Oct] + [SUM_Nov] + [SUM_Dec] + [SUM_Jan] + [SUM_Feb] + [SUM_Mar] + [SUM_Apr] + [SUM_May] + [SUM_Jun] + [SUM_Jul] + [SUM_Aug] + [SUM_Sep]
AnnualPerCapita	Double	[AnnualTotal] / [Assigned_Population_Adjusted]
AnnualPerCaptiaPerDay	Double	[AnnualPerCapita]/365
SummerTotal	Double	[SUM_Jun] + [SUM_Jul] + [SUM_Aug] + [SUM_Sep]
SummerPerCapita	Double	[SummerlTotal] / [Assigned_Population_Adjusted]
SummerPerCapitaPerDay	Double	[SummerlPerCapita] /122
NonSummerTotal	Double	[SUM_Oct] + [SUM_Nov] + [SUM_Dec] + [SUM_Jan] + [SUM_Feb] + [SUM_Mar] + [SUM_Apr] + [SUM_May]
NonSummerPerCapita	Double	[NonSummerlTotal] / [Assigned_Population_Adjusted]
NonSummerPerCapitaPerDay	Double	[NonSummerPerCapita] /243
AnnualPerPremisID	Double	[AnnualTotal] / [COUNT_Premise_ID]
AnnualPerPremisIDPerDay	Double	[AnnualPerPremisID] /365
SummerPerPremisID	Double	[SummerlTotal] / [COUNT_Premise_ID]
SummerPerPremisIDPerDay	Double	[SummerlPerPremisID] /122
NonSummerPerPremisID	Double	[NonSummerlTotal] / [COUNT_Premise_ID]
NonSummerPerPremisIDPerDay	Double	[NonSummerPerPremisID] /243

a. After all of the fields have been added and populated use the 'Dissolve' tool. Use the "LU12" Field as the dissolve field. Choose the following fields as statistics field and set the statistic type to SUM.
   i. AnnualTotal
   ii. PopTotal
   iii. PremisIDTotal
   iv. SummerTotal
   v. NonSummerTotal

b. Use the "Table To Excel" tool to export layer to Excel spreadsheet. Calculate each of the fields using the following methods:

Field Name	Field Type	Calculation Method
AnnualPerCapita	Double	AnnualTotal/PopTotal
AnnualPerCapitaPerDay	Double	AnnualTotal/PopTotal/365
SummerPerCapita	Double	SummerTotal/ PopTotal
SummerPerCapitaPerDay	Double	SummerTotal/ PopTotal/122
NonSummerPerCapita	Double	NonSummerTotal/ PopTotal
NonSummerPerCapitaPerDay	Double	NonSummerTotal/ PopTotal/243
AnnualPerPremisID	Double	AnnualTotal/PremisIDTotal
AnnualPerPremisIDPerDay	Double	AnnualTotal/PremisIDTotal/365
SummerPerPremisID	Double	SummerTotal/PremisIDTotal
SummerPerPremisIDPerDay	Double	SummerTotal/PremisIDTotal/122
NonSummerPerPremisID	Double	NonSummerTotal/PremisIDTotal
NonSummerPerPremisIDPerDay	Double	NonSummerTotal/PremisIDTotal/122

Appendix B. Residential Demands Model Construction

The spreadsheet model for 2010 and 2040 residential demands (Model RES 2010_2040 Demands 2017.08.01.xlsx) includes over 20 individual worksheets, which are described below. For each worksheet, the individual columns are described with the information source and equations as appropriate. The worksheets are grouped as:

- PCWS Population
- Annual Demands for 2010 and 2040, No Conservation and Conservation Scenarios
- Summer Demands for 2010 and 2040, No Conservation Scenario
- Non-Summer Demands for 2010 and 2040, No Conservation Scenario
- Lookup Tables
- Per Capita Calculations for Case PCWS Systems

Caveats - #1

As mentioned in the Caveats worksheet, the populations associated with each type of area are based on the dasymetric analysis and PCWS service areas using a June 2017 version of the NJDEP PCWS Service Area GIS mapping, which is not public and may have inaccuracies. However, the June 2017 service area coverage was not used in its entirety, as that would have required a complete reanalysis of the entire project, including the dasymetric analysis and all subsequent steps. The project schedule and budget did not allow for a complete reanalysis of this type. However, the population estimates for each PCWS service area are consistent through the model and report.

PCWS Population 2010 Pivot Table - #2

PCWS Pop 2010. For each PCWS system, provides a 2010 population estimate for each Group Code, the combination of residential density, housing age, topographic slope, geophysical area and precipitation density, as discussed in Per Capita Residential Water Demands by Housing Category. These population estimates are from the GIS-based dasymetric evaluation described in Appendix A.

PCWS Population 2040 Pivot Table - #3

PCWS Pop 2040. For each PCWS system, provides a 2040 population estimate for each Group Code. These population estimates are derived as described in Appendix A.

PCWS Population by Residential Development Density - #4

PCWS Pop HDMDLD. For each PCWS system, provides a 2010 and 2040 population estimate for each combination of residential density.

Annual Demands Table - #5

Annual. For each PCWS system, provides 2010 and 2040 estimates of demand for each relevant Group Code. Per capita demands for each Group Code are drawn from the worksheet #20 "2010 Lookup" for the 2010 and the 2040 No Conservation (Static) scenarios, and from the worksheet #21 "2040 Lookup" for the 2040 Conservation scenario. Populations are drawn from worksheets #2 "PCWS Pop 2010" and #3 "PCWS Pop 2040" respectively.

Annual Demands 2010 Pivot Table - #6

Ann2010. Pivot table drawn from worksheet #5 "Annual," with 2010 annual demands for each relevant Group Code and the complete PCWS.

Annual Demands 2040 No Conservation Scenario Pivot Table - #7

Ann2040 NC. Pivot table drawn from worksheet #5 "Annual," with 2040 annual demands under the No Conservation scenario for each relevant Group Code and the complete PCWS.

Annual Demands 2040 Conservation Scenario Pivot Table - #8

Ann2040 Cons. Pivot table drawn from worksheet #5 "Annual," with 2040 annual demands under the Conservation scenario for each relevant Group Code and the complete PCWS.

Summer Demands Table - #9

Summer. The information here is developed in the same manner as worksheet #5 "Annual" but for Summer demands.

Summer Demands 2010 Pivot Table - #10

S 2010. The information here is developed in the same manner as worksheet #6 "Ann2010" but for Summer demands.

Summer Demands 2040 No Conservation Scenario Pivot Table - #11

S 2040 NC. The information here is developed in the same manner as worksheet #7 "Ann2040 NC" but for Summer demands.

Summer Demands 2040 Conservation Scenario Pivot Table - #12

S 2040 Con. The information here is developed in the same manner as worksheet #8 "Ann2040 Cons" but for Summer demands.

Non-Summer Demands Table - #13

Non-Summer. The information here is developed in the same manner as worksheet #5 "Annual" but for Non-Summer demands.

Non-Summer Demands 2010 Pivot Table - #14

N-S 2010. The information here is developed in the same manner as worksheet #6 "Ann2010" but for Non-Summer demands.

Non-Summer Demands 2040 No Conservation Scenario Pivot Table - #15

N-S 2040 NC. The information here is developed in the same manner as worksheet #7 "Ann2040 NC" but for Non-Summer demands.

Non-Summer Demands 2040 Conservation Scenario Pivot Table - #16

N-S 2040 Cons. The information here is developed in the same manner as worksheet #8 "Ann2040 Cons" but for Non-Summer demands.

2010 Demands Summary Table - #17

2010 Summary. For each PCWS system, provides the sum of demands for Annual, Summer and Non-Summer from worksheets #6 "Ann2010", #10 "S 2010" and #14 "N-S 2010."

2040 Demands No Conservation Scenario Summary Table - #18

2040 NC Summary. For each PCWS system, provides the sum of demands for Annual, Summer and Non-Summer from worksheets #7 "Ann2040 NC", #11 "S 2040 NC" and #15 "N-S 2040 NC."

2040 Demands Conservation Scenario Summary Table - #19

2040 Cons Summary. For each PCWS system, provides the sum of demands for Annual, Summer and Non-Summer from worksheets #8 "Ann2040 Cons", #12 "S 2040 Cons" and #16 "N-S 2040 Cons."

2010 Lookup Table for Per Capita Residential Demand Rates - #20

2010 Lookup. Provides the applicable per capita rates by relevant Group Code for use in both the 2010 and 2040 No Conservation scenarios. The rates are derived from the results from the case PCWS systems, using the median values for each Group Code (excluding outlier values). Where results for a Group Code were unavailable or too sparse for an appropriate median, the results for another relevant Group Code were used. As shown in the worksheet, the result is that per capita demands could not be differentiated based on housing age, slope or precipitation. Only geophysical province and residential density were found to provide useable results.

2040 Lookup Table for Per Capita Residential Demand Rates, Conservation Scenario - #21

2040 Lookup. Provides the applicable per capita rates by relevant Group Code for use in the 2040 Conservation scenario. The scenario is discussed in Residential Demand Scenarios. The rates are derived from the results from the 2010 Lookup Table. These rates were modified using the Conservation scenario where rates were assumed to trend lower unless they were already at or below 35 gpcd, at which point they remained stable.

Per Capita Demand Estimates for Case PCWS Systems - #22

gpcd for Case PCWS. This table summarizes the 2010 per capital residential demands by development density for each PCWS system that provided residential demand data, for Annual, Summer and Non-Summer periods. These values are pasted from separate spreadsheets for each system, and those spreadsheets were derived from GIS analyses of the raw data using the methodology discussed in Per Capital Residential Water Demands by Housing Category.

The table also provides 2040 values for the Conservation scenario that are used in direct calculation of these demands for these systems only. The values are based on the methodology described in Residential Demand Scenarios in the same manner as for other PCWS systems, but using the actual values for each case PCWS system rather than the nominal values used for the other systems.

Appendix C. PCWS System Demands Model Construction

The NJDEP 2040 Demands Model spreadsheet is multiple models within a single spreadsheet. The models are:

- Case PCWS Systems Models – Developed only for systems for which useable data were provided, as discussed in Evaluation of Current Water Demands. Results are calculated for 2010, 2040 (No Conservation) and 2040 (Conservation) scenarios.
    1. **2010**: The residential demands are based on the calculated per capita rates using system-specific data. The commercial and industrial demands are based on either available data or estimates using relative commercial and industrial land uses. Water losses are based on available data or the application of values based on other systems for which water loss rates were available.
    2. **2040**: The residential demands as for the 2010 demands, but using population changes for 2040 (No Conservation Scenario). For the Conservation Scenario, the model applies modified per capita rates using the same assumptions on per capita rates as for other systems, as discussed in "2040 Conservation Scenario Calculated Model" below.
- 2010 Baseline Model – Calculated for all systems, including the case PCWS systems, using the 2010 Residential demands as discussed in Appendix B, and estimates of commercial and industrial demands based on either available data or estimates using relative commercial and industrial land uses. Water losses are based on available data or the application of values based on other systems for which water loss rates were available.
- 2040 No Conservation Scenario Calculated Model – Calculated for all systems, including the case PCWS systems, using the 2040 Residential demands as discussed in Appendix B. Commercial demands for 2010 were assumed to change proportional to changes in residential demands, and industrial demands were assumed to remain stable from 2010. Water losses are based on two scenarios (Nominal and Optimal), using the current median and 25th percentile results, respectively, from systems for which water loss rates were available.
- 2040 No Conservation Scenario Extrapolation Models – Two sets of three scenarios are used here. The first set uses the peak demands from the Water Supply Deficit/Surplus calculations of NJDEP for each system as the starting point (i.e., initial demands), while the second set uses as its starting point the average demands for 2008 to 2015 from the NJ Water Tracking model (NJWaTr) as provided by NJDEP in August 2017. Because the first set uses a peak year as its initial demand, it is likely to overestimate future average demands. The second set, being based on average demands, is likely to underestimate peak stresses in the future. Each has its value but also its limitations. For each set of models, there are three scenarios.
    1. Assumes that initial demands will increase or decrease proportionally to population change with no alteration of water losses.
    2. Applies the Nominal water loss values along with the effects of population change
    3. Applies the Optimum water loss values along with the effects of population change.

- 2040 Conservation Scenario Calculated Model – Calculated in the same manner as for the 2040 No Conservation Scenario Calculated Model except that the model applies modified per capita rates using assumptions as discussed in Residential Demand Scenarios.
- 2040 Conservation Scenario Extrapolation Models – These estimates are developed in the same manner as for the 2040 No Conservation Scenario Extrapolation Models. However, for each set of models, there are only two scenarios.
    1. Applies the Nominal water loss values along with the effects of population change
    2. Applies the Optimum water loss values along with the effects of population change.

Worksheet Explanations

Comparisons of All Model Results

Model Comparisons. This worksheet includes available information on PCWS system capacity and recent demands, and incorporates the results of all the modeling scenarios discussed above. By worksheet Column, the provided information is as follows:

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
D. **PWCS Data?** "Y" indicates that the PCWS system provided residential demand data used in the analysis.
E. **Top 80% Cumulative Demand**. "Y" indicates that the PCWS system is among the largest systems in terms of total demand, not firm capacity. All of the indicated systems add to 80% of total supplied demand in Column G.
F. **Firm Capacity (MGD)**. As provided by NJDEP. Not all systems have available values.
G. **Peak Annual D/S Demand (MGD)**. The highest annual demand in the last five completed years for which data were compiled by NJDEP. Most recent spreadsheet provided in May 2017. Not all systems have available values.

2010 Baseline Model Demands

H. **Baseline Model Demand (WL on D/S) (MGD)**. From worksheet 'Baseline Model' Column T.
I. **Baseline Model Demand (WL on NJWaTr) (MGD)**. From worksheet 'Baseline Model' Column U.

2040 No Change Scenarios

J. **Total Demand (Nominal WL) (MGD)**. From worksheet 'Baseline Model' Column AE.
K. **Total Demand (Optimum WL) (MGD)**. From worksheet 'Baseline Model' Column AG.

2040 Conservation Scenarios

L. **Total Demand (Nominal WL) (MGD)**. From worksheet 'Conservation Model' Column M.
M. **Total Demand (Optimum WL) (MGD)**. From worksheet 'Conservation Model' Column O.

2040 NC Scenario Extrapolations from D/S Demands

N. **Pop Change % X D/S Annual (MGD)**. From worksheet 'Baseline Model' Column AN.
O. **2040 NC Change % (Nominal WL) X D/S Annual (MGD)**. From worksheet 'Baseline Model' Column AO.
P. **2040 NC Change % (Optimal WL) X D/S Annual (MGD)**. From worksheet 'Baseline Model' Column AP.

2040 NC Scenario Extrapolations from NJWaTr Demands

Q. **Pop Change % X NJWaTr Avg (MGD)**. From worksheet 'Baseline Model' Column AQ.
R. **2040 NC Change % (Nominal WL) X NJWaTr Avg (MGD)**. From worksheet 'Baseline Model' Column AR.
S. **2040 NC Change % (Optimal WL) X NJWaTr Avg (MGD)**. From worksheet 'Baseline Model' Column AS.

2040 Cons Extrapolations from D/S Demands

T. **Model Change % (Nominal WL) X D/S Annual (MGD)**. From worksheet 'Conservation Model' Column W.
U. **Model Change % (Optimal WL) X D/S Annual (MGD)**. From worksheet 'Conservation Model' Column X.

2040 Cons Extrapolations from NJWaTr Demands

V. **Model Change % (Nominal WL) X NJWaTr (MGD)**. From worksheet 'Conservation Model' Column Y.
W. **Model Change % (Optimal WL) X NJWaTr (MGD)**. From worksheet 'Conservation Model' Column Z.

Baseline Models for 2010 and 2040 No Conservation Scenarios

<u>Baseline Model</u>. This worksheet includes available information on PCWS system capacity and recent demands, and calculates or provides the results of the case PCWS system and calculated modeling for 2010 and for 2040 No Conservation scenarios. By worksheet Column, the provided information is as follows:

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
D. **PWCS Data?** "Y" indicates that the PCWS system provided residential demand data used in the analysis.
E. **Top 80% Cumulative Demand**. "Y" indicates that the PCWS system is among the largest systems in terms of total demand, not firm capacity. All of the indicated systems add to 80% of total supplied demand in Column G.
F. **Firm Capacity (MGD)**. As provided by NJDEP. Not all systems have available values.
G. **Peak Annual D/S Demand (MGD)**. The highest annual demand in the last five completed years for which data were compiled by NJDEP. Most recent spreadsheet provided in May 2017. Not all systems have available values.

NJWaTr 2008-2015 Demands and Comparisons

H. **NJWaTr 2008-2015 Average Demand (MGD)**. Provided by NJDEP August 2017. Not all systems have available values.
I. **Peak D/S - NJWaTr Avg (MGD)**. Comparison of the demands in Columns G and H, with a positive indicating that the D/S peak annual demand is higher. A negative indicates that the 2008-2015 average is higher, which could be explained by high demands prior to 2012 (the most recent year included in the D/S spreadsheet) or inconsistencies in the demands included within the two spreadsheets.
J. **Peak D/S - NJWaTr Avg (% of Peak D/S)**. Column I expressed as a percentage of Column G. As can be seen, some values are highly positive or negative, indicating that additional analysis of the underlying data may be appropriate.

Estimated Water Losses-D/S Demand

K. **Estimated Total Water Loss 2015 (MGD)**. From the worksheet 'WL Filled', Column P, based on a percentage of Column G.
L. **Estimated Delivered Water 2015 (MGD**). Column K subtracted from Column G.

Estimated Water Losses-NJWaTr Demand

M. **Estimated Total Water Loss 2015 (MGD)**. From the worksheet 'WL Filled', Column Q, based on a percentage of Column H.
N. **Estimated Delivered Water 2015 (MGD)**. Column M subtracted from Column H.

Summary Calculations for Initial Demand Scenarios

O. **RES 2010 (MGD)**. From worksheet 'PCWS 2010 RES' Column AJ.
P. **COMM 2010 (MGD)**. From worksheet '2010 COMM' Column I
Q. **IND 2010 (MGD)**. From worksheet 'INDUSTRIAL' Column J
R. **Baseline Model Demand (WL on D/S) (MGD)**. Sum of Columns K,O,P,Q
S. **Baseline Model Demand (WL on NJWaTr) (MGD)**. Sum of Columns Q,P,O,M

Model v D/S Demand Comparison

T. **Baseline-D/S Demand (MGD)**. Column R subtracted from Column G
U. **Baseline-D/S Demand (%)**. Column T as a percentage of Column G

Model v NJWaTr Demand Comparison

V. **Baseline-NJWaTr Demand (MGD)**. Column S subtracted from Column H
W. **Baseline-NJWaTr Demand (%)**. Column V as a percentage of Column H
X. **Change in % Difference from D/S to NJWaTr**. Column U subtracted from Column W. A negative indicates that the estimates based on NJWaTr are lower than those based on the D/S Demand as an initial value. See Column J for further notes.

2040 Annualized Water Demand Calculations Summary (No Change in Residential gpcd from 2010 Calculations)

Y. **RES 2040 (MGD)**. From worksheet 'PCWS 2040 RES NC Scenario' Column AJ
Z. **COMM 2040 (MGD)**. From worksheet '2040 COMM' Column E
AA. **2040 RIC Demand (MGD)**. Sum of Columns Y,Z,Q.
AB. **Water Loss 2040 "Nominal Rates" (MGD)**. Back-calculation of water losses in MGD by subtracting RIC demand of Column AA from total demand of Column AC3
AC. **2040 Total Demand (Nominal WL) (MGD)**. Calculated by dividing Column AA by the fraction (1 minus the WL percentage from worksheet 'WL Filled' Column R)
AD. **Water Loss 2040 "Optimal System" (MGD)**. Back-calculation of water losses in MGD by subtracting RIC demand of Column AA from total demand of Column AE
AE. **2040 Total Demand (Optimum WL) (MGD)**. Calculated by dividing Column AA by the fraction (1 minus the WL percentage from worksheet 'WL Filled' Column S)

Comparisons (Water Losses based on D/S Demands)

AF. **Total Demand (Nominal WL) Change 2010 to 2040 (MGD)**. Column AC minus Column R. Column R demands incorporate water losses using a percentage of the D/S Demands, which will be different from water losses based on the same percentage of NJWaTr demands. Nominal Water Losses are used for this calculation.

AG. **Change from 2010 Totals (%) (Nominal WL) (MGD)**. Column AF divided by Column R as a percentage. High positive and negative percentages indicate greater change from the 2010 demands.

AH. **Total Demand (Optimal WL) Change 2010 to 2040 (MGD)**. Column AE minus Column R. Column R demands incorporate water losses using a percentage of the D/S Demands, which will be different from water losses based on the same percentage of NJWaTr demands. Optimal Water Losses are used for this calculation, and so generally the result is slight to major reductions in demand.

AI. **Change from 2010 Totals (%) (Optimum WL)**. Column AH divided by Column R as a percentage. High positive and negative percentages indicate greater change from the 2010 demands.

AJ. **Firm Capacity - 2040 Total (Nominal WL) (MGD)**. Column F minus Column AC, provided a measure of remaining Firm Capacity as of 2040 in this scenario.

AK. **2040 - D/S Annual (MGD)**. Column AC minus Column G. Indicates whether 2040 demands in this scenario are higher or lower than the current D/S peak demands.

Extrapolations from D/S Demands

AL. **Pop Change % X D/S Annual (MGD)**. Straight population-based extrapolation of the D/S Demand to 2040. Column G plus Column G times Column O from worksheet 'PCWS Pop 2010-40'.

AM. **2040 NC Change % (Nominal WL) X D/S Annual (MGD)**. Extrapolation based on D/S Demands and the calculations of change using Nominal Water Loss rates. Column G plus Column G times Column AG.

AN. **2040 NC Change % (Optimal WL) X D/S Annual (MGD)**. Extrapolation based on D/S Demands and the calculations of change using Optimum Water Loss rates. Column G plus Column G times Column AI.

Extrapolations from NJWaTr 2008-2015 Average Demands

AO. **Pop Change % X NJWaTr Avg (MGD)**. Straight population-based extrapolation of the NJWaTr Demand to 2040. Column H plus Column H times Column O from worksheet 'PCWS Pop 2010-40'.

AP. **2040 NC Change % (Nominal WL) X NJWaTr Avg (MGD)**. Extrapolation based on NJWaTr Demands and the calculations of change using Nominal Water Loss rates. Column H plus Column H times Column AG.

AQ. **2040 NC Change % (Optimal WL) X NJWaTr Avg (MGD)**. Extrapolation based on NJWaTr Demands and the calculations of change using Optimum Water Loss rates. Column H plus Column H times Column AI.

2040 Seasonal Water Demand Calculations Summary (No Change in Residential gpcd from 2010 Calculations)

AR. **RES Non-Summer 2040 (MGD)**. From worksheet 'PCWS 2040 RES NC Scenario' Column AK

AS. **COMM/IND Non-Summer 2040 (MGD)**. Sum of Columns Z+Q

AT. **Water Loss Nominal Rates 2040 (MGD)**. Back-calculation of water losses by subtracting RIC demands (Columns Q+AR+AS) from total demand of Column AU.

AU. **2040 Non-Summer Demand (MGD)**. Calculated by dividing the sum of Columns AR+AS by the fraction (1 minus the WL percentage from worksheet 'WL Filled' Column R). This calculation uses Nominal Water Losses.
AV. **Firm Capacity - 2040 Non-Summer (MGD)**. Column F minus Column AU, provided a measure of remaining Firm Capacity as of 2040 in this scenario.
AW. **RES Summer 2040 (MGD)**. From worksheet 'PCWS 2040 RES NC Scenario' Column AL
AX. **COMM/IND Summer 2040 (MGD)**. Sum of Columns Z+Q
AY. **Water Loss Nominal Rates 2040 (MGD)**. Back-calculation of water losses by subtracting RIC demands (Columns Q+AW+AX) from total demand of Column AZ.
AZ. **2040 Summer Demand (MGD)**. Calculated by dividing the sum (of Columns Q+AW+AX+Column AC of the worksheet 'PCWS 2040 RES NC Scenario') by the fraction (1 minus the WL percentage from worksheet 'WL Filled' Column R). This calculation uses Nominal Water Losses. The value from Column AC of the worksheet 'PCWS 2040 RES NC Scenario' is an estimate of tourism-driven summer demands.
BA. **Firm Capacity - 2040 Summer (MGD)**. Column F minus Column AZ.

2040 Conservation Scenario Models

Conservation Model. This worksheet includes available information on PCWS system capacity and recent demands, and calculates or provides the results of the case PCWS system and calculated modeling for the 2040 Conservation scenario. By worksheet Column, the provided information is as follows:

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
D. **PWCS Data?** "Y" indicates that the PCWS system provided residential demand data used in the analysis.
E. **Top 80% Cumulative Demand**. "Y" indicates that the PCWS system is among the largest systems in terms of total demand, not firm capacity. All of the indicated systems add to 80% of total supplied demand in Column G.
F. **Firm Capacity (MGD)**. As provided by NJDEP. Not all systems have available values.
G. **Peak Annual D/S Demand (MGD)**. The highest annual demand in the last five completed years for which data were compiled by NJDEP. Most recent spreadsheet provided in May 2017. Not all systems have available values.
H. **NJWaTr 2008-2015 Average Demand (MGD)**. Provided by NJDEP August 2017. Not all systems have available values.

2040 Annualized Water Demand Calculations Summary (Residential gpcd Conservation Rates)

I. **RES 2040 (MGD)**. From worksheet 'PCWS 2040 RES Cons Scenario' Column AJ
J. **COMM 2040 (MGD)**. From worksheet '2040 COMM' Column E
K. **2040 RIC Demand (MGD)**. Sum of I+J+Column Q from worksheet 'Baseline Model'
L. **Water Loss 2040 "Nominal Rates" (MGD)**. Back-calculation of water losses in MGD by subtracting RIC demand of Column K from total demand of Column M.

M. **2040 Total Demand (Nominal WL) (MGD)**. Calculated by dividing Column K by the fraction (1 minus the WL percentage using worksheet 'WL Filled' Column R).
N. **Water Loss 2040 "Optimal System" (MGD)**. Back-calculation of water losses in MGD by subtracting RIC demand of Column K from total demand of Column O.
O. **2040 Total Demand (Optimum WL) (MGD)**. Calculated by dividing Column K by the fraction (1 minus the WL percentage using worksheet 'WL Filled' Column S).

Comparisons

P. **Change from 2010 Totals (Nominal WL) (MGD)**. Calculated by subtracting the 2010 demands (Column R from worksheet 'Baseline Model') from Column M.
Q. **Change from 2010 Totals (%) (Nominal WL)**. Column P divided by Column R from worksheet 'Baseline Model'.
R. **Change from 2010 Totals (MGD) (Optimal WL)**. Calculated by subtracting the 2010 demands (Column R from worksheet 'Baseline Model') from Column O.
S. **Change from 2010 Totals (%) (Optimal WL)**. Column R divided by Column R from worksheet 'Baseline Model'.
T. **2040 Reductions from No Change to Cons (Optimal WL)**. Column O from the worksheet 'Conservation Model'! minus Column AE from the worksheet 'Baseline Model'.
U. **Firm Capacity - 2040 Cons Total (Nominal WL) (MGD)**. Column F minus Column M.
V. **D/S Annual -2040 Cons (MGD)**. Column G minus Column M.

2040 Cons Extrapolations from D/S Demands

W. **Model Change % (Nominal WL) X D/S Annual (MGD)**. Extrapolation based on D/S Demands and the calculations of change using Nominal Water Loss rates. Column G plus Column G times Column Q.
X. **Model Change % (Optimal WL) X D/S Annual (MGD)**. Extrapolation based on D/S Demands and the calculations of change using Optimum Water Loss rates. Column G plus Column G times Column S.

2040 Cons Extrapolations from NJWaTr Demands

Y. **Model Change % (Nominal WL) X NJWaTr (MGD)**. Extrapolation based on NJWaTr Demands and the calculations of change using Nominal Water Loss rates. Column H plus Column H times Column Q.
Z. **Model Change % (Optimal WL) X NJWaTr (MGD)**. Extrapolation based on NJWaTr Demands and the calculations of change using Optimal Water Loss rates. Column H plus Column H times Column S.

2040 Seasonal Water Demand Calculations Summary (Residential gpcd Conservation Rates)

AA. **RES Summer 2040 (MGD)**. From worksheet 'PCWS 2040 RES Cons Scenario' Column AK

AB. **COMM/IND Non-Summer 2040 (MGD)**. Column J plus Column Q from worksheet 'Baseline Model'

AC. **Water Loss Nominal Rates 2040 (MGD)**. Back-calculated as Column AD minus the sum of Columns AA+AB.

AD. **2040 Non-Summer Demand (MGD)**. Calculated by dividing sum of Columns AA+AB by the fraction (1 minus the WL percentage using worksheet 'WL Filled' Column R).

AE. **Firm Capacity -2040 Non-Summer (MGD)**. Column F minus Column AD.

AF. **RES Summer 2040 (MGD)**. From worksheet 'PCWS 2040 RES Cons Scenario' Column AL.

AG. **COMM/IND Summer 2040 (MGD)**. Value from Column AB.
AH. **Water Loss Nominal Rates 2040 (MGD)**. Back-calculated as Column AI minus the sum of Columns AF+AG.
AI. **2040 Summer Demand (MGD)**. Calculated by dividing sum of Columns AF+AG by the fraction (1 minus the WL percentage using worksheet 'WL Filled' Column R).
AJ. **Firm Capacity - 2040 Summer (MGD)**. Column F minus Column AI.

Table of PCWS System Populations for 2010 and 2040

PCWS Pop 2010-2040. This table provides the results of the dasymetric analysis of populations by PCWS system and development density. Values are available only for those PCWS systems that have been mapped by NJDEP as of June 2017. By worksheet Column, the provided information is as follows:

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
D. **PWCS Data?** "Y" indicates that the PCWS system provided residential demand data used in the analysis.
E. **PWID**. Where a value is shown, it matches the PWSID in Column A and indicates that a mapped service area existed and therefore the dasymetric analysis was feasible for the system. All other PCWS systems are blank from Column E through S.
F. **HD Total**. High Density Residential population estimate for 2010.
G. **MD Total**. Medium Density Residential population estimate for 2010.
H. **LD Total**. Low Density Residential population estimate for 2010.
I. **2010 TOTAL**. Total population for the PCWS System in 2010.
J. **HD Total**. High Density Residential population estimate for 2040.
K. **MD Total**. Medium Density Residential population estimate for 2040.
L. **LD Total**. Low Density Residential population estimate for 2040.
M. **2010 TOTAL**. Total population for the PCWS System in 2040.
N. **Change**. Change in total population (2040 minus 2010).
O. **% Change**. Change based on Column N as a percent of Column I.
P. **HD Pop Change**. Change in High Density population (2040 minus 2010).
Q. **MD Pop Change**. Change in Medium Density population (2040 minus 2010).
R. **LD Pop Change**. Change in Low Density population (2040 minus 2010).
S. **LD %**. Low Density population as a percent of total population in 2010. Column H as a percent of Column I.

Residential Demands by PCWS System for 2010 Baseline Model

PCWS 2010 RES. This worksheet includes two modeling approaches for 2010 residential demands. One applies only to the case PCWS systems and uses the per capita residential rates derived from their residential demand data to calculate demands. The other uses the information from the "Model RES 2010_2040 Demands 2017.08.01" spreadsheet discussed in Appendix B. The results of the PCWS 2010 RES worksheet are used in the Baseline Model worksheet. By worksheet Column, the provided information is as follows:

PCWS System Listing from NJDEP Water Supply Deficit/Surplus Spreadsheet

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
D. **PWSID Check**. This column is included to ensure that the results of Columns E through G (from the "Model RES 2010_2040 Demands 2017.08.01" spreadsheet) are properly associated with the value in Column A. Where there is no listing in Column D, no information was available from the "Model RES 2010_2040 Demands 2017.08.01" spreadsheet, for the reasons discussed in Appendix B.

Based on Calculated Residential gpcd Rates from Purveyor Data

H – J; N – O; T – V. **Case PCWS Per Capita Rates**. For case PCWS only, the values shown are per capita residential demand rates (gpcd) from the analysis of their system demand data, for High, Medium and Low density residential, respectively. Annual, Non-Summer and Summer rates are shown.

K – M; Q – S; W – Y. **Case PCWS Residential Density-Related Demands**. For case PCWS only, the values shown are the relevant per capita residential demand rates (gpcd) for High, Medium and Low density residential, respectively, multiplied by the relevant 2010 population for the system, for Annual, Non-Summer and Summer demands.

Z – AB. **Case PCWS Total Demands**. For case PCWS only, the values shown are sum of demands for High, Medium and Low density residential, as Annual, Non-Summer and Summer.

AC. **Seasonal Component (MGD)**. PCWS systems with a major component of their service areas along the Atlantic Ocean coast have distinctive demand patterns driven by summer tourism, both residential and commercial. The spreadsheet "Seasonal Coastal Users Demand Factors" provides an analysis of the extent to which increased summer demands exceed the ratios normally associated with summer to non-summer demands, resulting in a "Seasonal Component" of demand that is listed in this column.

Totals Based on Calculated Demands

AD. **Total Annual Demand (MGD)**. If Column Z=0, then this column is the sum of Columns E+AC (the generic model demand plus the Seasonal Component); otherwise it is the sum of Columns Z+AC (the case PCWS demand plus the Seasonal Component) for Annual Demands.

AE. **Total Non-Summer Demand (MGD)**. Likewise, if Column AA=0, then this column has the value of Column F (the Seasonal Component is not relevant to Non-Summer demands); otherwise it is Column AA (the case PCWS demand) for Non-Summer Demands.

AF. **Total Summer Demand (MGD)**. Likewise, if Column AB=0, then this column is the sum of Columns G+AC (the generic model demand plus the Seasonal Component); otherwise it is the sum of Columns AB+AC (the case PCWS demand plus the Seasonal Component) for Summer Demands.

Totals Based on D/S Demands. There are PCWS systems where no demands could be calculated due to the lack of GIS-based service areas and other key data. In these cases, the peak annual demand from the D/S spreadsheet is used as a surrogate demand.

AG. **Total Annual Demand (MGD)**. If Column AD=0, then the value from the worksheet 'DeficitSurplus 2017' Column K is used. Otherwise, the value FALSE is logged.

AH. **Total Non-Summer Demand (MGD)**. If Column AE=0, then the value from the worksheet 'DeficitSurplus 2017' Column K is used. Otherwise, the value FALSE is logged.

AI. **Total Summer Demand (MGD)**. If Column AF=0, then the value from the worksheet 'DeficitSurplus 2017' Column K is used. Otherwise, the value FALSE is logged.

Applicable Totals

AJ. **Total Annual Demand (MGD)**. If Column AD is >0, then the AD value is shown; otherwise the Column AG value is shown.

AK. **Total Non-Summer Demand (MGD)**. If Column AE is >0, then the AE value is shown; otherwise the Column AH value is shown.

AL. **Total Summer Demand (MGD)**. If Column AF is >0, then the AF value is shown; otherwise the Column AI value is shown.

Residential Demands by PCWS System for 2040 No Conservation Scenario

PCWS 2040 RES NC Scenario. This spreadsheet is structured the same as the worksheet 'PCWS 2010 RES', but uses 2040 population estimates. All other factors and equations are the same as 'PCWS 2010 RES'.

Residential Demands by PCWS System for 2040 Conservation Scenario

PCWS 2040 RES Cons Scenario. This spreadsheet is structured the same as the worksheets 'PCWS 2010 RES' and 'PCWS 2040 RES NC Scenario', but uses 2040 population estimates and conservation rates for per capita residential demands. All other factors and equations are the same as the prior two worksheets.

Land Uses of Water Supply Service Areas

WSSA LU. The values in this worksheet were derived in GIS from the PCWS Service Area information provided to Rutgers by NJDEP, with the latest version being June 2017. The service area mapping is not complete and therefore is not a publicly available product. By worksheet Column, the provided information is as follows:

C. **PWSID #**. The PWSID associated with the PCWS system
D. **County**. The primary county for the PCWS system as listed by NJDEP
E. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez)
F. **PWSID Check**. This column is included to ensure that the results of Columns G through X are properly associated with the value in Column C. Where there is no listing in Column G, no information was available for land uses in the PCWS service area, for the reasons discussed in Appendix B.
G. **PCWS Acres**. Total acres in the PCWS service area for all types of land use and undeveloped areas.
H. **1110 HDR Acres**. Total acres of High Density Residential (Anderson Code 1110) within the PCWS service area.
I. **1110 HDR %**. Column H as a percentage of Column G.

J. **1120 MDR Acres**. Total acres of Medium Density Residential (Anderson Code 1120) within the PCWS service area.
K. **1120 MDR %**. Column J as a percentage of Column G.
L. **1130 LDR Acres**. Total acres of Low and Rural Density Residential (Anderson Codes 1130 and 1140) within the PCWS service area.
M. **1130 LDR %**. Column L as a percentage of Column G.
N. **1200 COMM**. Total acres of Commercial land use (Anderson Code 1200) within the PCWS service area.
O. **1200 C %**. Column N as a percentage of Column G.
P. **1300 IND**. Total acres of Industrial land use (Anderson Code 1300) within the PCWS service area.
Q. **1300 IND %**. Column P as a percentage of Column G.
R. **Total Acres**. Total acres in the PCWS service area for developed land uses only, from Columns H, J, L, N and P.
S. **Total %**. Column R as a percentage of Column G.
T. **Comm/Res Ratio**. Column N divided by the sum of Columns H, J and L.
U. **<=2% Commercial**. Y or N value regarding whether Column O is equal to or less than 2%.
V. **<=6% Commercial**. Y or N value regarding whether Column O is equal to or less than 6%.
W. **>6% Commercial**. Y or N value regarding whether Column O is greater than 6%.
X. **<=2% Industrial**. Y or N value regarding whether Column Q is equal to or less than 2%.

Commercial Demands 2010

<u>2010 COMM</u>. This worksheet calculates estimated Commercial demands based on the relative PCWS service area within Commercial land use, as provided in the worksheet 'WSSA LU.' The equations used for Commercial demands are discussed in Commercial and Industrial Demands under the section Extrapolation to Other PCWS Systems. By worksheet Column, the provided information is as follows:

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez).
D. **Purveyor Provided %**. Some purveyors provided information on the percent of total demand that is metered to Commercial Customers. These values are used here.
E. **COMM Purveyor**. Equal to Column D times Column L of the worksheet 'Baseline Model', which is the estimated delivered water for the PCWS system. In some cases, the PCWS system provided actual Commercial demand, which is noted here without a corresponding value in Column D.
F. **<=2% Commercial**. If Column U from worksheet 'WSSA LU' is "Y", then the value is zero (0). Otherwise, the value is "NA". The model assigns no Commercial demand if the Commercial land use percentage is less than 2%.
G. **<=6% Commercial**. If Column V from worksheet 'WSSA LU' is "Y" then the value here is the 2010 Residential demand from Column AD of worksheet 'PCWS 2010 RES' divided by 5. Otherwise, the value is NA.

H. **>6% Commercial**. If Column W from worksheet 'WSSA LU' is "Y" then the value here is the 2010 Residential demand from Column AD of worksheet 'PCWS 2010 RES' divided by 2.5. Otherwise, the value is NA.
I. **COMM (MGD)**. This column enters either Column E if greater than zero (0) or the maximum value in Columns F, G and H. This value also is shown as Column P in the worksheet 'Baseline Model'.

Commercial Demands 2040

2040 COMM. This worksheet calculates the 2040 Commercial demand estimates as the 2010 demand times the percent change in population, for both the No Conservation and Conservation scenarios. By worksheet Column, the provided information is as follows:

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez).
D. **%Pop Change 2010-2040**. From Column O of worksheet 'PCWS Pop 2010-40'.
E. **2040 COMM NC Demand (MGD)**. Calculated as the 2010 Commercial demand (Column P of worksheet 'Baseline Model') plus that value times Column D. The assumption is that Commercial demand is linear with changes in population.
F. **2040 COMM Cons Demand (MGD)**. Calculated as Column E times 0.9 to reflect a 10% reduction in demand due to conservation.

Industrial Demands

INDUSTRIAL. This worksheet calculates estimated Industrial demands based on the relative PCWS service area within Industrial land use, as provided in the worksheet 'WSSA LU.' The equations used for Industrial demands are discussed in Commercial and Industrial Demands under the section Extrapolation to Other PCWS Systems. By worksheet Column, the provided information is as follows:

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez).
D. **Purveyor Provided %**. Some purveyors provided information on the percent of total demand that is metered to Industrial customers. These values are used here.
E. **IND 2010 Purveyor**. Equal to Column D times Column L of the worksheet 'Baseline Model', which is the estimated delivered water for the PCWS system. In some cases, the PCWS system provided actual Industrial demand, which is noted here without a corresponding value in Column D.
F. **<=2% Industrial**. Inserts Column X from worksheet 'WSSA LU' as "Y" or "N".
G. **%IND Land**. Inserts Column Q from worksheet 'WSSA LU' as a percentage
H. **Imputed % IND**. Calculates an industrial demand factor for any PCWS where Column F is "Y". The value is equal to "0.01+((G2-0.02)*2.375)".
I. **Imputed IND (MGD)**. Column H2 times Column G in the worksheet 'Baseline Model'.

J. **IND Demand (MGD)**. This column enters either Column E if greater than zero (0) or Column I. This value also is shown as Column Q in the worksheet 'Baseline Model'.

Water Losses Values for 2010 and 2040 Models

WL Filled. This worksheet is based on the next worksheet, 'WL Analysis' and has many of the same fields. However, this worksheet includes estimated water losses for all systems that lack direct information. By worksheet Column, the provided information is as follows:

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez).
D. **Total Limits (MGM)**. From Column I of worksheet 'D_S 2017'.
E. **System Size: L (>=300MGM); M (>=30MGM); S (<30MGM)**. Based on Column D.
F. **Baseline WL (%) Reported**. Percentage water losses as reported. No value is shown for PCWS systems that did not report recent estimates to NJDEP or the Delaware River Basin Commission. Problematic values are highlighted in orange.
G. **Year Reported**. Most recent year for water loss estimate.
H. **PWCS Data?** "Y" indicates that a case PCWS provided demand data. From Column D of 'Baseline Model'.
I. **UAW or NRW Method**. As relevant.
J. **Peak Annual D/S Demand (MGD)**. From Column G of 'Baseline Model'.
K. **NJWaTr Average Demand**. From Column H of 'Baseline Model'.
L. **Topography: CP=Coastal Plain; BR=Bedrock**. Based on predominant location of the PCWS service area.
M. **2010 WL (%) for Model**. For PCWS systems that reported values to NJDEP or DRBC, the value in Column F is used except for highlighted values, where the 25th percentile value is substituted. For all other PCWS systems, a value is Assigned based on a table of median water losses, by Topography and System Size.
N. **Basis**. Recent Estimate, 25th Percentile or Assigned.
O. **Total UAW/NRW (D/S Demands)**. Column M times Column J.
P. **Total UAW/NRW (NJWaTr Demands)**. Column M times Column K.
Q. **2040 WL Nominal Value (%)**. "Business as Usual" percentage. Discussed in Water Loss Projections.
R. **2040 WL "Optimum System" Value (%)**. "Aggressive Water Loss Reduction" percentage. Discussed in Water Loss Projections.

Water Losses Analysis

WL Analysis. This worksheet uses available information from NJDEP and the Delaware River Basin Commission to develop Water Loss percentages to use for systems lacking recent Water Loss estimates, and as a basis for assumed 2040 water losses. The worksheet includes all PCWS, but only those with Water Loss information (228 of 584 systems) are shown. By worksheet Column, the provided information is as follows:

A. **PWSID #**. The PWSID associated with the PCWS system
B. **County**. The primary county for the PCWS system as listed by NJDEP
C. **Name**. The PCWS system name as listed by NJDEP (with limited modifications to update names, such as from United Water to Suez).
D. **Total Limits (MGM)**. From Column I of worksheet 'D_S 2017'.
E. **System Size: L (>=300MGM); M (>=30MGM); S (<30MGM)**. Based on Column D.
F. **Baseline WL (%) Reported**. Percentage water losses as reported. Problematic values are highlighted in orange.
G. **Year Reported**. Most recent year for water loss estimate.
H. **UAW or NRW Method**. As relevant.
I. **Annual Demand Per NJDEP D/S (MGD)**. From Column G of 'Baseline Model'.
J. **Topography: CP=Coastal Plain; BR=Bedrock**. Based on predominant location of the PCWS service area.
K. **2010 WL (%) for Model**. The value in Column F is used except for highlighted values, where the 25th percentile value is substituted.
L. **Basis**. Recent Estimate or 25th Percentile.
M. **Comments**. Used to capture ILI values were available.
N. **Total UAW/NRW**. Column K times Column I.
O. **Assumed Real Losses (82%)**. Column O times 0.82, based on DRBC findings that "real" losses are 82% of total losses, on weighted average.

NJDEP May 2017 Water Supply Deficit/Surplus Spreadsheet

D_S 2017. This spreadsheet is a direct copy of the spreadsheet provided by NJDEP. One value (Column O for Garfield City Water Department, PWSID 0221001) was corrected with information confirmed by the NJDEP Bureau of Water Allocation. Some names were updated, especially from United Water to Suez New Jersey (Suez-NJ).

Appendix D. Case PCWS System Per Capita Residential Rates and Seasonal Ratios

The following pages show paired figures of per capita residential demand rates (gpcd) and seasonal ratios for thirteen case PCWS systems. The figures are followed by tables of per household and per capita residential water demands for all the case study PCWS systems.

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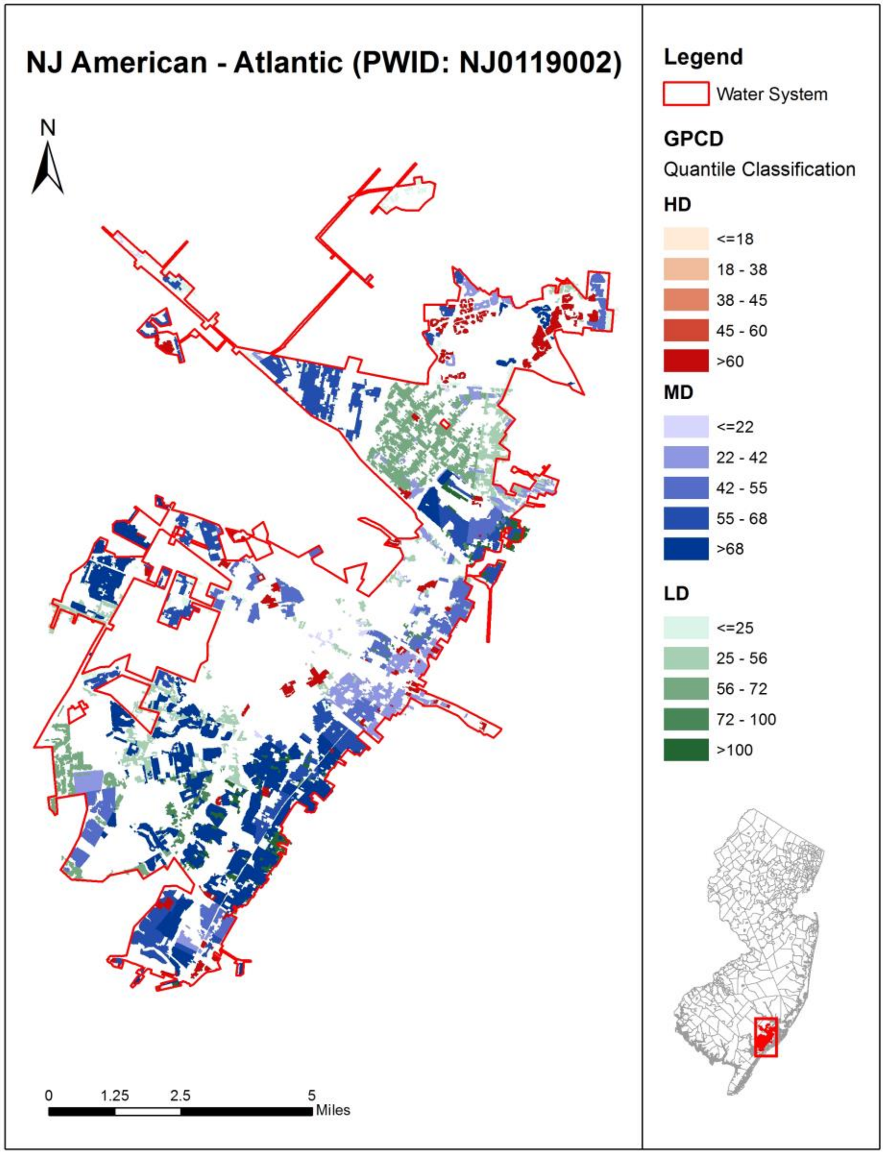
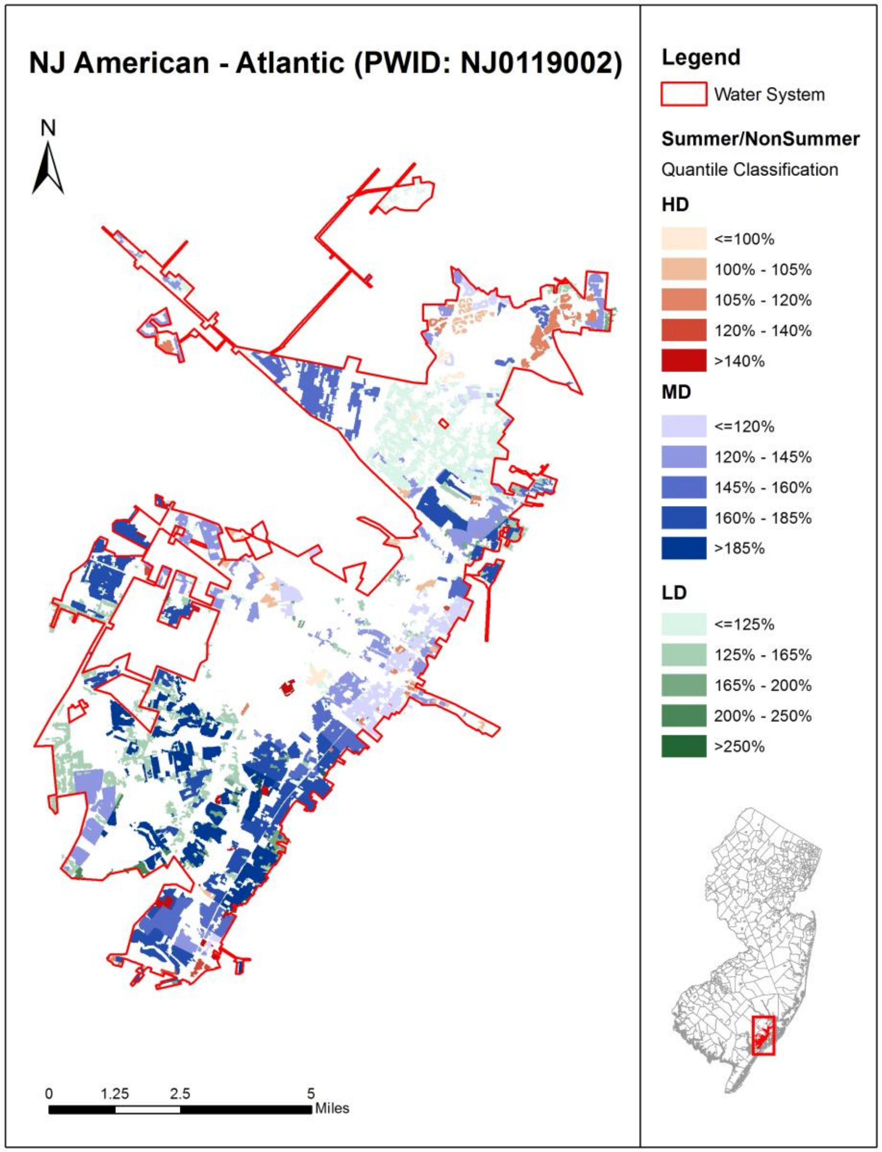
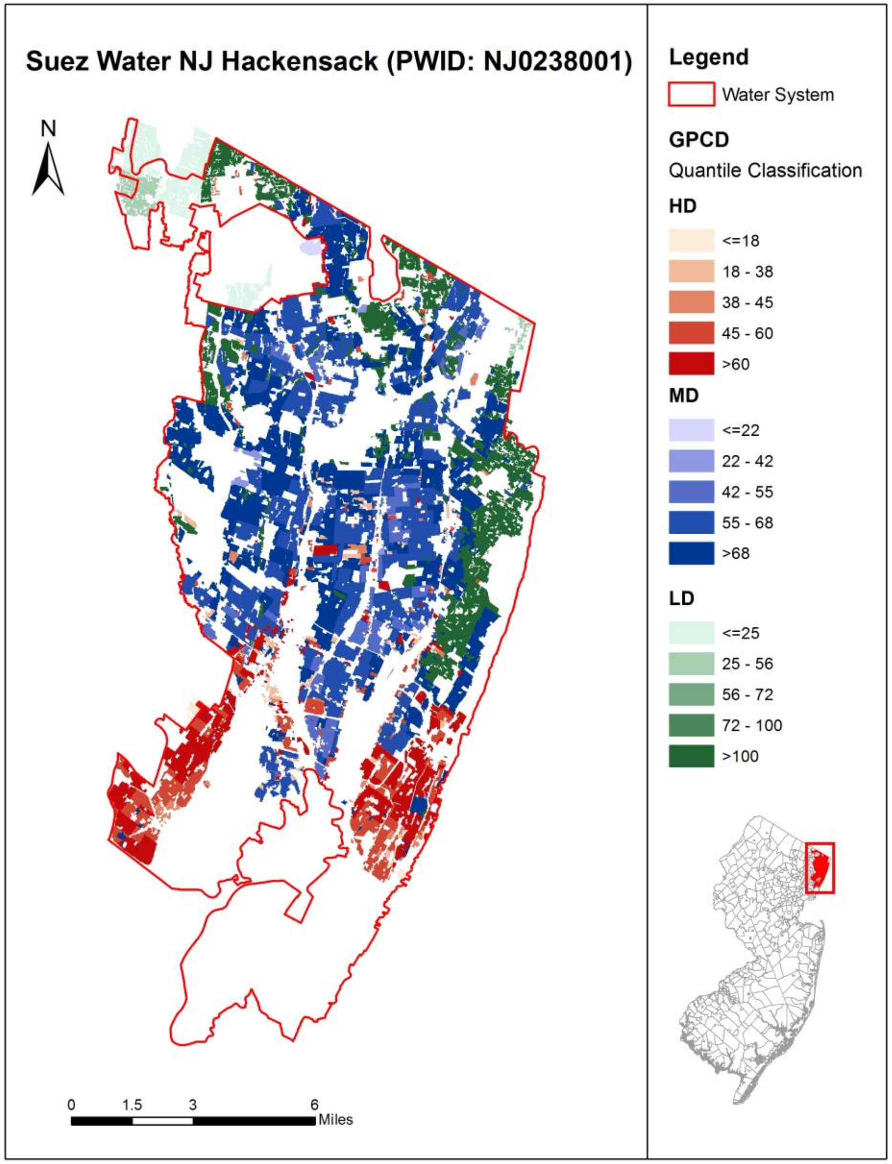
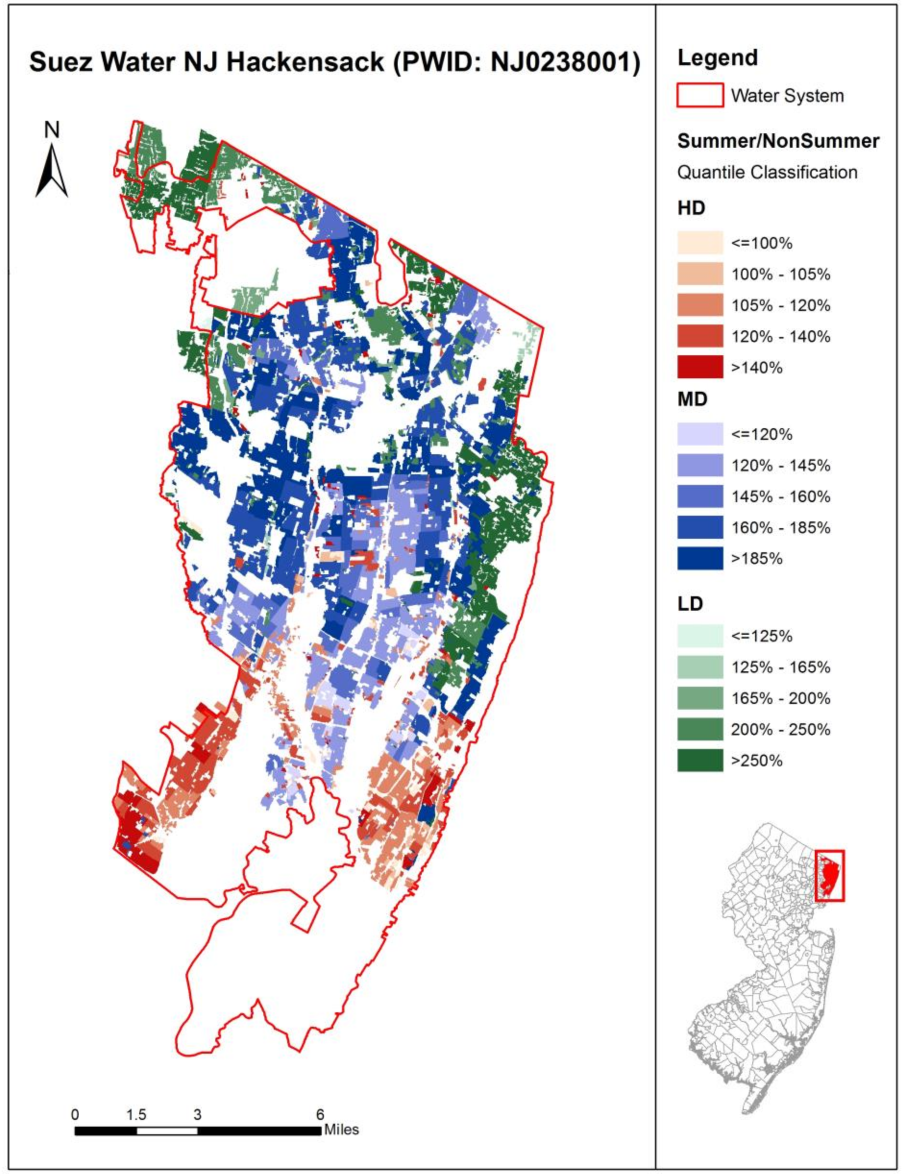


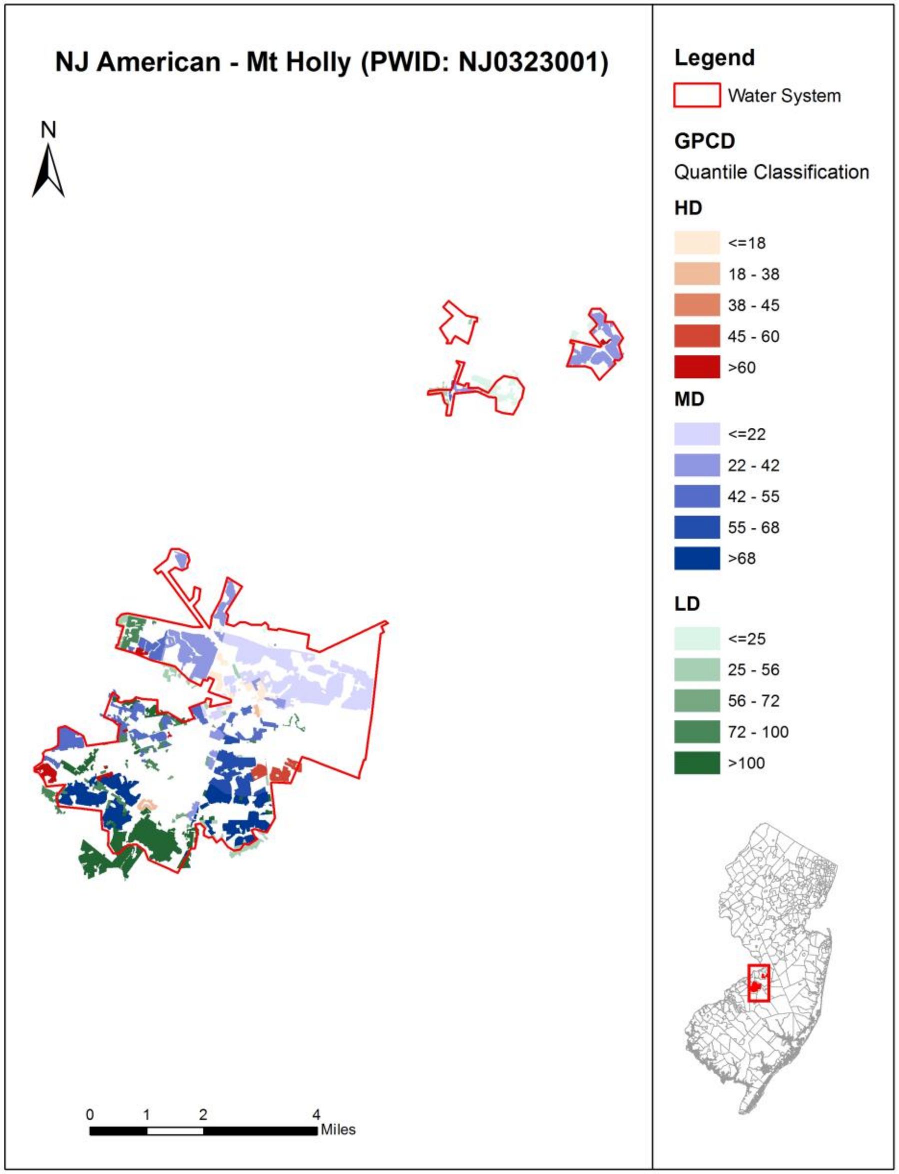


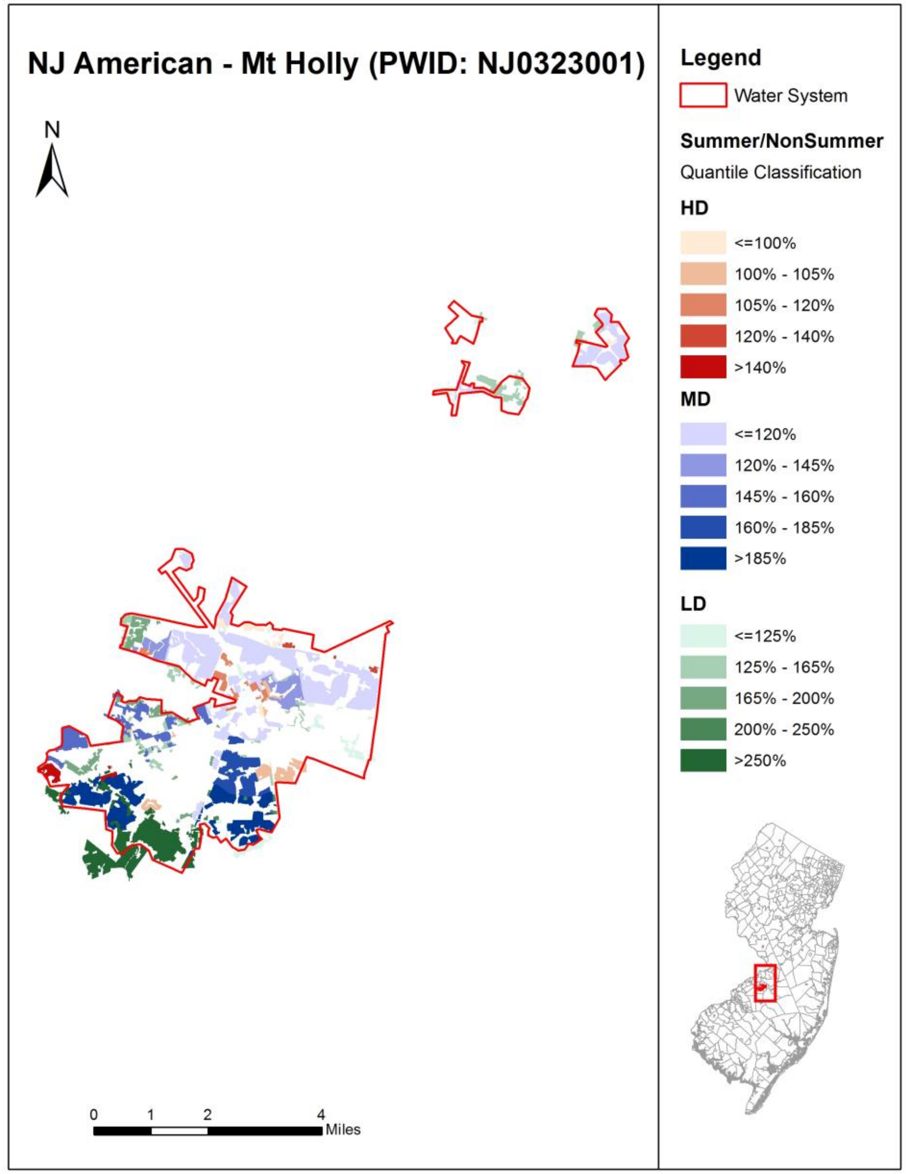
NJ0238001, Suez-New Jersey – Hackensack and Franklin Lakes (NJ022001)



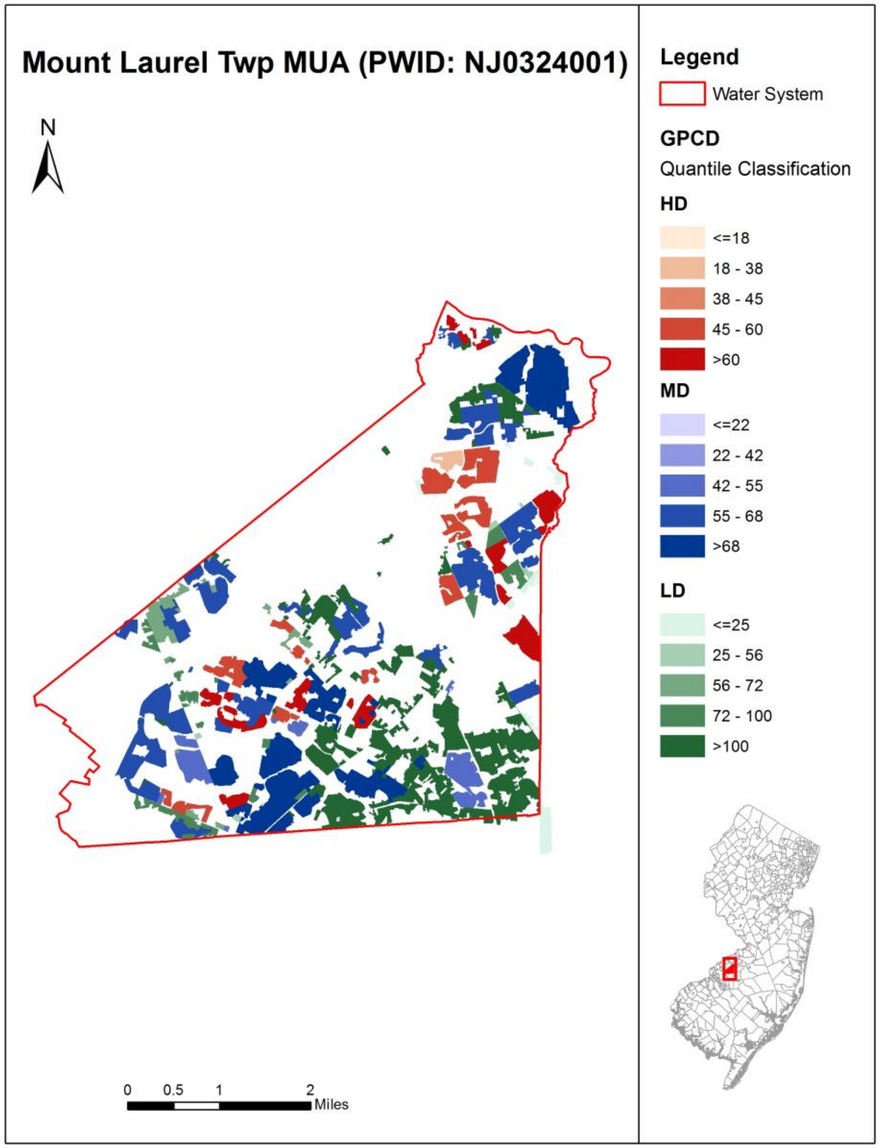


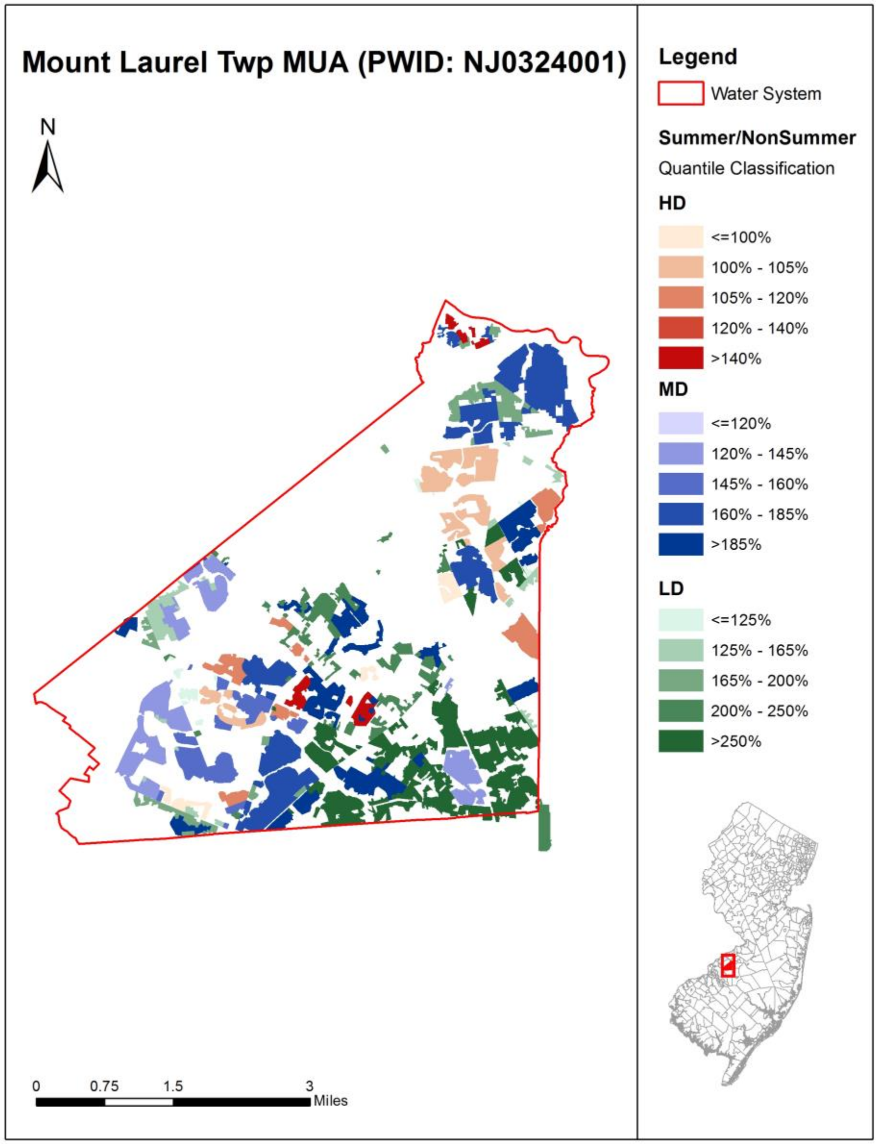
NJ0323001, New Jersey American Water –Mount Holly



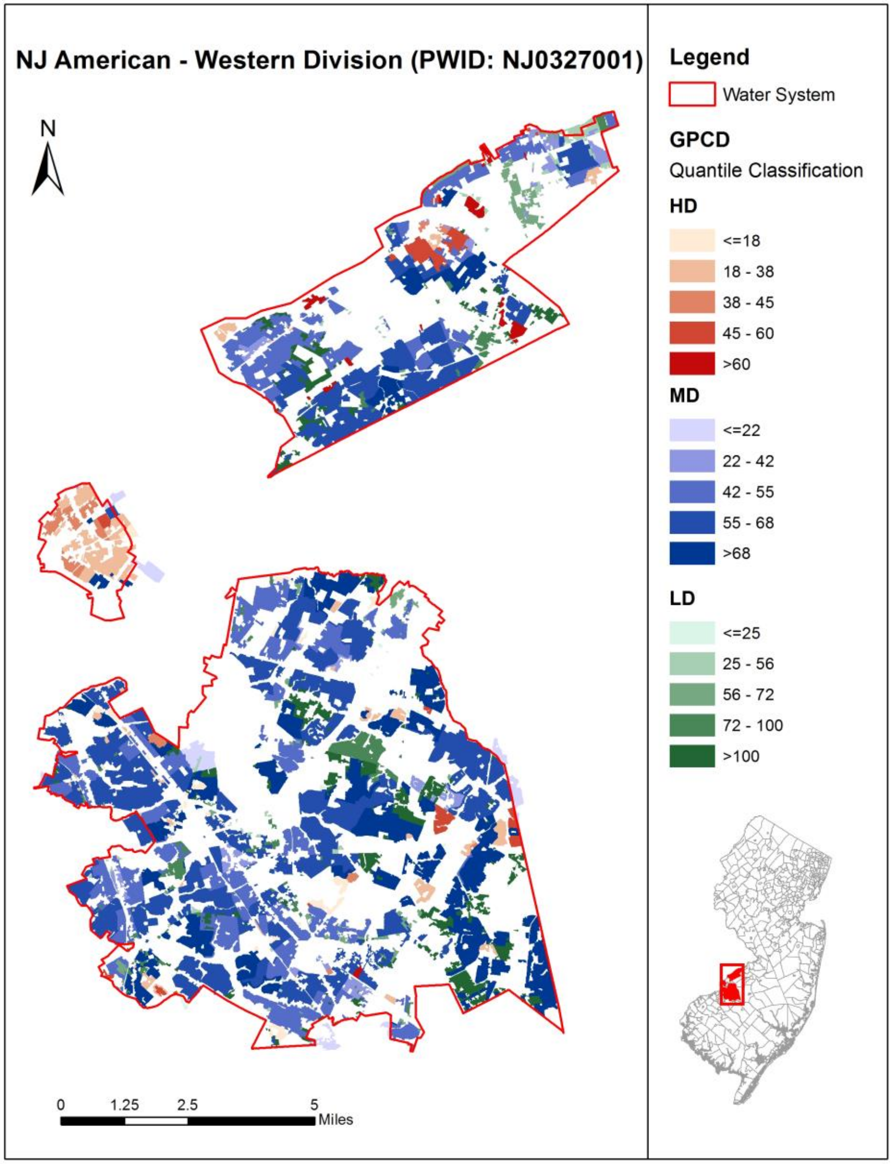


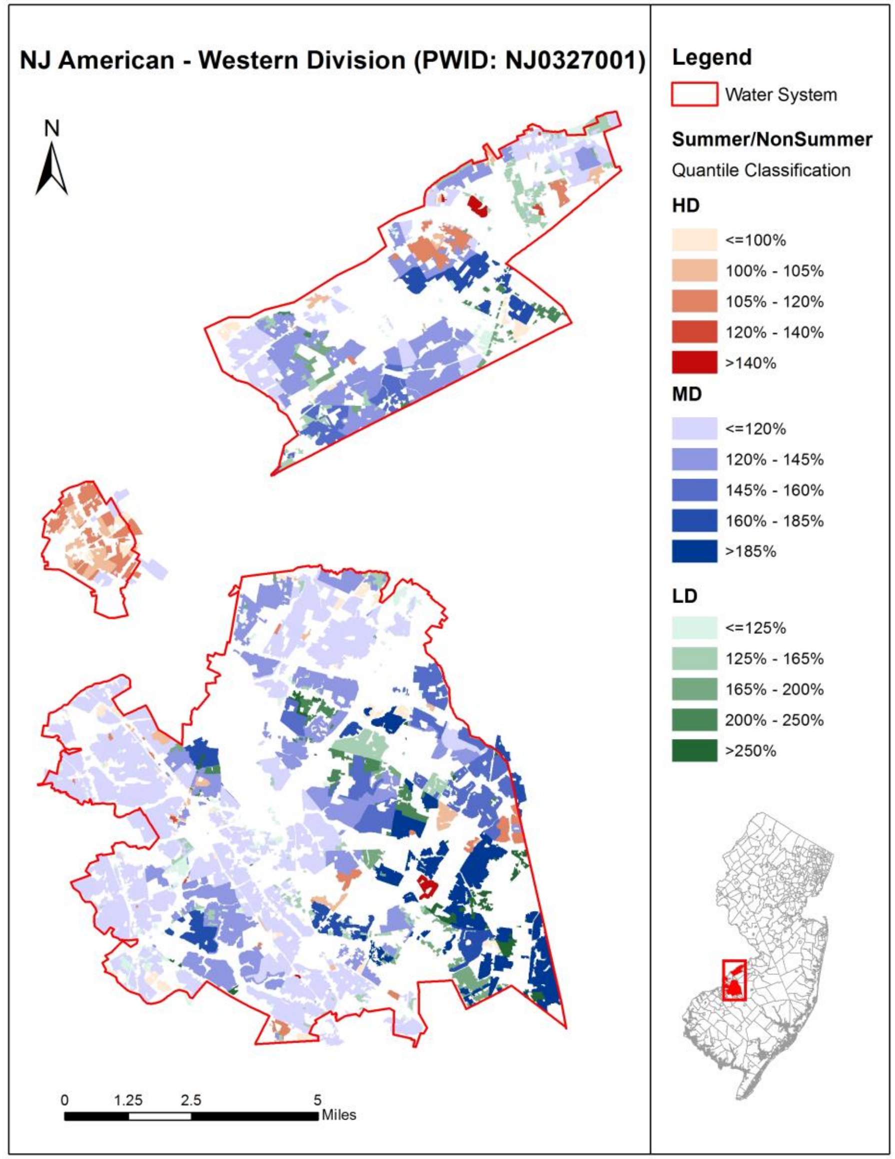
NJ0324001, Mount Laurel Municipal Utilities Authority



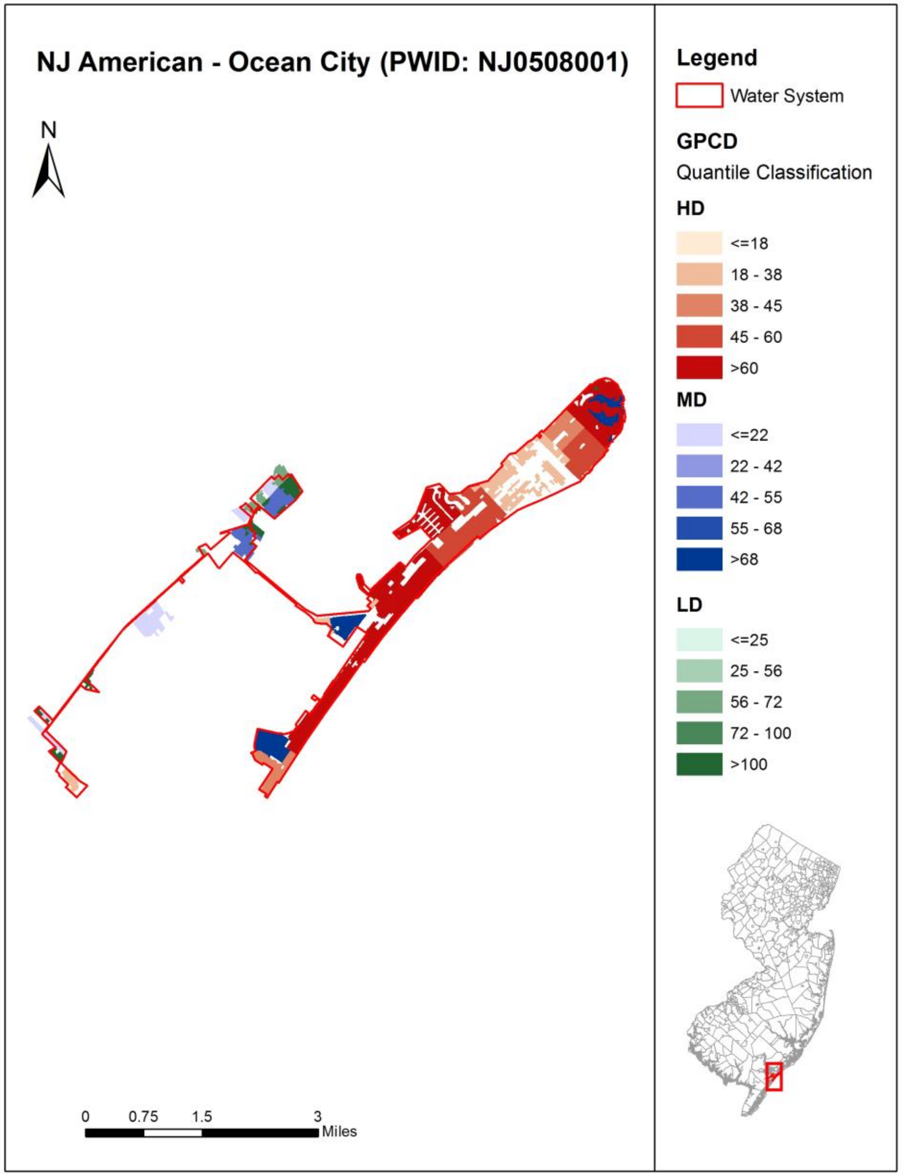


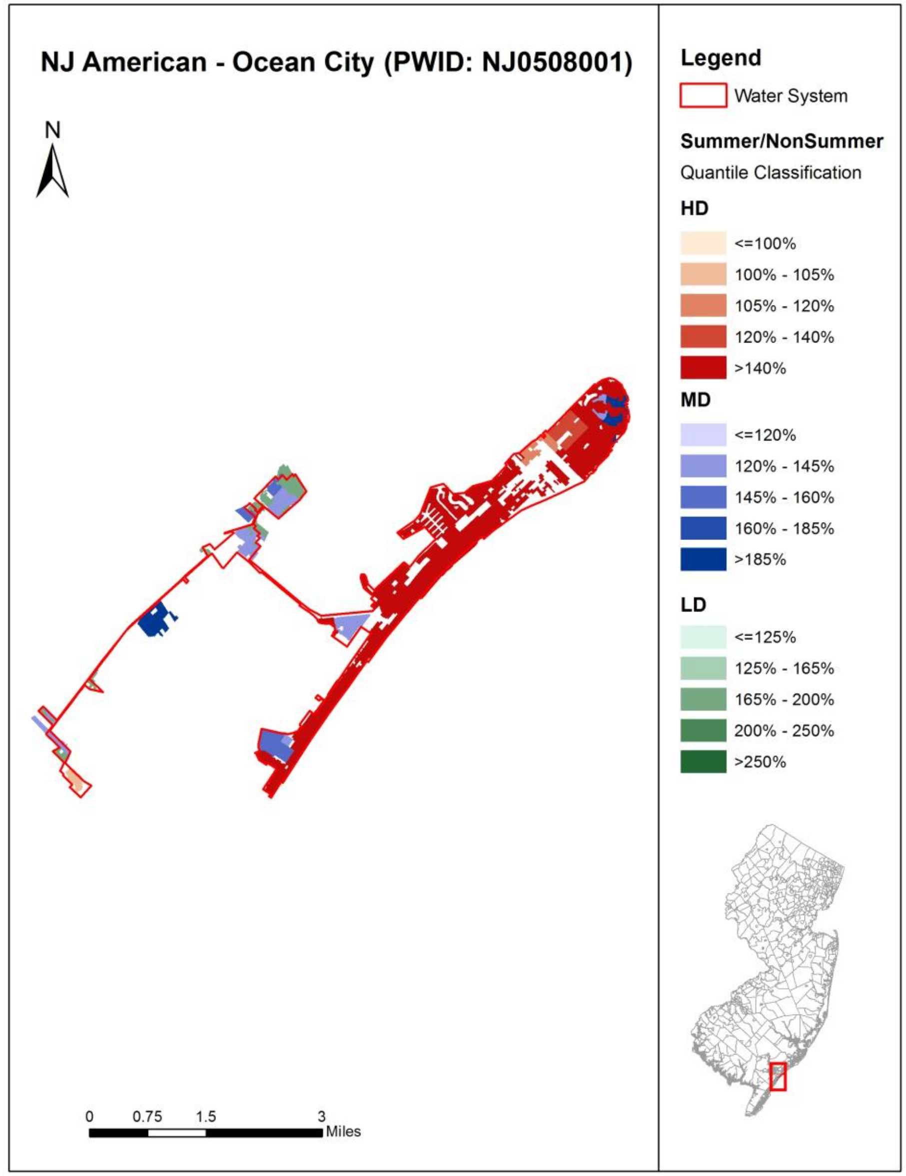
NJ0327001, New Jersey American Water – Delaware Division (also known as Western Division)



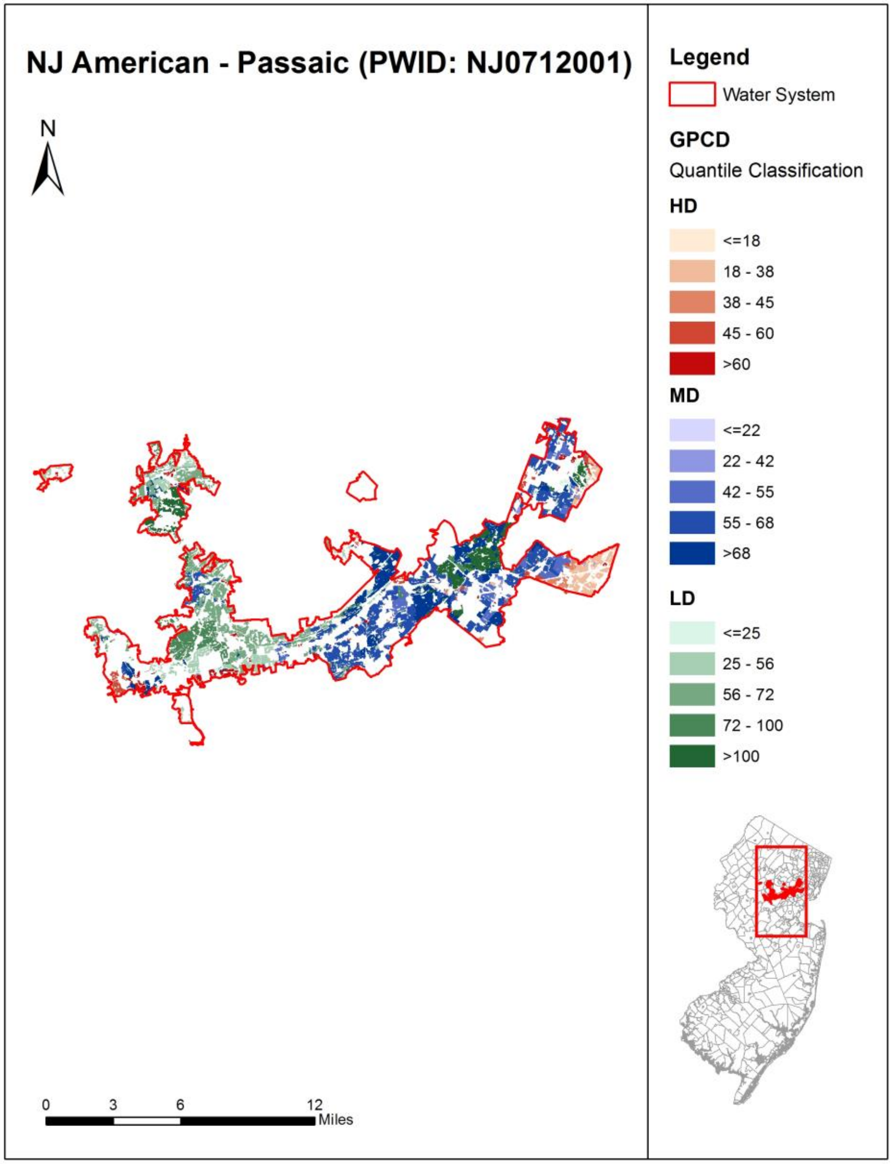


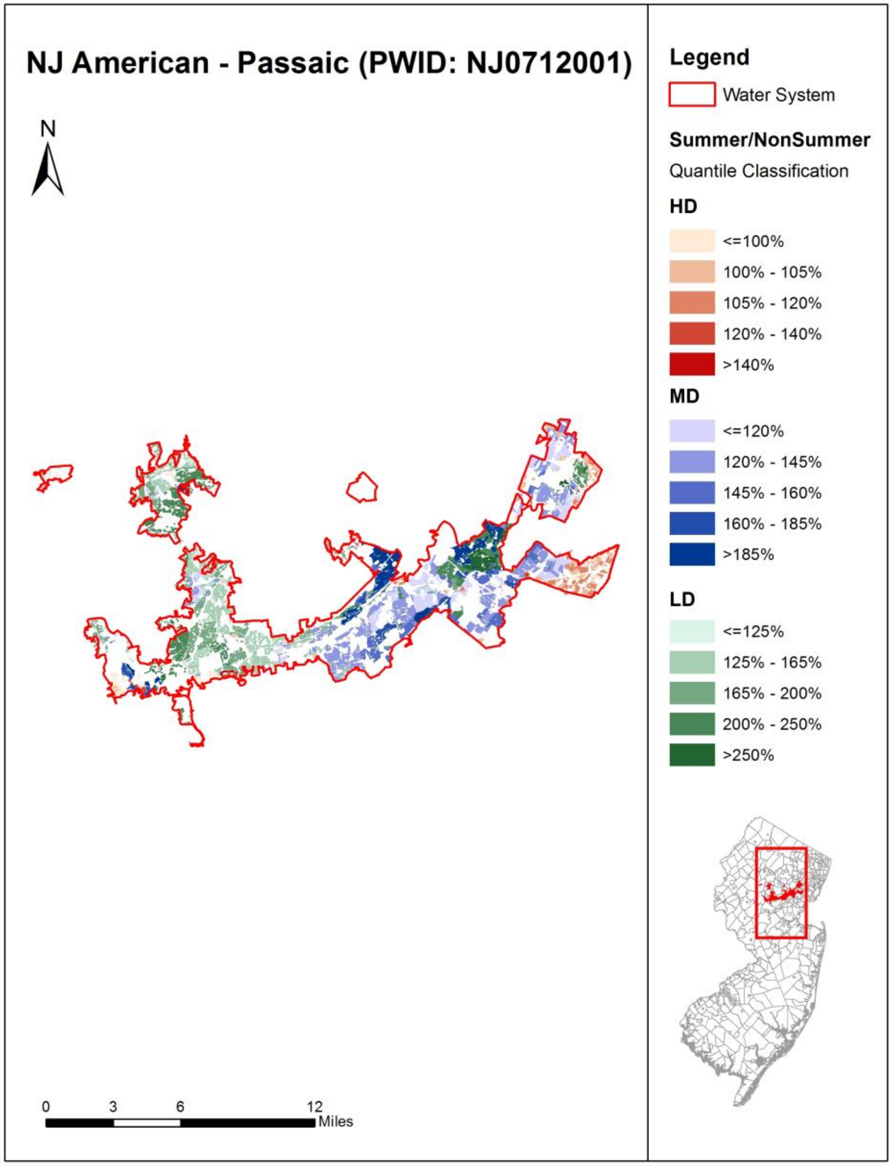
NJ0508001, New Jersey American Water – Ocean City



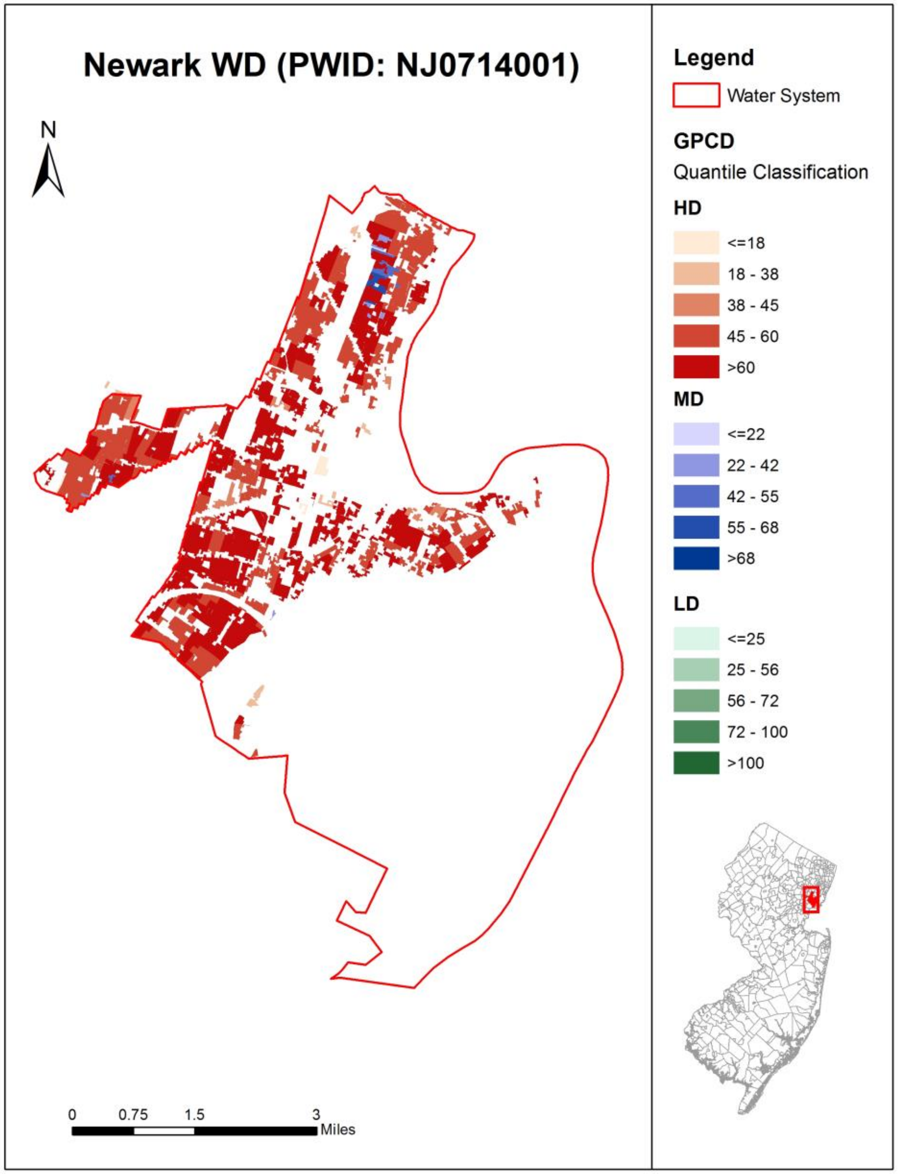


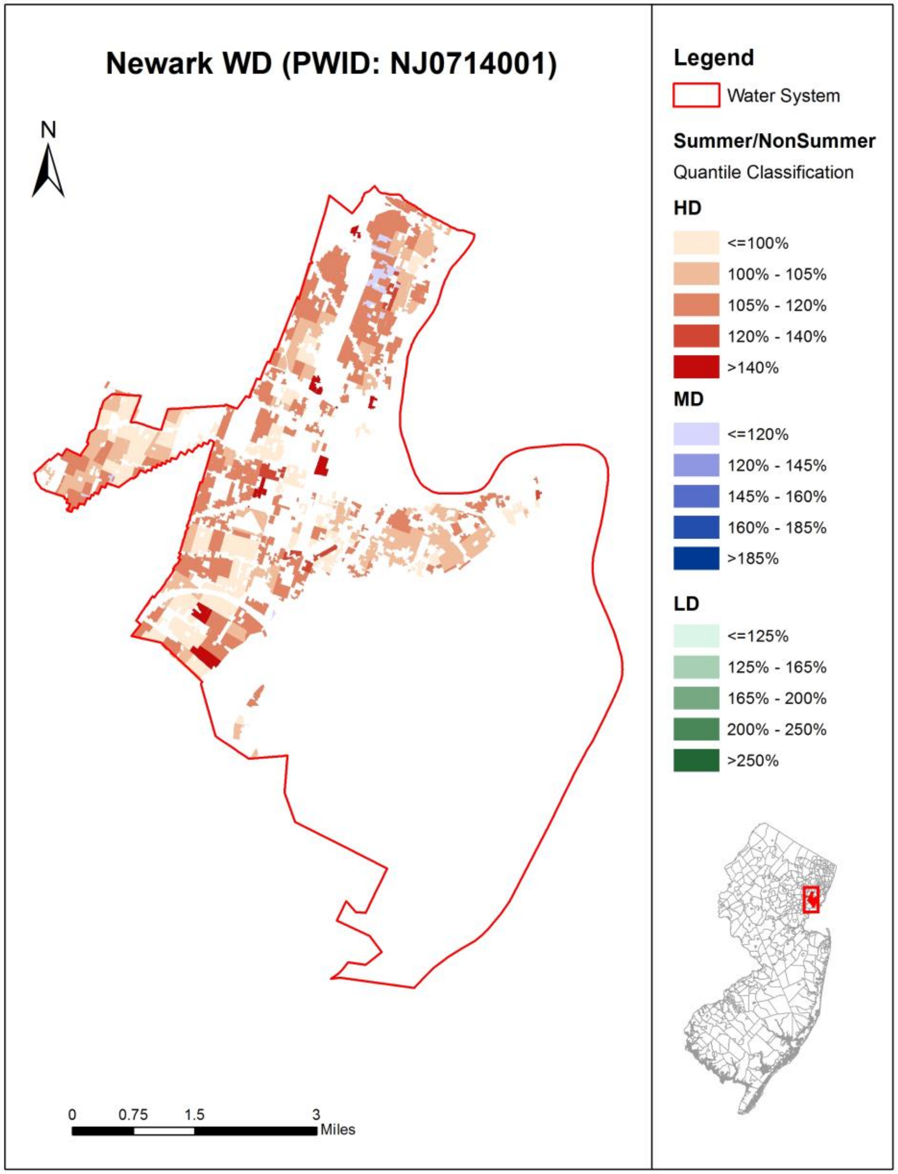
NJ0712001, New Jersey American Water – Passaic



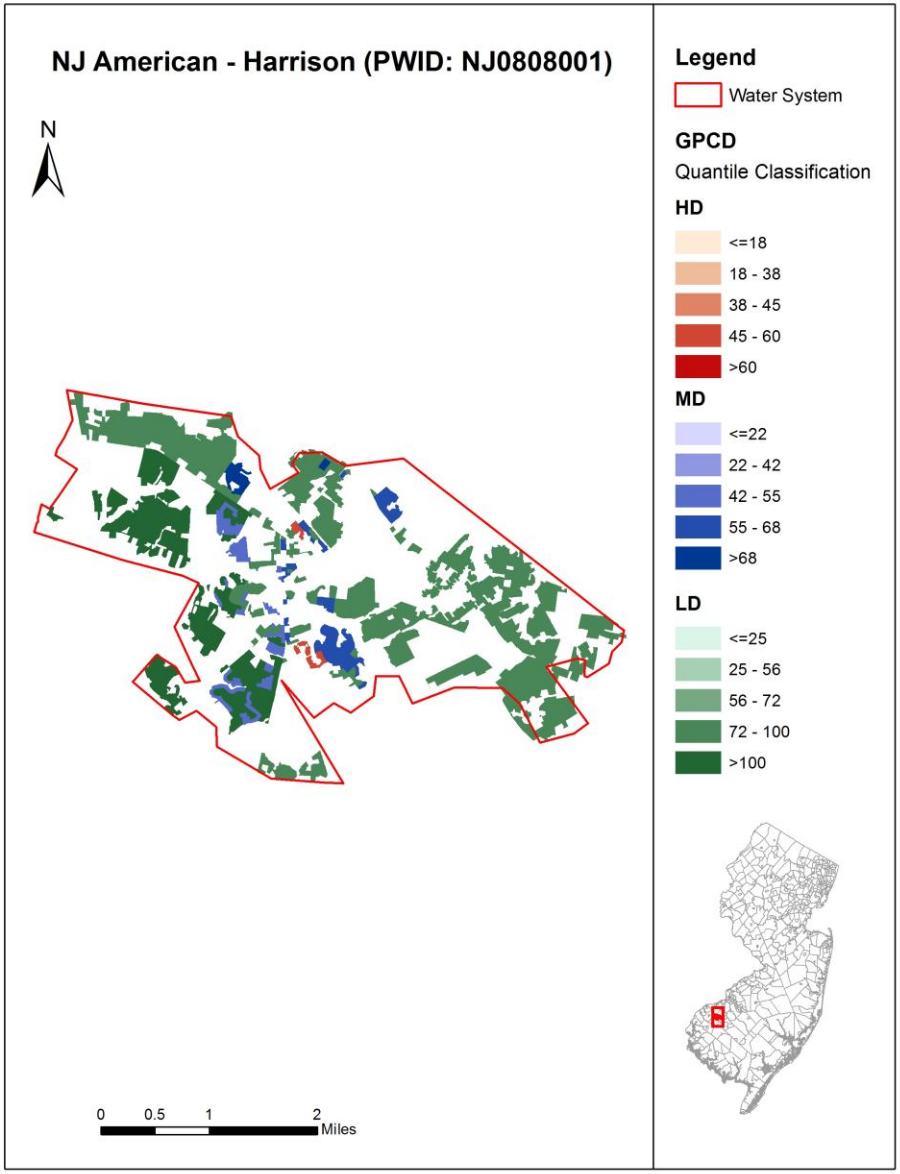


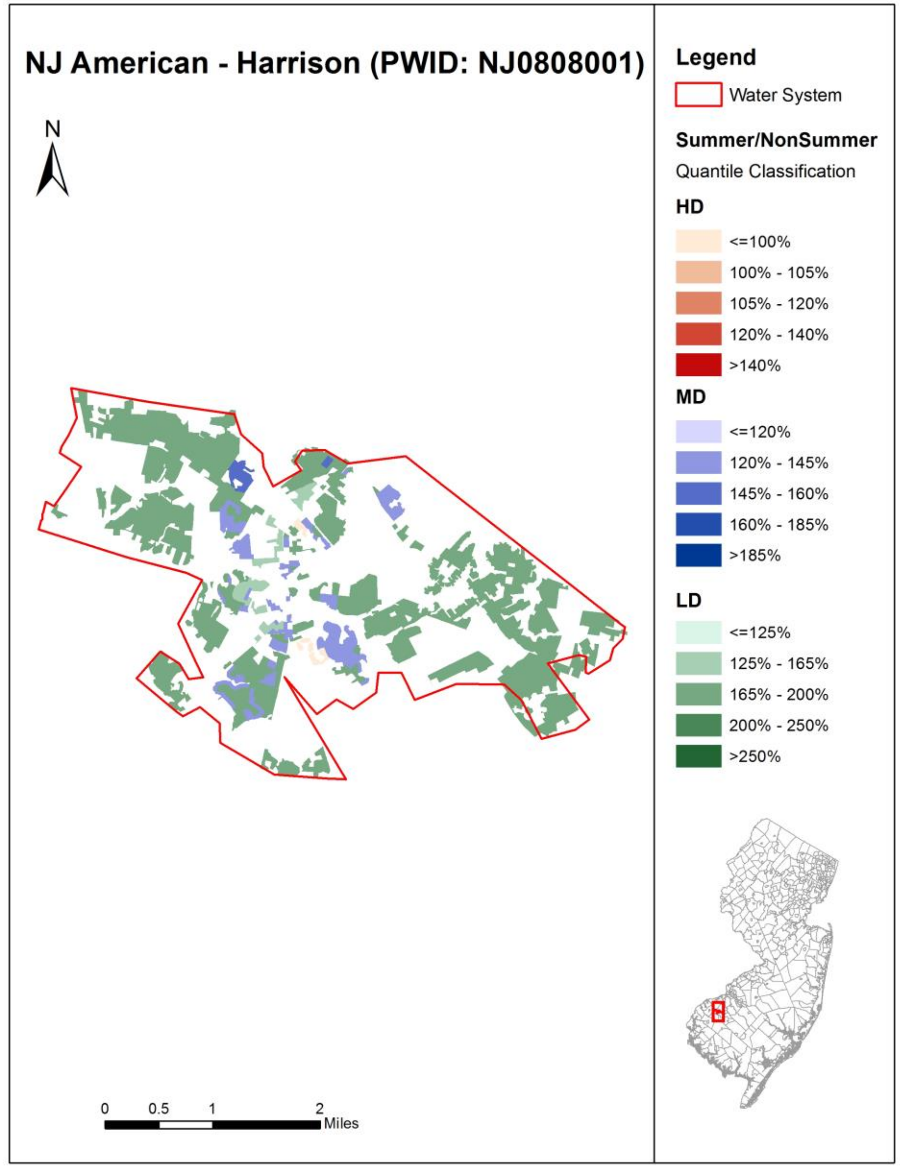
NJ0714001, Newark Water & Sewer Department



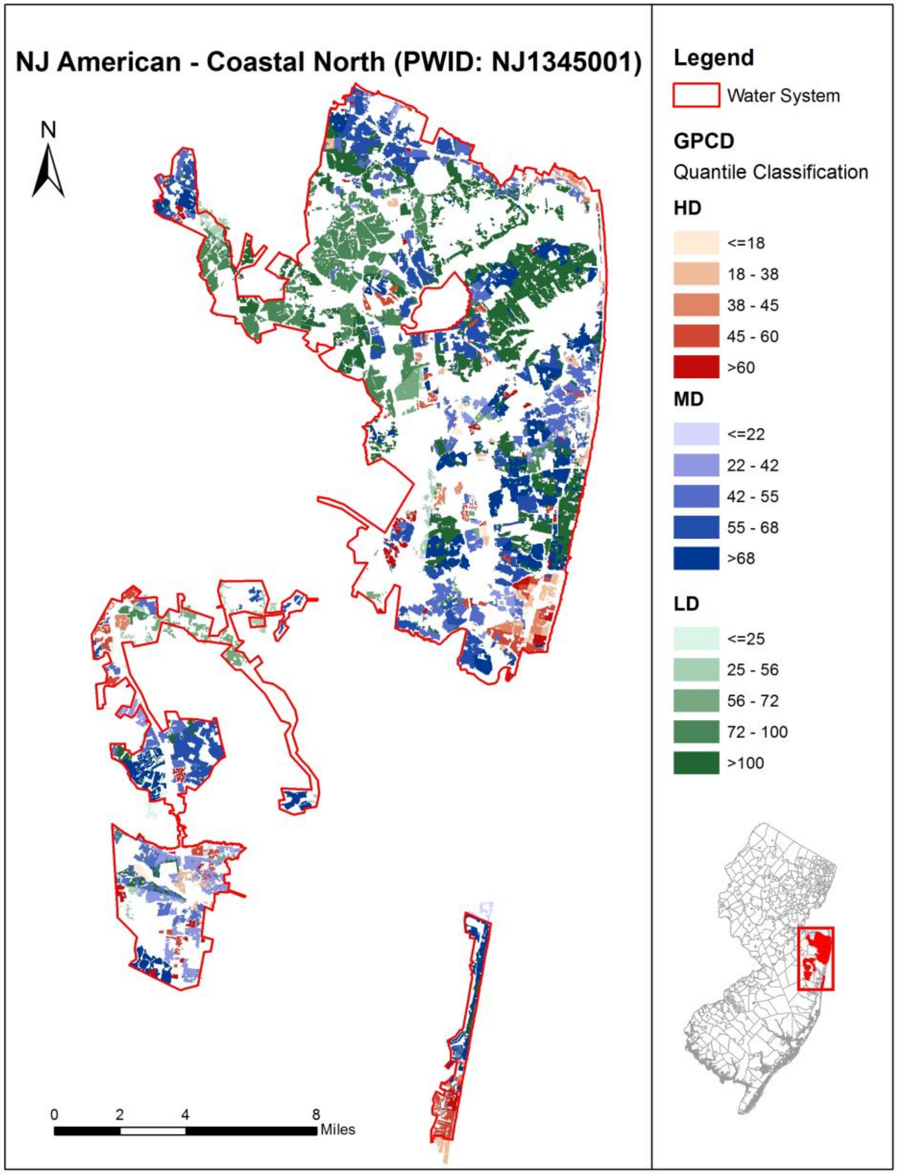


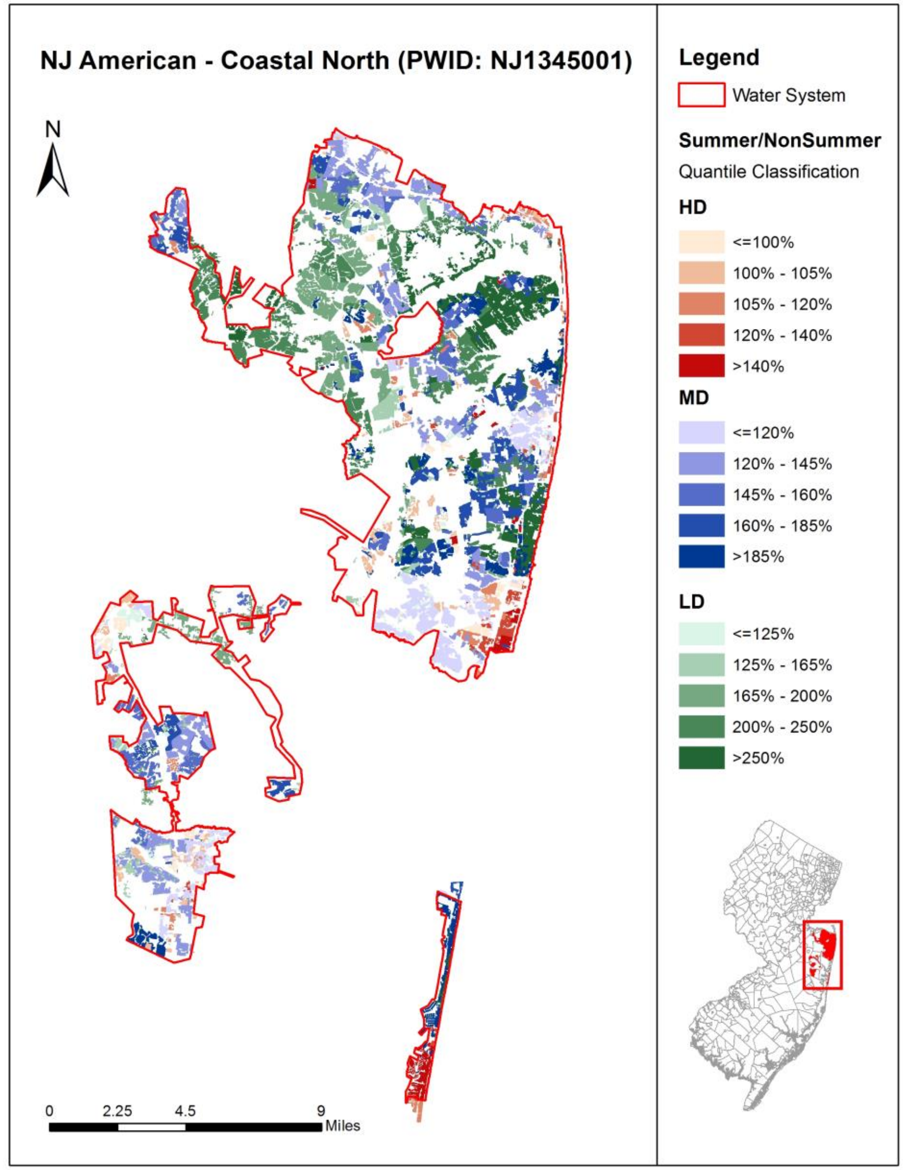
NJ0808001, New Jersey American Water – Harrison



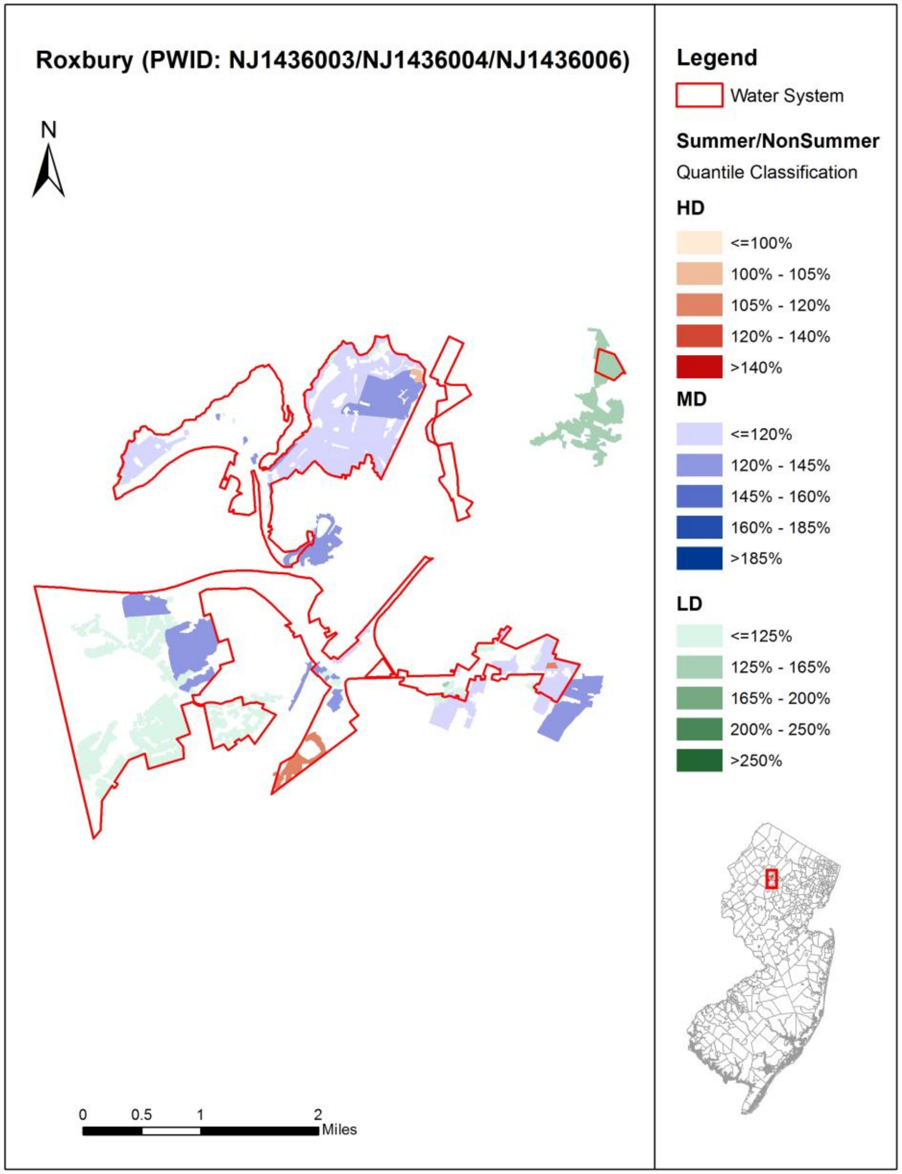


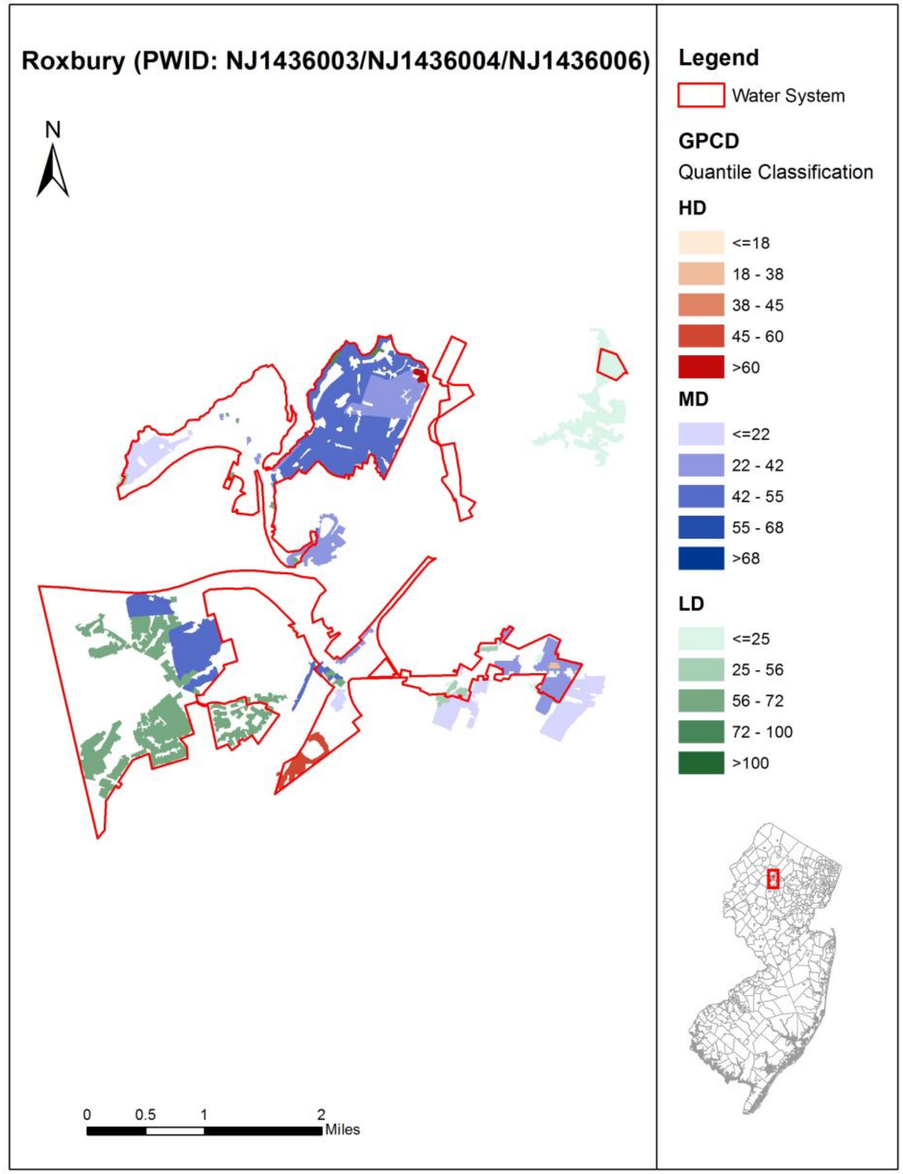
NJ1345001, New Jersey American Water – Coastal North



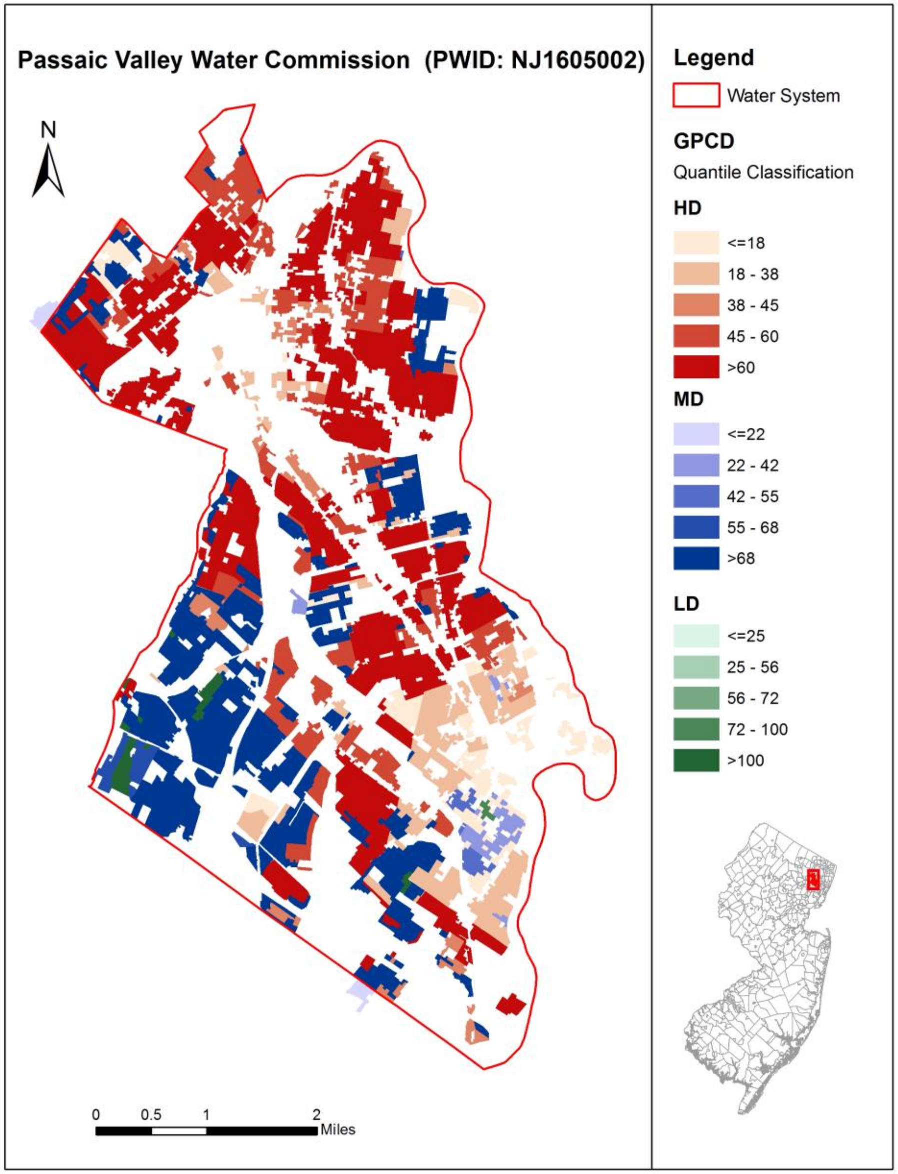


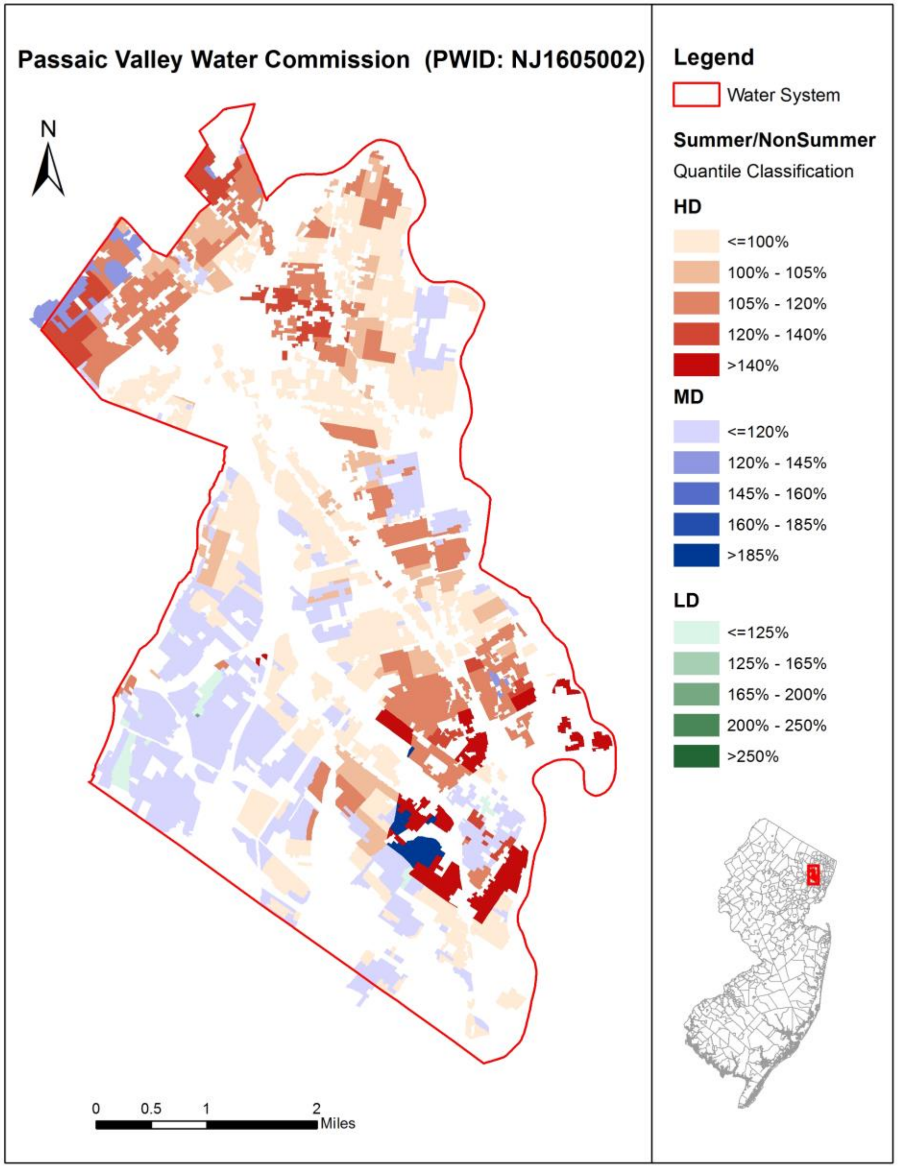
NJ1436003, NJ1436004, NJ1436006, Roxbury Township



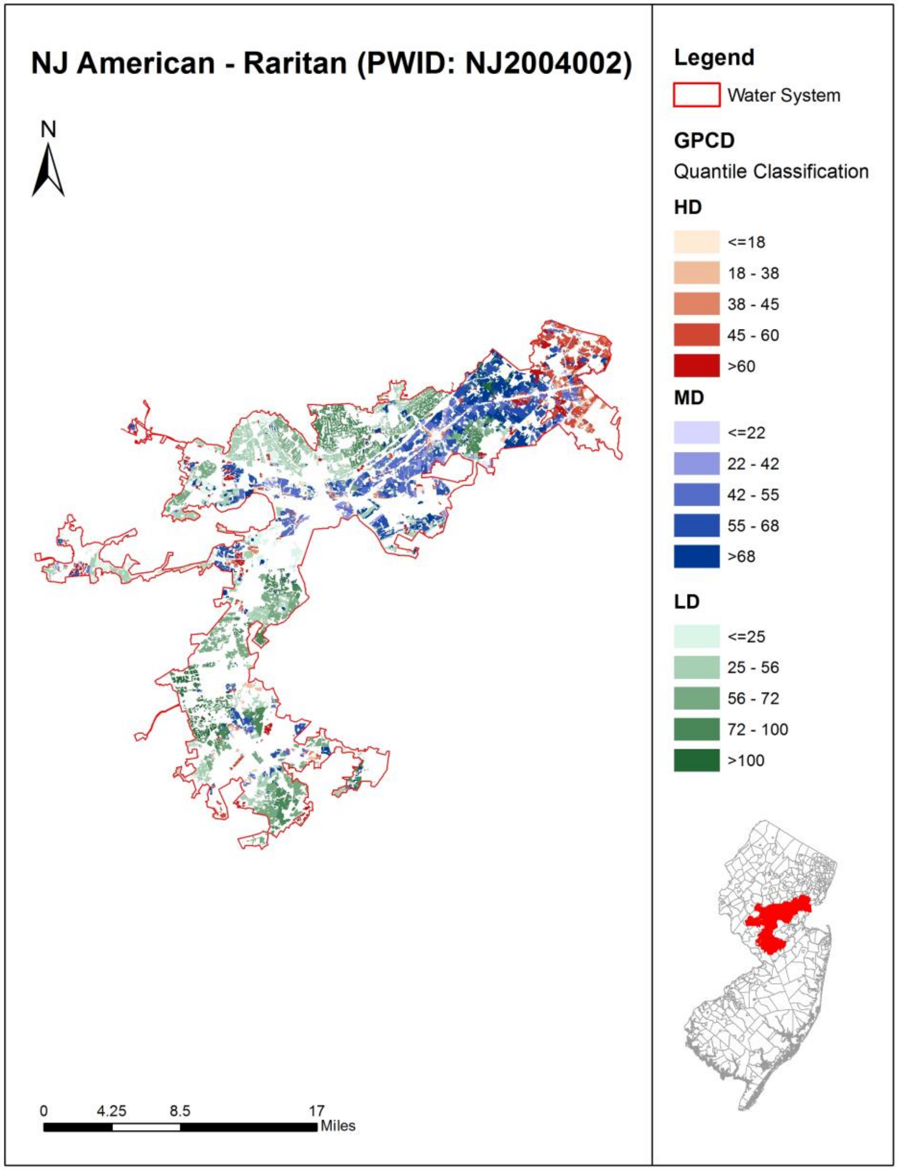


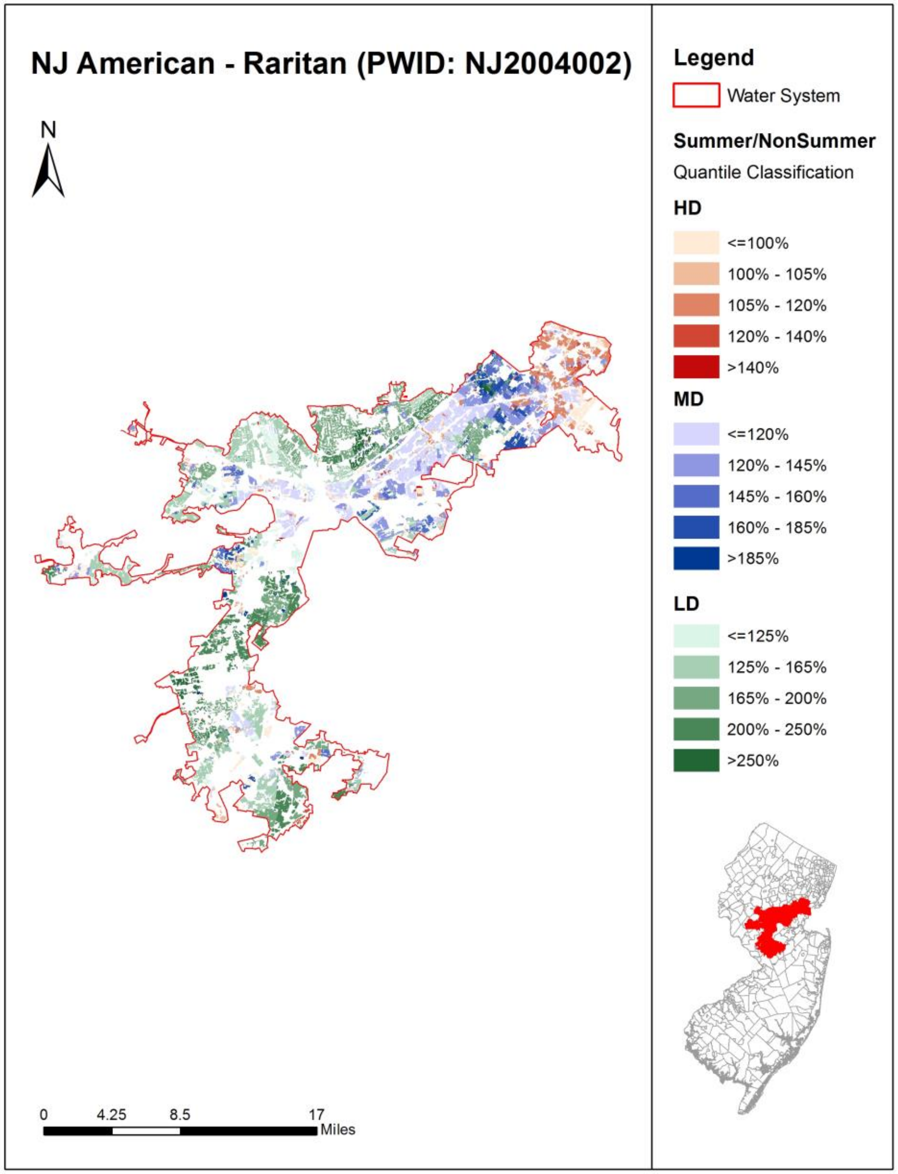
NJ1605002, Passaic Valley Water Commission





NJ2004002, New Jersey American Water – Raritan





Mount Laurel MUA (PWSID 0324001)

Year Long Users

	Density	01/08-09/08	10/08-09/09	10/09-09/10	10/10-09/11	10/11-09/12	10/12-09/13	10/13-09/14	10/14-09/15	Average
Population 13-14	high	14,502	14,502	14,502	14,502	14,502	14,502	14,502	14,502	14,502
	medium	20,171	20,171	20,171	20,171	20,171	20,171	20,171	20,171	20,171
	low	4,419	4,419	4,419	4,419	4,419	4,419	4,419	4,419	4,419
Average Annual Use (1000 gallon)	high	259,122	329,229	329,230	329,143	322,553	313,301	298,906	300,834	321,087
	medium	429,275	473,093	528,029	517,490	496,261	429,260	424,600	457,019	487,265
	low	179,828	177,673	221,862	212,862	202,249	158,162	170,421	187,963	196,370
Average Annual Per Capita	high	23,888.73	22,701.60	22,701.67	22,695.64	22,241.25	21,603.31	20,610.66	20,743.61	22,148
	medium	28,454.02	23,454.43	26,177.97	25,655.46	24,602.99	21,281.31	21,050.31	22,657.54	24,167
	low	54,413.16	40,210.22	50,211.04	48,174.07	45,772.17	35,794.73	38,568.96	42,539.09	44,460
Average Annual Per Capita Per Day	high	65.45	62.20	62.20	62.18	60.93	59.19	56.47	56.83	60.68
	medium	77.96	64.26	71.72	70.29	67.41	58.30	57.67	62.08	66.21
	low	149.08	110.16	137.56	131.98	125.40	98.07	105.67	116.55	121.81
Average Summer Use (1000 gallon)	high	120,865	110,789	119,476	120,416	115,290	108,824	102,754	106,752	113,146
	medium	266,013	191,075	272,517	253,183	244,594	184,181	187,248	218,748	227,195
	low	126,217	81,631	137,052	119,513	116,214	74,582	90,190	104,929	106,291
Average Summer Use Per Capita	high	8,334	7,639	8,238	8,303	7,950	7,504	7,085	7,361	7,802
	medium	13,188	9,473	13,510	12,552	12,126	9,131	9,283	10,845	11,264
	low	28,565	18,475	31,017	27,048	26,301	16,879	20,411	23,747	24,055
Average Summer Use Per Capita Per Day	high	68.31	62.62	67.53	68.06	65.16	61.51	58.08	60.34	63.95
	medium	108.10	77.65	110.74	102.89	99.39	74.85	76.09	88.89	92.32
	low	234.14	151.43	254.24	221.70	215.58	138.35	167.31	194.65	197.18
Average NonSummer Use (1000 gallon)	high	138,258	218,440	209,754	208,727	207,263	204,478	196,152	194,082	210,970
	medium	163,262	282,018	255,512	264,307	251,667	245,079	237,353	238,271	258,510
	low	53,612	96,041	84,810	93,348	86,035	83,580	80,231	83,034	87,948
Average NonSummer Use Per Capita	high	15,342	15,062	14,463	14,393	14,292	14,099	13,525	13,383	14,320
	medium	13,025	13,982	12,667	13,103	12,477	12,150	11,767	11,813	12,623
	low	19,526	21,736	19,194	21,126	19,471	18,916	18,158	18,792	19,615
Avreage NonSummer Use Per Capita Per Day	high	63.13	61.98	59.52	59.23	58.81	58.02	55.66	55.07	58.93
	medium	53.60	57.54	52.13	53.92	51.34	50.00	48.42	48.61	51.95
	low	80.35	89.45	78.99	86.94	80.13	77.84	74.72	77.33	80.72
Ratio of Summer to NonSummer Use Per Capital Per Day	high	108.2%	101.0%	113.5%	114.9%	110.8%	106.0%	104.3%	109.6%	108.5%
	medium	201.7%	135.0%	212.4%	190.8%	193.6%	149.7%	157.1%	182.9%	177.9%
	low	291.4%	169.3%	321.9%	255.0%	269.0%	177.7%	223.9%	251.7%	245.0%
PremisID Count	high	7,865	7,865	7,865	7,865	7,865	7,865	7,865	7,865	7,865
	medium	6,463	6,463	6,463	6,463	6,463	6,463	6,463	6,463	6,463
	low	2,282	2,282	2,282	2,282	2,282	2,282	2,282	2,282	2,282
Average Annual Use Per PremisID	high	32,945	41,859	41,859	41,848	41,010	39,834	38,003	38,249	40,380
	medium	66,417	73,196	81,696	80,065	76,781	66,415	65,694	70,710	73,508
	low	78,806	77,861	97,226	93,282	88,631	69,311	74,683	82,371	83,338
Average Annual Use Per PremisID Per Day	high	120.68	114.68	114.68	114.65	112.36	109.13	104.12	104.79	111
	medium	243.29	200.54	223.82	219.36	210.36	181.96	179.98	193.72	201
	low	288.67	213.32	266.37	255.57	242.83	189.89	204.61	225.67	228
Average Summer Use Per PremisID	high	15,367	14,086	15,190	15,310	14,658	13,836	13,064	13,573	14,245
	medium	41,157	29,563	42,164	39,172	37,843	28,496	28,971	33,844	34,293
	low	55,312	35,773	60,060	52,374	50,928	32,684	39,524	45,983	45,332
Average Summer Use Per PremisID Per Day	high	125.96	115.46	124.51	125.49	120.15	113.41	107.08	111.25	117
	medium	337.35	242.32	345.60	321.08	310.19	233.58	237.47	277.41	281
	low	453.37	293.22	492.30	429.30	417.44	267.90	323.97	376.91	372
Average NonSummer Use Per PremisID	high	17,578	27,773	26,669	26,538	26,352	25,998	24,939	24,676	26,135
	medium	25,260	43,633	39,533	40,893	38,938	37,918	36,723	36,865	39,215
	low	23,494	42,088	37,166	40,908	37,703	36,627	35,159	36,388	38,006
Average NonSummer Use Per PremisID Per Day	high	116	114	110	109	108	107	103	102	108
	medium	167	180	163	168	160	156	151	152	161
	low	156	173	153	168	155	151	145	150	156

Newark (PWSID 0714001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population	high	264,791	264,791	265,933	264,791	264,791	264,791	264,982
	medium	710	710	710	710	710	710	710
	low	2	2	2	2	2	2	2
Average Annual Use ('1000s)	high	6,010,772	6,239,865	6,078,380	5,983,167	5,868,240	5,966,035	6,024,410
	medium	28,697	28,868	28,656	27,424	26,700	27,156	27,917
	low	80	56	59	148	29	31	67
Average Annual Use Per Captia	high	22,700.03	23,565.21	22,856.84	22,595.78	22,161.75	22,531.08	22,735.12
	medium	40,411.86	40,652.67	40,354.12	38,619.19	37,599.63	38,241.78	39,313.21
	low	33,980.82	23,786.58	25,060.86	62,864.52	12,318.05	13,167.57	28,529.73
Average Annual Per Capita Per Day	high	62.19	64.56	62.62	61.91	60.72	61.73	62.29
	medium	110.72	111.38	110.56	105.81	103.01	104.77	107.71
	low	93.10	65.17	68.66	172.23	33.75	36.08	78.16
Average Summer Use ('1000s)	high	2,006,443	2,167,693	2,124,154	2,105,536	2,077,907	2,067,024	2,091,460
	medium	10,499	12,467	11,815	10,502	10,363	10,018	10,944
	low	20	15	11	39	9	12	18
Average Summer Use Per Capita	high	7,577	8,186	7,988	7,952	7,847	7,806	7,893
	medium	14,785	17,556	16,638	14,789	14,593	14,108	15,412
	low	8,495	6,371	4,672	16,566	3,823	5,097	7,504
Average Summer Use Per Capita Per Day	high	62.11	67.10	65.47	65.18	64.32	63.99	64.69
	medium	121.19	143.90	136.38	121.22	119.62	115.64	126.32
	low	69.63	52.22	38.30	135.78	31.33	41.78	61.51
Average NonSummer Use ('1000s)	high	4,004,329	4,072,172	3,954,226	3,877,631	3,790,333	3,899,011	3,932,950
	medium	18,198	16,401	16,841	16,922	16,337	17,138	16,973
	low	60	41	48	109	20	19	50
Average NonSummer Use Per Capita	high	15,123	15,379	14,869	14,644	14,314	14,725	14,842.34
	medium	25,627	23,096	23,716	23,830	23,006	24,134	23,901.58
	low	25,486	17,415	20,388	46,299	8,495	8,070	21,025.63
Avreage NonSummer Use Per Capita Per Day	high	62.23	63.29	61.19	60.26	58.91	60.60	61.08
	medium	105.46	95.05	97.60	98.07	94.68	99.32	98.36
	low	104.88	71.67	83.90	190.53	34.96	33.21	86.53
Ratio of Summer to NonSummer	high	100%	106%	107%	108%	109%	106%	106%
	medium	115%	151%	140%	124%	126%	116%	129%
	low	66%	73%	46%	71%	90%	126%	79%
PremisID Count	high	25,860	27,943	27,681	27,277	27,425	27,511	27283
	medium	211	211	211	210	209	208	210
	low	1	1	1	1	1	1	1
Average Annual Use Per PremisID	high	232,435	223,307	219,587	219,348	213,974	216,860	220,919
	medium	136,005	136,815	135,810	130,590	127,751	130,558	132,922
	low	80,000	56,000	59,000	148,000	29,000	31,000	67,167
Average Annual Use Per PremisID Per Day	high	636.81	611.80	601.61	600.95	586.23	594.14	605.26
	medium	372.62	374.84	372.08	357.78	350.00	357.69	364.17
	low	219.18	153.42	161.64	405.48	79.45	84.93	184.02
Average Summer Use Per PremisID	high	77,589	77,576	76,737	77,191	75,767	75,134	76,666
	medium	49,758	59,085	55,995	50,010	49,584	48,163	52,099
	low	20,000	15,000	11,000	39,000	9,000	12,000	17,667
Average Summer Use Per PremisID Per Day	high	635.97	635.86	628.99	632.71	621.04	615.86	628
	medium	407.85	484.31	458.98	409.91	406.42	394.78	427
	low	163.93	122.95	90.16	319.67	73.77	98.36	145
Average NonSummer Use Per PremisID	high	154,846	145,731	142,850	142,158	138,207	141,726	144,253
	medium	86,246	77,730	79,815	80,581	78,167	82,394	80,822
	low	60,000	41,000	48,000	109,000	20,000	19,000	49,500
Average NonSummer Use Per PremisID Per Day	high	637	600	588	585	569	583	594
	medium	355	320	328	332	322	339	333
	low	247	169	198	449	82	78	204

NJ American Water – Atlantic (PWSID 0119002)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	17,239	17,239	17,239	17,239	17,239	17,239	17,239
	medium	85,777	85,777	85,818	85,831	85,853	85,853	85,818
	low	9,884	9,989	9,986	9,994	10,038	10,087	9,996
Average Annual Use (100 gallon)	high	2,688,580	2,787,150	2,730,850	2,615,550	2,614,890	2,581,926	2,669,824
	medium	19,558,400	21,959,790	20,417,300	19,411,547	18,410,020	18,519,780	19,712,806
	low	2,774,080	3,047,440	2,859,790	2,713,680	2,599,650	2,647,490	2,773,688
Average Annual Per Capita	high	15,595.52	16,167.29	15,840.71	15,171.90	15,168.07	14,976.86	15,487
	medium	22,801.41	25,600.98	23,791.35	22,616.11	21,443.66	21,571.50	22,971
	low	28,067.26	30,509.26	28,639.05	27,153.72	25,898.92	26,246.45	27,752
Average Annual Per Capita Per Day	high	43	44	43	42	42	41	42
	medium	62	70	65	62	59	59	63
	low	77	84	78	74	71	72	76
Average Summer Use	high	958,690	1,032,190	1,001,150	953,880	936,390	891,146	962,241
	medium	8,577,010	11,181,790	9,943,140	9,008,970	8,209,020	8,155,320	9,179,208
	low	1,165,040	1,486,980	1,307,100	1,200,420	1,113,660	1,031,220	1,217,403
Average Summer Use Per Capita	high	5,561.03	5,987.38	5,807.32	5,533.13	5,431.67	5,169.23	5,582
	medium	9,999.18	13,035.86	11,586.29	10,496.22	9,561.72	9,499.17	10,696
	low	11,787.50	14,886.81	13,089.81	12,011.69	11,094.80	10,223.22	12,182
Average Summer Use Per Capita Per Day	high	46	49	48	45	45	42	46
	medium	82	107	95	86	78	78	88
	low	97	122	107	98	91	84	100
Average NonSummer Use	high	1,729,890	1,754,960	1,729,700	1,661,670	1,678,500	1,690,780	1,707,583
	medium	10,981,390	10,778,000	10,474,160	10,402,577	10,201,000	10,364,460	10,533,598
	low	1,609,040	1,560,460	1,552,690	1,513,260	1,485,990	1,616,270	1,556,285
Average NonSummer Use Per Capita	high	10,034.49	10,179.91	10,033.39	9,638.77	9,736.40	9,807.63	9,905
	medium	12,802.23	12,565.12	12,205.06	12,119.89	11,881.94	12,072.33	12,274
	low	16,279.75	15,622.45	15,549.24	15,142.04	14,804.12	16,023.23	15,570
Avreage NonSummer Use Per Capita Per Day	high	41	42	41	40	40	40	41
	medium	53	52	50	50	49	50	51
	low	67	64	64	62	61	66	64
Ratio of Summer to NonSummer Use Per Capital Per Day	high	110%	117%	115%	114%	111%	105%	112%
	medium	156%	207%	189%	172%	160%	157%	173%
	low	144%	190%	168%	158%	149%	127%	156%
PremisID Count	high	5,263	5,263	5,263	5,263	5,263	5,263	5,263
	medium	24,415	24,415	24,415	24,415	24,415	24,415	24,415
	low	3,473	3,473	3,473	3,473	3,473	3,473	3,473
Average Annual Use Per PremisID	high	51,085	52,957	51,888	49,697	49,684	49,058	50,728
	medium	80,108	89,944	83,626	79,507	75,405	75,854	80,741
	low	79,876	87,747	82,344	78,136	74,853	76,231	79,864
Average Annual Use Per PremisID Per Day	high	139.96	145.09	142.16	136.16	136.12	134.41	139
	medium	219.47	246.42	229.11	217.83	206.59	207.82	221
	low	218.84	240.40	225.60	214.07	205.08	208.85	219
Average Summer Use Per PremisID	high	18,216	19,612	19,022	18,124	17,792	16,932	18,283
	medium	35,130	45,799	40,726	36,899	33,623	33,403	37,597
	low	33,546	42,815	37,636	34,564	32,066	29,692	35,053
Average Summer Use Per PremisID Per Day	high	149.31	160.76	155.92	148.56	145.84	138.79	150
	medium	287.95	375.40	333.82	302.45	275.60	273.79	308
	low	274.96	350.95	308.49	283.31	262.84	243.38	287
Average NonSummer Use Per PremisID	high	32,869	33,345	32,865	31,573	31,892	32,126	32,445
	medium	44,978	44,145	42,901	42,607	41,782	42,451	43,144
	low	46,330	44,931	44,707	43,572	42,787	46,538	44,811
Average NonSummer Use Per PremisID Per Day	high	135	137	135	130	131	132	134
	medium	185	182	177	175	172	175	178
	low	191	185	184	179	176	192	184

NJ American Water – Belvidere (PWSID 2103001)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,685	1,685	1,685	1,685	1,685	1,685	1,685
	medium	2,035	2,035	2,035	2,035	2,035	2,035	2,035
	low	70	62	62	62	62	62	63
Average Annual Use	high	158,320	154,080	152,950	150,640	144,130	144,090	150,702
	medium	386,860	400,680	391,940	387,920	373,060	359,400	383,310
	low	16,830	18,230	17,950	17,150	16,910	18,270	17,557
Average Annual Per Capita	high	9,395.97	9,144.33	9,077.27	8,940.17	8,553.82	8,551.44	8,944
	medium	19,008.75	19,687.80	19,258.36	19,060.83	18,330.67	17,659.47	18,834
	low	24,006.80	29,397.38	28,945.85	27,655.79	27,268.77	29,461.88	27,789
Average Annual Per Capita Per Day	high	26	25	25	24	23	23	25
	medium	52	54	53	52	50	48	52
	low	66	81	79	76	75	81	76
Average Summer Use	high	53,280	55,610	53,210	53,010	48,060	47,910	51,847
	medium	134,450	147,200	145,170	144,970	135,300	124,590	138,613
	low	6,390	6,450	6,590	6,260	6,030	6,400	6,353
Average Summer Use Per Capita	high	3,162.06	3,300.34	3,157.90	3,146.03	2,852.26	2,843.36	3,077
	medium	6,606.33	7,232.82	7,133.07	7,123.24	6,648.10	6,121.85	6,811
	low	9,114.88	10,401.16	10,626.92	10,094.77	9,723.87	10,320.53	10,047
Average Summer Use Per Capita Per Day	high	26	27	26	26	23	23	25
	medium	54	59	58	58	54	50	56
	low	75	85	87	83	80	85	82
Average NonSummer Use	high	105,040	98,470	99,740	97,630	96,070	96,180	98,855
	medium	252,410	253,480	246,770	242,950	237,760	234,810	244,697
	low	10,440	11,780	11,360	10,890	10,880	11,870	11,203
Average NonSummer Use Per Capita	high	6,233.91	5,843.99	5,919.36	5,794.14	5,701.56	5,708.08	5,867
	medium	12,402.41	12,454.99	12,125.29	11,937.59	11,682.57	11,537.62	12,023
	low	14,891.92	18,996.22	18,318.93	17,561.02	17,544.90	19,141.35	17,742
Avreage NonSummer Use Per Capita Per Day	high	26	24	24	24	23	23	24
	medium	51	51	50	49	48	47	49
	low	61	78	75	72	72	79	73
Ratio of Summer to NonSummer Use Per Capital Per Day	high	101%	112%	106%	108%	100%	99%	104%
	medium	106%	116%	117%	119%	113%	106%	113%
	low	122%	109%	116%	114%	110%	107%	113%
PremisID Count	high	360	349	350	351	350	356	353
	medium	652	650	647	646	652	634	647
	low	24	27	27	27	28	28	27
Average Annual Use Per PremisID	high	43,978	44,149	43,700	42,917	41,180	40,475	42,733
	medium	59,334	61,643	60,578	60,050	57,218	56,688	59,252
	low	70,125	67,519	66,481	63,519	60,393	65,250	65,548
Average Annual Use Per PremisID Per Day	high	120.49	120.96	119.73	117.58	112.82	110.89	117
	medium	162.56	168.89	165.97	164.52	156.76	155.31	162
	low	192.12	184.98	182.14	174.02	165.46	178.77	180
Average Summer Use Per PremisID	high	14,800	15,934	15,203	15,103	13,731	13,458	14,705
	medium	20,621	22,646	22,437	22,441	20,752	19,651	21,425
	low	26,625	23,889	24,407	23,185	21,536	22,857	23,750
Average Summer Use Per PremisID Per Day	high	121.31	130.61	124.61	123.79	112.55	110.31	121
	medium	169.03	185.62	183.91	183.94	170.09	161.08	176
	low	218.24	195.81	200.06	190.04	176.52	187.35	195
Average NonSummer Use Per PremisID	high	29,178	28,215	28,497	27,815	27,449	27,017	28,028
	medium	38,713	38,997	38,141	37,608	36,466	37,036	37,827
	low	43,500	43,630	42,074	40,333	38,857	42,393	41,798
Average NonSummer Use PremisID Per Day	high	120	116	117	114	113	111	115
	medium	159	160	157	155	150	152	156
	low	179	180	173	166	160	174	172

NJ American Water – Bridgeport (PWSID 0809001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium	461	461	461	461	461	461	461
	low	253	253	253	253	253	253	253
Average Annual Use (100 gallon)	high							
	medium		96,330	92,050	95,420	86,100	83,130	90,606
	low		61,360	55,690	58,760	50,040	52,130	55,596
Average Annual Per Capita	high							
	medium		20,886.93	19,958.91	20,689.62	18,668.79	18,024.81	19,646
	low		24,279.93	22,036.33	23,251.12	19,800.65	20,627.65	21,999
Average Annual Per Capita Per Day	high		-	-	-	-	-	-
	medium		57	55	57	51	49	54
	low		67	60	64	54	57	60
Average Summer Use	high							
	medium		39,140	36,940	36,650	31,270	28,130	34,426
	low		26,640	22,920	24,820	18,340	18,380	22,220
Average Summer Use Per Capita	high							
	medium		8,486.60	8,009.58	7,946.70	6,780.17	6,099.34	7,464
	low		10,541.35	9,069.36	9,821.18	7,257.07	7,272.90	8,792
Average Summer Use Per Capita Per Day	high		-	-	-	-	-	-
	medium		70	66	65	56	50	61
	low		86	74	81	59	60	72
Average NonSummer Use	high							
	medium		57,190	55,110	58,770	54,830	55,000	56,180
	low		34,720	32,770	33,940	31,700	33,750	33,376
Average NonSummer Use Per Capita	high		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	medium		12,400.33	11,949.33	12,742.91	11,888.61	11,925.48	12,181
	low		13,738.58	12,966.97	13,429.93	12,543.58	13,354.75	13,207
Avreage NonSummer Use Per Capita Per Day	high							
	medium		51	49	52	49	49	50
	low		57	53	55	52	55	54
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium		136%	134%	124%	114%	102%	122%
	low		153%	139%	146%	115%	108%	132%
PremisID Count	high							
	medium		152	152	150	144	138	147
	low		92	88	91	90	88	90
Average Annual Use Per PremisID	high							
	medium		63,375	60,559	63,613	59,792	60,239	61,516
	low		66,696	63,284	64,571	55,600	59,239	61,878
Average Annual Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		173.63	165.92	174.28	163.81	165.04	169
	low		182.73	173.38	176.91	152.33	162.30	170
Average Summer Use Per PremisID	high							
	medium		25,750	24,303	24,433	21,715	20,384	23,317
	low		28,957	26,045	27,275	20,378	20,886	24,708
Average Summer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		211.07	199.20	200.27	177.99	167.08	191
	low		237.35	213.49	223.56	167.03	171.20	203
Average NonSummer Use Per PremisID	high							
	medium		37,625	36,257	39,180	38,076	39,855	38,199
	low		37,739	37,239	37,297	35,222	38,352	37,170
Average NonSummer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		155	149	161	157	164	157
	low		155	153	153	145	158	153

NJ American Water – Cape May Courthouse (PWSID 0506010)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,439	1,439	1,439	1,439	1,439	1,439	1,439
	medium	2,639	2,732	2,732	2,732	2,732	2,779	2,724
	low	818	819	819	816	822	830	820
Average Annual Use (100 gallon)	high	111,940	110,320	107,050	108,820	109,450	102,300	108,313
	medium	463,380	512,170	494,540	478,160	446,820	468,190	477,210
	low	316,250	353,680	335,510	327,580	302,510	312,690	324,703
Average Annual Per Capita	high	7,778.15	7,665.58	7,438.37	7,561.35	7,605.13	7,108.31	7,526
	medium	17,557.18	18,749.02	18,103.64	17,504.01	16,356.75	16,846.57	17,520
	low	38,670.18	43,206.86	40,987.14	40,149.47	36,822.67	37,676.40	39,585
Average Annual Per Capita Per Day	high	21	21	20	21	21	19	21
	medium	48	51	50	48	45	46	48
	low	106	118	112	110	101	103	108
Average Summer Use	high	41,820	44,340	43,030	41,530	40,980	36,650	41,392
	medium	204,180	242,880	238,370	218,440	197,910	192,540	215,720
	low	147,280	182,800	178,910	158,550	143,110	142,250	158,817
Average Summer Use Per Capita	high	2,905.86	3,080.96	2,989.94	2,885.71	2,847.49	2,546.62	2,876
	medium	7,736.25	8,891.11	8,726.02	7,996.44	7,244.90	6,928.04	7,920
	low	18,008.99	22,331.52	21,856.31	19,432.50	17,419.89	17,139.88	19,365
Average Summer Use Per Capita Per Day	high	24	25	25	24	23	21	24
	medium	63	73	72	66	59	57	65
	low	148	183	179	159	143	140	159
Average NonSummer Use	high	70,120	65,980	64,020	67,290	68,470	65,650	66,922
	medium	259,200	269,290	256,170	259,720	248,910	275,650	261,490
	low	168,970	170,880	156,600	169,030	159,400	170,440	165,887
Average NonSummer Use Per Capita	high	4,872.29	4,584.62	4,448.43	4,675.64	4,757.64	4,561.69	4,650
	medium	9,820.93	9,857.90	9,377.62	9,507.58	9,111.85	9,918.53	9,599
	low	20,661.18	20,875.33	19,130.84	20,716.97	19,402.77	20,536.52	20,221
Avreage NonSummer Use Per Capita Per Day	high	20	19	18	19	20	19	19
	medium	40	41	39	39	37	41	40
	low	85	86	79	85	80	85	83
Ratio of Summer to NonSummer Use Per Capital Per Day	high	119%	134%	134%	123%	119%	111%	123%
	medium	157%	180%	185%	168%	158%	139%	164%
	low	174%	213%	228%	187%	179%	166%	191%
PremisID Count	high	265	269	256	260	268	247	261
	medium	701	704	704	706	713	709	706
	low	386	395	409	408	418	415	405
Average Annual Use Per PremisID	high	42,242	41,011	41,816	41,854	40,840	41,417	41,530
	medium	66,103	72,751	70,247	67,728	62,668	66,035	67,589
	low	81,930	89,539	82,032	80,289	72,371	75,347	80,251
Average Annual Use Per PremisID Per Day	high	115.73	112.36	114.57	114.67	111.89	113.47	114
	medium	181.10	199.32	192.46	185.56	171.69	180.92	185
	low	224.47	245.31	224.74	219.97	198.28	206.43	220
Average Summer Use Per PremisID	high	15,781	16,483	16,809	15,973	15,291	14,838	15,863
	medium	29,127	34,500	33,859	30,941	27,757	27,157	30,557
	low	38,155	46,278	43,743	38,860	34,237	34,277	39,259
Average Summer Use Per PremisID Per Day	high	129.35	135.11	137.78	130.93	125.34	121.62	130
	medium	238.75	282.79	277.54	253.61	227.52	222.59	250
	low	312.75	379.33	358.55	318.53	280.63	280.96	322
Average NonSummer Use Per PremisID	high	26,460	24,528	25,008	25,881	25,549	26,579	25,667
	medium	36,976	38,251	36,388	36,788	34,910	38,879	37,032
	low	43,775	43,261	38,289	41,429	38,134	41,070	40,993
Average NonSummer Use Per PremisID Per Day	high	109	101	103	107	105	109	106
	medium	152	157	150	151	144	160	152
	low	180	178	158	170	157	169	169

NJ American Water – Coastal North (PWSID 1345001)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	93,899	100,280	100,280	100,166	100,166	100,173	99,161
	medium	199,139	201,490	197,257	216,405	216,390	216,405	207,847
	low	49,367	49,974	49,547	50,948	50,919	50,948	50,284
Average Annual Use (100 gallon)	high	13,808,490	15,267,200	15,257,570	15,291,478	14,742,940	15,082,247	14,908,321
	medium	40,138,410	42,931,250	40,801,300	43,391,178	42,358,617	43,415,558	42,172,719
	low	20,057,720	23,431,790	21,210,520	20,610,653	20,219,675	20,859,334	21,064,949
Average Annual Per Capita	high	14,705.70	15,224.52	15,214.92	15,266.16	14,718.53	15,056.21	15,031
	medium	20,156.00	21,306.92	20,684.36	20,050.92	19,575.16	20,062.19	20,306
	low	40,629.48	46,888.24	42,808.61	40,454.48	39,709.14	40,942.35	41,905
Average Annual Per Capita Per Day	high	40	42	42	42	40	41	41
	medium	55	58	57	55	54	55	56
	low	111	128	117	111	109	112	115
Average Summer Use	high	5,044,360	5,788,280	5,701,390	5,658,405	5,331,427	5,379,186	5,483,841
	medium	16,349,210	19,846,220	17,894,520	18,818,544	17,898,717	18,279,948	18,181,193
	low	9,630,730	13,385,010	11,172,060	10,437,918	10,239,129	10,830,576	10,949,237
Average Summer Use Per Capita	high	5,372.12	5,772.10	5,685.45	5,649.04	5,322.60	5,369.90	5,529
	medium	8,209.96	9,849.75	9,071.69	8,695.99	8,271.52	8,447.10	8,758
	low	19,508.28	26,784.10	22,548.26	20,487.49	20,108.48	21,258.07	21,782
Average Summer Use Per Capita Per Day	high	44	47	47	46	44	44	45
	medium	67	81	74	71	68	69	72
	low	160	220	185	168	165	174	179
Average NonSummer Use	high	8,764,130	9,478,920	9,556,180	9,633,073	9,411,513	9,703,061	9,424,480
	medium	23,789,200	23,085,030	22,906,780	24,572,634	24,459,900	25,135,610	23,991,526
	low	10,426,990	10,046,780	10,038,460	10,172,735	9,980,546	10,028,758	10,115,712
Average NonSummer Use Per Capita	high	9,333.58	9,452.42	9,529.47	9,617.12	9,395.93	9,686.31	9,502
	medium	11,946.04	11,457.18	11,612.67	11,354.93	11,303.64	11,615.08	11,548
	low	21,121.20	20,104.13	20,260.35	19,966.99	19,600.65	19,684.28	20,123
Avreage NonSummer Use Per Capita Per Day	high	38	39	39	40	39	40	39
	medium	49	47	48	47	47	48	48
	low	87	83	83	82	81	81	83
Ratio of Summer to NonSummer Use Per Capital Per Day	high	115%	122%	119%	117%	113%	110%	116%
	medium	137%	171%	156%	153%	146%	145%	151%
	low	184%	265%	222%	204%	204%	215%	216%
PremisID Count	high	22,144	25,072	25,195	25,807	24,654	25,095	24,661
	medium	48,563	49,266	49,268	54,828	53,964	53,826	51,619
	low	16,677	16,836	16,825	17,381	17,294	17,174	17,031
Average Annual Use Per PremisID	high	62,358	60,893	60,558	59,253	59,799	60,101	60,494
	medium	82,652	87,142	82,815	79,141	78,494	80,659	81,817
	low	120,272	139,177	126,065	118,582	116,917	121,459	123,745
Average Annual Use Per PremisID Per Day	high	170.84	166.83	165.91	162.34	163.83	164.66	166
	medium	226.44	238.74	226.89	216.82	215.05	220.98	224
	low	329.51	381.31	345.38	324.88	320.32	332.76	339
Average Summer Use Per PremisID	high	22,780	23,087	22,629	21,926	21,625	21,435	22,247
	medium	33,666	40,284	36,321	34,323	33,168	33,961	35,287
	low	57,749	79,502	66,402	60,054	59,206	63,064	64,329
Average Summer Use Per PremisID Per Day	high	186.72	189.23	185.48	179.72	177.25	175.70	182
	medium	275.95	330.20	297.71	281.34	271.87	278.37	289
	low	473.35	651.66	544.27	492.24	485.30	516.92	527
Average NonSummer Use Per PremisID	high	39,578	37,807	37,929	37,327	38,174	38,665	38,247
	medium	48,986	46,858	46,494	44,818	45,326	46,698	46,530
	low	62,523	59,674	59,664	58,528	57,711	58,395	59,416
Average NonSummer Use Per PremisID Per Day	high	163	156	156	154	157	159	157
	medium	202	193	191	184	187	192	191
	low	257	246	246	241	237	240	245

NJ American Water – Delaware Division (PWSID 327001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	75,539	75,932	76,823	75,959	75,959	75,637	75,975
	medium	196,226	196,226	196,226	196,226	196,226	196,226	196,226
	low	8,521	8,542	8,547	8,548	8,540	8,545	8,541
Average Annual Use (100 gallon)	high	9,739,090	9,892,050	8,214,240	9,542,590	9,295,420	9,072,881	9,292,712
	medium	45,187,510	49,715,760	45,797,870	46,485,080	41,958,308	42,469,091	45,268,936
	low	3,331,270	3,824,770	3,523,160	3,537,846	2,989,750	3,068,750	3,379,258
Average Annual Per Capita	high	12,892.88	13,027.44	10,692.41	12,562.77	12,237.38	11,995.23	12,235
	medium	23,028.27	25,335.94	23,339.32	23,689.54	21,382.62	21,642.92	23,070
	low	39,094.46	44,774.05	41,220.74	41,387.37	35,009.54	35,913.70	39,567
Average Annual Per Capita Per Day	high	35	36	29	34	34	33	34
	medium	63	69	64	65	59	59	63
	low	107	123	113	113	96	98	108
Average Summer Use	high	3,548,060	3,767,390	2,986,190	3,595,660	3,189,970	3,150,495	3,372,961
	medium	17,800,870	22,798,580	19,526,270	20,416,310	16,058,660	16,738,051	18,889,790
	low	1,455,130	2,068,840	1,733,920	1,830,550	1,298,620	1,424,150	1,635,202
Average Summer Use Per Capita	high	4,697.02	4,961.51	3,887.10	4,733.67	4,199.58	4,165.26	4,441
	medium	9,071.61	11,618.52	9,950.90	10,404.48	8,183.75	8,529.98	9,627
	low	17,076.83	24,218.54	20,286.75	21,414.62	15,206.65	16,666.88	19,145
Average Summer Use Per Capita Per Day	high	39	41	32	39	34	34	36
	medium	74	95	82	85	67	70	79
	low	140	199	166	176	125	137	157
Average NonSummer Use	high	6,191,030	6,124,660	5,228,050	5,946,930	6,105,450	5,922,386	5,919,751
	medium	27,386,640	26,917,180	26,271,600	26,068,770	25,899,648	25,731,040	26,379,146
	low	1,876,140	1,755,930	1,789,240	1,707,296	1,691,130	1,644,600	1,744,056
Average NonSummer Use Per Capita	high	8,195.86	8,065.94	6,805.31	7,829.10	8,037.80	7,829.97	7,794
	medium	13,956.67	13,717.42	13,388.43	13,285.06	13,198.87	13,112.95	13,443
	low	22,017.63	20,555.51	20,933.99	19,972.74	19,802.89	19,246.82	20,422
Avreage NonSummer Use Per Capita Per Day	high	34	33	28	32	33	32	32
	medium	57	56	55	55	54	54	55
	low	91	85	86	82	81	79	84
Ratio of Summer to NonSummer Use Per Capital Per Day	high	114%	123%	114%	120%	104%	106%	113%
	medium	129%	169%	148%	156%	123%	130%	143%
	low	154%	235%	193%	214%	153%	172%	187%
PremisID Count	high	15,181	15,357	13,157	15,376	15,430	15,198	14,950
	medium	61,712	63,234	61,343	62,576	62,380	61,807	62,175
	low	3,514	3,554	3,477	3,510	3,498	3,478	3,505
Average Annual Use Per PremisID	high	64,153	64,414	62,432	62,062	60,243	59,698	62,167
	medium	73,223	78,622	74,659	74,286	67,262	68,712	72,794
	low	94,800	107,619	101,328	100,793	85,470	88,233	96,374
Average Annual Use Per PremisID Per Day	high	175.76	176.48	171.05	170.03	165.05	163.56	170
	medium	200.61	215.40	204.54	203.52	184.28	188.25	199
	low	259.73	294.85	277.61	276.15	234.17	241.73	264
Average Summer Use Per PremisID	high	23,372	24,532	22,697	23,385	20,674	20,730	22,565
	medium	28,845	36,054	31,831	32,626	25,743	27,081	30,364
	low	41,410	58,212	49,868	52,152	37,125	40,947	46,619
Average Summer Use Per PremisID Per Day	high	191.57	201.08	186.04	191.68	169.46	169.92	185
	medium	236.44	295.53	260.91	267.43	211.01	221.98	249
	low	339.42	477.14	408.76	427.48	304.30	335.63	382
Average NonSummer Use Per PremisID	high	40,781	39,882	39,736	38,677	39,569	38,968	39,602
	medium	44,378	42,568	42,827	41,659	41,519	41,631	42,430
	low	53,390	49,407	51,459	48,641	48,346	47,286	49,755
Average NonSummer Use Per PremisID Per Day	high	168	164	164	159	163	160	163
	medium	183	175	176	171	171	171	175
	low	220	203	212	200	199	195	205

NJ American Water – Frenchtown (PWSID 1011001)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	308	308	308	308	308	308	308
	medium	534	534	534	534	534	534	534
	low	316	316	316	316	316	316	316
Average Annual Use (100 gallon)	high	23,440	23,180	22,160	20,410	19,600	20,470	21,543
	medium	99,660	103,550	105,820	104,780	97,440	99,200	101,742
	low	34,670	41,050	38,340	37,900	38,370	38,030	38,060
Average Annual Per Capita	high	7,607.25	7,522.87	7,191.84	6,623.89	6,361.01	6,643.37	6,992
	medium	18,668.88	19,397.58	19,822.81	19,627.99	18,253.02	18,582.71	19,059
	low	10,972.84	12,992.07	12,134.37	11,995.12	12,143.87	12,036.26	12,046
Average Annual Per Capita Per Day	high	21	21	20	18	17	18	19
	medium	51	53	54	54	50	51	52
	low	30	36	33	33	33	33	33
Average Summer Use	high	8,380	8,830	7,740	7,100	6,910	7,080	7,673
	medium	36,530	39,220	39,800	37,910	35,290	35,490	37,373
	low	12,890	17,410	14,650	14,770	13,650	14,410	14,630
Average Summer Use Per Capita	high	2,719.66	2,865.70	2,511.95	2,304.25	2,242.58	2,297.75	2,490
	medium	6,843.01	7,346.91	7,455.56	7,101.52	6,610.72	6,648.19	7,001
	low	4,079.61	5,510.16	4,636.63	4,674.61	4,320.14	4,560.68	4,630
Average Summer Use Per Capita Per Day	high	22	23	21	19	18	19	20
	medium	56	60	61	58	54	54	57
	low	33	45	38	38	35	37	38
Average NonSummer Use	high	15,060	14,350	14,420	13,310	12,690	13,390	13,870
	medium	63,130	64,330	66,020	66,870	62,150	63,710	64,368
	low	21,780	23,640	23,690	23,130	24,720	23,620	23,430
Average NonSummer Use Per Capita	high	4,887.60	4,657.17	4,679.89	4,319.65	4,118.43	4,345.61	4,501
	medium	11,825.87	12,050.66	12,367.24	12,526.47	11,642.29	11,934.52	12,058
	low	6,893.24	7,481.91	7,497.74	7,320.50	7,823.73	7,475.58	7,415
Avreage NonSummer Use Per Capita Per Day	high	20	19	19	18	17	18	19
	medium	49	50	51	52	48	49	50
	low	28	31	31	30	32	31	31
Ratio of Summer to NonSummer Use Per Capital Per Day	high	111%	123%	107%	106%	108%	105%	110%
	medium	115%	121%	120%	113%	113%	111%	116%
	low	118%	147%	123%	127%	110%	122%	124%
PremisID Count	high	44	44	42	42	42	45	43
	medium	186	185	185	188	191	190	188
	low	68	72	72	71	73	69	71
Average Annual Use Per PremisID	high	53,273	52,682	52,762	48,595	46,667	45,489	49,911
	medium	53,581	55,973	57,200	55,734	51,016	52,211	54,286
	low	50,985	57,014	53,250	53,380	52,562	55,116	53,718
Average Annual Use Per PremisID Per Day	high	145.95	144.33	144.55	133.14	127.85	124.63	137
	medium	146.80	153.35	156.71	152.70	139.77	143.04	149
	low	139.69	156.20	145.89	146.25	144.00	151.00	147
Average Summer Use Per PremisID	high	19,045	20,068	18,429	16,905	16,452	15,733	17,772
	medium	19,640	21,200	21,514	20,165	18,476	18,679	19,946
	low	18,956	24,181	20,347	20,803	18,699	20,884	20,645
Average Summer Use Per PremisID Per Day	high	156.11	164.49	151.05	138.56	134.86	128.96	146
	medium	160.98	173.77	176.34	165.29	151.45	153.11	163
	low	155.38	198.20	166.78	170.51	153.27	171.18	169
Average NonSummer Use Per PremisID	high	34,227	32,614	34,333	31,690	30,214	29,756	32,139
	medium	33,941	34,773	35,686	35,569	32,539	33,532	34,340
	low	32,029	32,833	32,903	32,577	33,863	34,232	33,073
Average NonSummer Use Per PremisID Per Day	high	141	134	141	130	124	122	132
	medium	140	143	147	146	134	138	141
	low	132	135	135	134	139	141	136

NJ American Water – Harrison (Gloucester County) (PWSID 0808001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	350	350	350	350	350	350	350
	medium	3,138	3,138	3,138	3,138	3,138	3,138	3,138
	low	5,625	5,757	5,770	5,770	5,770	5,770	5,744
Average Annual Use (100 gallon)	high		69,350	65,010	64,020	64,770	66,310	65,892
	medium		706,040	701,920	701,240	621,270	677,420	681,578
	low		2,161,120	2,101,100	2,070,150	1,714,270	1,919,620	1,993,252
Average Annual Per Capita	high	-	19,799.43	18,560.36	18,277.72	18,491.84	18,931.51	15,677
	medium	-	22,501.20	22,369.89	22,348.22	19,799.61	21,589.09	18,101
	low	-	37,542.11	36,411.45	35,875.09	29,707.80	33,266.45	28,800
Average Annual Per Capita Per Day	high	-	54	51	50	51	52	43
	medium	-	62	61	61	54	59	50
	low	-	103	100	98	81	91	79
Average Summer Use	high		24,010	21,840	22,640	21,560	21,070	22,224
	medium		361,180	329,720	349,370	261,640	279,530	316,288
	low		1,288,440	1,103,110	1,197,160	803,330	890,980	1,056,604
Average Summer Use Per Capita	high	-	6,854.86	6,235.32	6,463.72	6,155.38	6,015.49	5,287
	medium	-	11,510.65	10,508.04	11,134.27	8,338.36	8,908.50	8,400
	low	-	22,382.26	19,116.57	20,746.43	13,921.47	15,440.42	15,268
Average Summer Use Per Capita Per Day	high	-	56	51	53	50	49	43
	medium	-	94	86	91	68	73	69
	low	-	183	157	170	114	127	125
Average NonSummer Use	high		45,340	43,170	41,380	43,210	45,240	43,668
	medium		344,860	372,200	351,870	359,630	397,890	365,290
	low		872,680	997,990	872,990	910,940	1,028,640	936,648
Average NonSummer Use Per Capita	high	-	12,944.57	12,325.04	11,813.99	12,336.46	12,916.02	10,389
	medium	-	10,990.54	11,861.86	11,213.95	11,461.26	12,680.59	9,701
	low	-	15,159.85	17,294.87	15,128.66	15,786.32	17,826.03	13,533
Avreage NonSummer Use Per Capita Per Day	high	-	53	51	49	51	53	43
	medium	-	45	49	46	47	52	40
	low		62	71	62	65	73	67
Ratio of Summer to NonSummer Use Per Capital Per Day	high		105%	101%	109%	99%	93%	101%
	medium		209%	176%	198%	145%	140%	174%
	low		294%	220%	273%	176%	173%	227%
PremisID Count	high		127	125	122	123	120	123
	medium		809	816	838	848	850	832
	low		1,548	1,580	1,589	1,607	1,614	1,588
Average Annual Use Per PremisID	high		54,606	52,008	52,475	52,659	55,258	53,401
	medium		87,273	86,020	83,680	73,263	79,696	81,986
	low		139,607	132,981	130,280	106,675	118,936	125,696
Average Annual Use Per PremisID Per Day	high		149.61	142.49	143.77	144.27	151.39	146
	medium		239.10	235.67	229.26	200.72	218.35	225
	low		382.49	364.33	356.93	292.26	325.85	344
Average Summer Use Per PremisID	high		18,906	17,472	18,557	17,528	17,558	18,004
	medium		44,645	40,407	41,691	30,854	32,886	38,097
	low		83,233	69,817	75,340	49,989	55,203	66,717
Average Summer Use Per PremisID Per Day	high		154.96	143.21	152.11	143.68	143.92	148
	medium		365.94	331.20	341.73	252.90	269.56	312
	low		682.23	572.27	617.54	409.75	452.49	547
Average NonSummer Use Per PremisID	high		35,701	34,536	33,918	35,130	37,700	35,397
	medium		42,628	45,613	41,989	42,409	46,811	43,890
	low		56,375	63,164	54,940	56,686	63,732	58,979
Average NonSummer Use Per PremisID Per Day	high		147	142	140	145	155	146
	medium		175	188	173	175	193	181
	low		232	260	226	233	262	243

NJ American Water – Homestead (Burlington County) (PWSID 0318002)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,645	1,645	1,645	1,645	1,645	1,645	1,645
	medium	318	318	318	318	318	318	318
	low	8	8	8	8	8	8	8
Average Annual Use (100 gallon)	high		335,360	314,870	307,770	297,480	283,560	307,808
	medium		176,680	155,320	159,600	132,220	131,890	151,142
	low		9,270	8,270	6,960	4,900	5,570	6,994
Average Annual Per Capita	high		20,385.81	19,140.27	18,708.67	18,083.17	17,237.00	18,711
	medium		55,500.94	48,791.07	50,135.56	41,534.61	41,430.95	47,479
	low		112,528.13	100,389.17	84,487.14	59,480.89	67,613.99	84,900
Average Annual Per Capita Per Day	high		56	52	51	50	47	51
	medium		152	134	137	114	114	130
	low		308	275	231	163	185	233
Average Summer Use	high		120,560	109,200	102,840	99,630	95,950	105,636
	medium		111,890	85,340	83,200	62,170	61,600	80,840
	low		6,950	5,210	4,110	2,190	2,430	4,178
Average Summer Use Per Capita	high		7,328.58	6,638.03	6,251.42	6,056.29	5,832.59	6,421
	medium		35,148.29	26,808.07	26,135.83	19,529.62	19,350.57	25,394
	low		84,365.75	63,243.96	49,891.11	26,584.32	29,497.66	50,717
Average Summer Use Per Capita Per Day	high		60	54	51	50	48	53
	medium		288	220	214	160	159	208
	low		692	518	409	218	242	416
Average NonSummer Use	high		214,800	205,670	204,930	197,850	187,610	202,172
	medium		64,790	69,980	76,400	70,050	70,290	70,302
	low		2,320	3,060	2,850	2,710	3,140	2,816
Average NonSummer Use Per Capita	high		13,057.23	12,502.23	12,457.25	12,026.87	11,404.41	12,290
	medium		20,352.65	21,983.00	23,999.73	22,004.99	22,080.38	22,084
	low		28,162.38	37,145.21	34,596.03	32,896.57	38,116.32	34,183
Avreage NonSummer Use Per Capita Per Day	high		54	51	51	49	47	51
	medium		84	90	99	91	91	91
	low		116	153	142	135	157	141
Ratio of Summer to NonSummer Use Per Capital Per Day	high		112%	106%	100%	100%	102%	104%
	medium		344%	243%	217%	177%	175%	231%
	low		597%	339%	287%	161%	154%	308%
PremisID Count	high		956	941	943	952	929	944
	medium		165	168	170	165	170	168
	low		7	7	7	7	7	7
Average Annual Use Per PremisID	high		35,079	33,461	32,637	31,248	30,523	32,590
	medium		107,079	92,452	93,882	80,133	77,582	90,226
	low		132,429	118,143	99,429	70,000	79,571	99,914
Average Annual Use Per PremisID Per Day	high		96.11	91.67	89.42	85.61	83.63	89
	medium		293.37	253.29	257.21	219.54	212.55	247
	low		362.82	323.68	272.41	191.78	218.00	274
Average Summer Use Per PremisID	high		12,611	11,605	10,906	10,465	10,328	11,183
	medium		67,812	50,798	48,941	37,679	36,235	48,293
	low		99,286	74,429	58,714	31,286	34,714	59,686
Average Summer Use Per PremisID Per Day	high		103.37	95.12	89.39	85.78	84.66	92
	medium		555.84	416.37	401.16	308.84	297.01	396
	low		813.82	610.07	481.26	256.44	284.54	489
Average NonSummer Use Per PremisID	high		22,469	21,857	21,732	20,783	20,195	21,407
	medium		39,267	41,655	44,941	42,455	41,347	41,933
	low		33,143	43,714	40,714	38,714	44,857	40,229
Average NonSummer Use Per PremisID Per Day	high		92	90	89	86	83	88
	medium		162	171	185	175	170	173
	low		136	180	168	159	185	166

NJ American Water – Jamesburg (now part of PWSID 2004002)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	2,988	2,988	2,988	2,988	2,988	2,988	2,988
	medium	3,754	3,754	3,754	3,754	3,754	3,754	3,754
	low	517	517	520	520	520	520	519
Average Annual Use (100 gallon)	high	325,260	336,040	338,740	326,230	318,200	311,005	325,913
	medium	617,340	664,860	645,200	617,380	590,140	589,150	620,678
	low	82,350	87,420	80,240	78,780	76,110	73,910	79,802
Average Annual Per Capita	high	10,885.42	11,246.19	11,336.55	10,917.88	10,649.14	10,408.35	10,907
	medium	16,446.10	17,712.05	17,188.30	16,447.17	15,721.49	15,695.11	16,535
	low	15,938.58	16,919.87	15,442.04	15,161.07	14,647.23	14,223.84	15,389
Average Annual Per Capita Per Day	high	30	31	31	30	29	29	30
	medium	45	49	47	45	43	43	45
	low	44	46	42	42	40	39	42
Average Summer Use	high	111,140	116,220	117,630	115,200	111,220	103,305	112,453
	medium	232,720	272,030	255,240	251,250	226,380	221,090	243,118
	low	33,630	38,320	33,850	35,060	30,940	28,710	33,418
Average Summer Use Per Capita	high	3,719.50	3,889.51	3,936.70	3,855.38	3,722.18	3,457.29	3,763
	medium	6,199.72	7,246.95	6,799.66	6,693.37	6,030.82	5,889.90	6,477
	low	6,508.98	7,416.72	6,514.37	6,747.23	5,954.35	5,525.19	6,444
Average Summer Use Per Capita Per Day	high	30	32	32	32	31	28	31
	medium	51	59	56	55	49	48	53
	low	53	61	53	55	49	45	53
Average NonSummer Use	high	214,120	219,820	221,110	211,030	206,980	207,700	213,460
	medium	384,620	392,830	389,960	366,130	363,760	368,060	377,560
	low	48,720	49,100	46,390	43,720	45,170	45,200	46,383
Average NonSummer Use Per Capita	high	7,165.91	7,356.68	7,399.85	7,062.50	6,926.96	6,951.06	7,144
	medium	10,246.38	10,465.09	10,388.64	9,753.80	9,690.66	9,805.22	10,058
	low	9,429.60	9,503.15	8,927.67	8,413.83	8,692.88	8,698.66	8,944
Avreage NonSummer Use Per Capita Per Day	high	29	30	30	29	29	29	29
	medium	42	43	43	40	40	40	41
	low	39	39	37	35	36	36	37
Ratio of Summer to NonSummer Use Per Capital Per Day	high	103%	105%	106%	109%	107%	99%	105%
	medium	121%	138%	130%	137%	124%	120%	128%
	low	137%	155%	145%	160%	136%	127%	143%
PremisID Count	high	600	604	602	589	584	574	592
	medium	889	900	895	882	869	861	883
	low	110	110	110	109	110	110	110
Average Annual Use Per PremisID	high	54,210	55,636	56,269	55,387	54,486	54,182	55,028
	medium	69,442	73,873	72,089	69,998	67,910	68,426	70,290
	low	74,864	79,473	72,945	72,275	69,191	67,191	72,656
Average Annual Use Per PremisID Per Day	high	148.52	152.43	154.16	151.75	149.28	148.44	151
	medium	190.25	202.39	197.51	191.77	186.06	187.47	193
	low	205.11	217.73	199.85	198.01	189.56	184.08	199
Average Summer Use Per PremisID	high	18,523	19,242	19,540	19,559	19,045	17,997	18,984
	medium	26,178	30,226	28,518	28,486	26,051	25,678	27,523
	low	30,573	34,836	30,773	32,165	28,127	26,100	30,429
Average Summer Use Per PremisID Per Day	high	151.83	157.72	160.16	160.32	156.10	147.52	156
	medium	214.57	247.75	233.76	233.50	213.53	210.48	226
	low	250.60	285.54	252.24	263.65	230.55	213.93	249
Average NonSummer Use Per PremisID	high	35,687	36,394	36,729	35,829	35,442	36,185	36,044
	medium	43,264	43,648	43,571	41,511	41,860	42,748	42,767
	low	44,291	44,636	42,173	40,110	41,064	41,091	42,227
Average NonSummer Use Per PremisID Per Day	high	147	150	151	147	146	149	148
	medium	178	180	179	171	172	176	176
	low	182	184	174	165	169	169	174

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	8,795	8,795	8,795	8,795	8,795	8,795	8,795
	medium	7,676	7,676	7,676	7,676	7,676	7,676	7,676
	low	314	314	314	314	314	314	314
Average Annual Use (100 gallon)	high	707,540	739,660	718,590	702,214	685,560	682,020	705,931
	medium	1,446,050	1,569,350	1,499,110	1,555,360	1,458,020	1,467,510	1,499,233
	low	86,110	98,960	94,550	98,820	83,710	83,330	90,913
Average Annual Per Capita	high	8,044.78	8,409.99	8,170.42	7,984.23	7,794.87	7,754.62	8,026
	medium	18,838.62	20,444.93	19,529.87	20,262.67	18,994.56	19,118.19	19,531
	low	27,386.95	31,473.84	30,071.26	31,429.31	26,623.64	26,502.78	28,915
Average Annual Per Capita Per Day	high	22	23	22	22	21	21	22
	medium	52	56	54	56	52	52	54
	low	75	86	82	86	73	73	79
Average Summer Use	high	249,600	277,880	263,030	257,910	245,300	237,970	255,282
	medium	545,820	661,410	607,590	623,320	570,700	564,710	595,592
	low	34,910	49,480	43,390	42,980	33,200	38,980	40,490
Average Summer Use Per Capita	high	2,837.97	3,159.52	2,990.67	2,932.46	2,789.08	2,705.74	2,903
	medium	7,110.75	8,616.61	7,915.46	8,120.39	7,434.88	7,356.84	7,759
	low	11,102.99	15,736.92	13,800.02	13,669.62	10,559.13	12,397.44	12,878
Average Summer Use Per Capita Per Day	high	23	26	25	24	23	22	24
	medium	58	71	65	67	61	60	64
	low	91	129	113	112	87	102	106
Average NonSummer Use	high	457,940	461,780	455,560	444,304	440,260	444,050	450,649
	medium	900,230	907,940	891,520	932,040	887,320	902,800	903,642
	low	51,200	49,480	51,160	55,840	50,510	44,350	50,423
Average NonSummer Use Per Capita	high	5,206.81	5,250.47	5,179.75	5,051.77	5,005.79	5,048.88	5,124
	medium	11,727.87	11,828.32	11,614.40	12,142.28	11,559.69	11,761.35	11,772
	low	16,283.96	15,736.92	16,271.24	17,759.69	16,064.51	14,105.34	16,037
Avreage NonSummer Use Per Capita Per Day	high	21	22	21	21	21	21	21
	medium	48	49	48	50	48	48	48
	low	67	65	67	73	66	58	66
Ratio of Summer to NonSummer Use Per Capital Per Day	high	109%	120%	115%	116%	111%	107%	113%
	medium	121%	145%	136%	133%	128%	125%	131%
	low	136%	199%	169%	153%	131%	175%	161%
PremisID Count	high	1,041	1,044	1,027	1,026	1,039	1,015	1,032
	medium	2,120	2,123	2,119	2,183	2,169	2,164	2,146
	low	99	101	100	104	103	102	102
Average Annual Use Per PremisID	high	67,967	70,849	69,970	68,442	65,983	67,194	68,401
	medium	68,210	73,921	70,746	71,249	67,221	67,815	69,860
	low	86,980	97,980	94,550	95,019	81,272	81,696	89,583
Average Annual Use Per PremisID Per Day	high	186.21	194.11	191.70	187.51	180.77	184.09	187
	medium	186.88	202.52	193.82	195.20	184.17	185.79	191
	low	238.30	268.44	259.04	260.33	222.66	223.82	245
Average Summer Use Per PremisID	high	23,977	26,617	25,611	25,137	23,609	23,445	24,733
	medium	25,746	31,154	28,673	28,553	26,312	26,096	27,756
	low	35,263	48,990	43,390	41,327	32,233	38,216	39,903
Average Summer Use Per PremisID Per Day	high	196.53	218.17	209.93	206.04	193.52	192.17	203
	medium	211.03	255.36	235.03	234.04	215.67	213.90	228
	low	289.04	401.56	355.66	338.75	264.20	313.24	327
Average NonSummer Use Per PremisID	high	43,990	44,232	44,358	43,304	42,373	43,749	43,668
	medium	42,464	42,767	42,073	42,695	40,909	41,719	42,104
	low	51,717	48,990	51,160	53,692	49,039	43,480	49,680
Average NonSummer Use Per PremisID Per Day	high	181	182	183	178	174	180	180
	medium	175	176	173	176	168	172	173
	low	213	202	211	221	202	179	204

NJ American Water – Logan (PWSID 0809002)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,021	1,021	1,021	1,021	1,021	1,021	1,021
	medium	4,201	4,325	4,325	4,325	4,325	4,325	4,304
	low	209	244	244	251	251	251	242
Average Annual Use (100 gallon)	high	226,390	236,230	230,310	228,080	213,820	222,980	226,302
	medium	872,210	1,064,900	995,600	1,010,780	906,530	912,130	960,358
	low	15,900	74,630	74,400	78,130	64,460	65,800	62,220
Average Annual Per Capita	high	22,176.01	23,139.89	22,560.00	22,341.56	20,944.72	21,841.99	22,167
	medium	20,762.80	24,624.63	23,022.14	23,373.16	20,962.50	21,091.99	22,306
	low	7,604.36	30,560.01	30,465.83	31,172.05	25,718.04	26,252.67	25,295
Average Annual Per Capita Per Day	high	61	63	62	61	57	60	61
	medium	57	67	63	64	57	58	61
	low	21	84	83	85	70	72	69
Average Summer Use	high	80,130	90,530	86,210	85,300	72,060	79,290	82,253
	medium	345,390	490,180	444,110	455,950	358,400	366,330	410,060
	low	6,000	33,620	33,790	33,850	24,680	26,800	26,457
Average Summer Use Per Capita	high	7,849.13	8,867.86	8,444.69	8,355.55	7,058.63	7,766.84	8,057
	medium	8,221.95	11,334.87	10,269.55	10,543.34	8,287.60	8,470.97	9,521
	low	2,869.57	13,766.95	13,836.56	13,505.36	9,846.74	10,692.58	10,753
Average Summer Use Per Capita Per Day	high	64	73	69	68	58	64	66
	medium	67	93	84	86	68	69	78
	low	24	113	113	111	81	88	88
Average NonSummer Use	high	146,260	145,700	144,100	142,780	141,760	143,690	144,048
	medium	526,820	574,720	551,490	554,830	548,130	545,800	550,298
	low	9,900	41,010	40,610	44,280	39,780	39,000	35,763
Average NonSummer Use Per Capita	high	14,326.89	14,272.03	14,115.30	13,986.00	13,886.09	14,075.14	14,110
	medium	12,540.85	13,289.76	12,752.59	12,829.83	12,674.90	12,621.02	12,785
	low	4,734.79	16,793.06	16,629.26	17,666.69	15,871.29	15,560.09	14,543
Avreage NonSummer Use Per Capita Per Day	high	59	59	58	58	57	58	58
	medium	52	55	52	53	52	52	53
	low	19	69	68	73	65	64	60
Ratio of Summer to NonSummer Use Per Capital Per Day	high	109%	124%	119%	119%	101%	110%	114%
	medium	131%	170%	160%	164%	130%	134%	148%
	low	121%	163%	166%	152%	124%	137%	144%
PremisID Count	high	404	408	411	406	400	392	404
	medium	1,177	1,357	1,355	1,364	1,370	1,366	1,332
	low	21	91	92	94	91	90	80
Average Annual Use Per PremisID	high	56,037	57,900	56,036	56,177	53,455	56,883	56,081
	medium	74,105	78,475	73,476	74,104	66,170	66,774	72,184
	low	75,714	82,011	80,870	83,117	70,835	73,111	77,610
Average Annual Use Per PremisID Per Day	high	153.53	158.63	153.52	153.91	146.45	155.84	154
	medium	203.03	215.00	201.30	203.02	181.29	182.94	198
	low	207.44	224.69	221.56	227.72	194.07	200.30	213
Average Summer Use Per PremisID	high	19,834	22,189	20,976	21,010	18,015	20,227	20,375
	medium	29,345	36,122	32,776	33,427	26,161	26,818	30,775
	low	28,571	36,945	36,728	36,011	27,121	29,778	32,526
Average Summer Use Per PremisID Per Day	high	162.58	181.87	171.93	172.21	147.66	165.80	167
	medium	240.53	296.08	268.65	274.00	214.43	219.82	252
	low	234.19	302.83	301.05	295.17	222.30	244.08	267
Average NonSummer Use Per PremisID	high	36,203	35,711	35,061	35,167	35,440	36,656	35,706
	medium	44,760	42,352	40,700	40,677	40,009	39,956	41,409
	low	47,143	45,066	44,141	47,106	43,714	43,333	45,084
Average NonSummer Use PremisID Per Day	high	149	147	144	145	146	151	147
	medium	184	174	167	167	165	164	170
	low	194	185	182	194	180	178	186

NJ American Water – Mansfield (Warren County) (PWSID 2116003)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium	158	158	158	158	158	158	158
	low	76	76	76	76	76	76	76
Average Annual Use (100 gallon)	high							
	medium	9,160	9,630	8,690	8,910	9,040	11,430	9,477
	low	8,720	8,760	7,650	8,150	7,760	6,540	7,930
Average Annual Per Capita	high							
	medium	5,797.98	6,095.47	5,500.48	5,639.74	5,722.02	7,234.81	5,998
	low	11,502.31	11,555.07	10,090.90	10,750.43	10,236.00	8,626.73	10,460
Average Annual Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	16	17	15	15	16	20	16
	low	32	32	28	29	28	24	29
Average Summer Use	high							
	medium	3,460	3,320	2,890	3,270	3,460	3,450	3,308
	low	3,290	3,040	2,880	3,690	2,890	2,320	3,018
Average Summer Use Per Capita	high							
	medium	2,190.07	2,101.45	1,829.27	2,069.80	2,190.07	2,183.74	2,094
	low	4,339.75	4,009.98	3,798.93	4,867.37	3,812.12	3,060.25	3,981
Average Summer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	18	17	15	17	18	18	17
	low	36	33	31	40	31	25	33
Average NonSummer Use	high							
	medium	5,700	6,310	5,800	5,640	5,580	7,980	6,168
	low	5,430	5,720	4,770	4,460	4,870	4,220	4,912
Average NonSummer Use Per Capita	high							
	medium	3,607.91	3,994.02	3,671.21	3,569.93	3,531.96	5,051.08	3,904
	low	7,162.56	7,545.09	6,291.97	5,883.06	6,423.88	5,566.48	6,479
Avreage NonSummer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	15	16	15	15	15	21	16
	low	29	31	26	24	26	23	27
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium	121%	105%	99%	115%	124%	86%	108%
	low	121%	106%	120%	165%	118%	110%	123%
PremisID Count	high							
	medium	21	23	22	22	22	26	23
	low	16	18	15	14	15	13	15
Average Annual Use Per PremisID	high							
	medium	43,619	41,870	39,500	40,500	41,091	43,962	41,757
	low	54,500	48,667	51,000	58,214	51,733	50,308	52,404
Average Annual Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	119.50	114.71	108.22	110.96	112.58	120.44	114
	low	149.32	133.33	139.73	159.49	141.74	137.83	144
Average Summer Use Per PremisID	high							
	medium	16,476	14,435	13,136	14,864	15,727	13,269	14,651
	low	20,563	16,889	19,200	26,357	19,267	17,846	20,020
Average Summer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	135.05	118.32	107.68	121.83	128.91	108.76	120
	low	168.55	138.43	157.38	216.04	157.92	146.28	164
Average NonSummer Use Per PremisID	high							
	medium	27,143	27,435	26,364	25,636	25,364	30,692	27,106
	low	33,938	31,778	31,800	31,857	32,467	32,462	32,383
Average NonSummer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	112	113	108	105	104	126	112
	low	140	131	131	131	134	134	133

NJ American Water – Mount Holly (PWSID 0323001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	7,638	7,638	7,638	7,638	7,638	7,638	7,638
	medium	27,663	27,663	27,663	27,663	27,663	27,663	27,663
	low	3,562	3,562	3,565	3,556	3,546	3,546	3,556
Average Annual Use (100 gallon)	high		689,000	1,060,340	1,343,738	1,344,954	920,870	1,071,780
	medium		2,717,890	4,268,350	5,981,276	5,430,891	3,755,649	4,430,811
	low		530,470	939,460	1,169,321	962,151	947,783	909,837
Average Annual Per Capita	high		9,021.17	13,883.17	17,593.75	17,609.66	12,057.07	14,033
	medium		9,824.96	15,429.75	21,621.85	19,632.25	13,576.38	16,017
	low		14,894.31	26,352.95	32,880.90	27,129.76	26,724.63	25,597
Average Annual Per Capita Per Day	high		25	38	48	48	33	38
	medium		27	42	59	54	37	44
	low		41	72	90	74	73	70
Average Summer Use	high		291,990	406,530	517,524	474,143	340,489	406,135
	medium		1,370,680	2,055,840	2,831,531	2,231,559	1,703,553	2,038,633
	low		336,750	541,290	647,396	464,796	510,590	500,164
Average Summer Use Per Capita	high		3,823.06	5,322.75	6,776.01	6,208.01	4,458.07	5,318
	medium		4,954.90	7,431.70	10,235.77	8,066.91	6,158.21	7,369
	low		9,455.12	15,183.82	18,204.55	13,105.85	14,397.10	14,069
Average Summer Use Per Capita Per Day	high		31	44	56	51	37	44
	medium		41	61	84	66	50	60
	low		78	124	149	107	118	115
Average NonSummer Use	high		397,010	653,810	826,214	870,811	580,381	665,645
	medium		1,347,210	2,212,510	3,149,745	3,199,332	2,052,096	2,392,179
	low		193,720	398,170	521,925	497,355	437,193	409,673
Average NonSummer Use Per Capita	high		5,198.10	8,560.42	10,817.73	11,401.65	7,599.00	8,715
	medium		4,870.06	7,998.05	11,386.08	11,565.34	7,418.17	8,648
	low		5,439.19	11,169.14	14,676.35	14,023.91	12,327.53	11,527
Avreage NonSummer Use Per Capita Per Day	high		21	35	45	47	31	36
	medium		20	33	47	48	31	36
	low		22	46	60	58	51	47
Ratio of Summer to NonSummer Use Per Capital Per Day	high		146%	124%	125%	108%	117%	124%
	medium		203%	185%	179%	139%	165%	174%
	low		346%	271%	247%	186%	233%	257%
PremisID Count	high		1,235	1,923	2,415	2,451	1,712	1,947
	medium		3,410	5,604	8,146	8,249	5,182	6,118
	low		464	906	1,141	1,164	1,015	938
Average Annual Use Per PremisID	high		55,789	55,140	55,641	54,874	53,789	55,047
	medium		79,704	76,166	73,426	65,837	72,475	73,521
	low		114,325	103,693	102,482	82,659	93,378	99,307
Average Annual Use Per PremisID Per Day	high		152.85	151.07	152.44	150.34	147.37	151
	medium		218.37	208.67	201.17	180.38	198.56	201
	low		313.22	284.09	280.77	226.46	255.83	272
Average Summer Use Per PremisID	high		23,643	21,140	21,430	19,345	19,888	21,089
	medium		40,196	36,685	34,760	27,052	32,874	34,314
	low		72,575	59,745	56,739	39,931	50,304	55,859
Average Summer Use Per PremisID Per Day	high		193.79	173.28	175.65	158.56	163.02	173
	medium		329.47	300.70	284.92	221.74	269.46	281
	low		594.88	489.71	465.08	327.30	412.33	458
Average NonSummer Use Per PremisID	high		32,147	33,999	34,212	35,529	33,901	33,957
	medium		39,508	39,481	38,666	38,784	39,600	39,208
	low		41,750	43,948	45,743	42,728	43,073	43,448
Average NonSummer Use Per PremisID Per Day	high		132	140	141	146	140	140
	medium		163	162	159	160	163	161
	low		172	181	188	176	177	179

NJ American Water – New Egypt (PWSID 1523003)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium		1,243	1,243	1,243	1,243	1,243	1,243
	low		263	263	263	263	263	263
Average Annual Use (100 gallon)	high							
	medium		67,580	74,860	117,800	120,420	115,864	99,305
	low		23,280	26,150	47,253	46,659	41,273	36,923
Average Annual Per Capita	high							
	medium		5,435.44	6,020.97	9,474.62	9,685.31	9,318.88	7,987
	low		8,837.90	9,927.46	17,938.82	17,713.32	15,668.59	14,017
Average Annual Per Capita Per Day	high		-	-	-	-	-	-
	medium		15	16	26	27	26	22
	low		24	27	49	49	43	38
Average Summer Use	high							
	medium		27,340	28,660	47,278	42,253	41,439	37,394
	low		9,580	9,960	19,067	15,585	14,797	13,798
Average Summer Use Per Capita	high							
	medium		2,198.95	2,305.12	3,802.57	3,398.40	3,332.89	3,008
	low		3,636.90	3,781.17	7,238.31	5,916.65	5,617.64	5,238
Average Summer Use Per Capita Per Day	high		-	-	-	-	-	-
	medium		18	19	31	28	27	25
	low		30	31	59	48	46	43
Average NonSummer Use	high							
	medium		40,240	46,200	70,522	78,167	74,425	61,911
	low		13,700	16,190	28,186	31,074	26,475	23,125
Average NonSummer Use Per Capita	high							
	medium		3,236.49	3,715.85	5,672.04	6,286.91	5,985.98	4,979
	low		5,201.00	6,146.29	10,700.51	11,796.67	10,050.94	8,779
Avreage NonSummer Use Per Capita Per Day	high		-	-	-	-	-	-
	medium		13	15	23	26	25	20
	low		21	25	44	49	41	36
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium		135%	124%	134%	108%	111%	122%
	low		139%	123%	135%	100%	111%	122%
PremisID Count	high							
	medium		127	149	229	229	231	193
	low		36	48	76	74	71	61
Average Annual Use Per PremisID	high							
	medium		53,213	50,242	51,441	52,585	50,157	51,528
	low		64,667	54,479	62,175	63,052	58,131	60,501
Average Annual Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		145.79	137.65	140.93	144.07	137.42	141
	low		177.17	149.26	170.34	172.75	159.26	166
Average Summer Use Per PremisID	high							
	medium		21,528	19,235	20,646	18,451	17,939	19,560
	low		26,611	20,750	25,088	21,061	20,842	22,870
Average Summer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		176.46	157.66	169.23	151.24	147.04	160
	low		218.12	170.08	205.64	172.63	170.83	187
Average NonSummer Use Per PremisID	high							
	medium		31,685	31,007	30,796	34,134	32,219	31,968
	low		38,056	33,729	37,087	41,991	37,289	37,631
Average NonSummer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		130	128	127	140	133	132
	low		157	139	153	173	153	155

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	11,546	11,546	11,546	11,546	11,546	11,546	11,546
	medium	1,776	1,776	1,776	1,776	2,268	2,268	1,940
	low	223	223	223	223	223	223	223
Average Annual Use (100 gallon)	high	2,270,510	2,323,750	2,171,350	2,201,580	2,084,030	2,065,010	2,186,038
	medium	364,780	386,820	374,820	355,640	349,260	354,410	364,288
	low	75,590	95,410	84,370	72,660	88,000	72,610	81,440
Average Annual Per Capita	high	19,665.08	20,126.20	18,806.25	19,068.07	18,049.96	17,885.23	18,933
	medium	20,542.02	21,783.17	21,107.41	20,027.32	15,402.10	15,629.21	19,082
	low	33,955.55	42,858.83	37,899.59	32,639.38	39,530.21	32,616.92	36,583
Average Annual Per Capita Per Day	high	54	55	52	52	49	49	52
	medium	56	60	58	55	42	43	52
	low	93	117	104	89	108	89	100
Average Summer Use	high	1,135,610	1,212,280	1,107,120	1,140,470	1,047,060	963,130	1,100,945
	medium	158,820	184,440	178,520	156,380	148,360	152,000	163,087
	low	37,180	59,110	49,340	35,070	43,420	34,340	43,077
Average Summer Use Per Capita	high	9,835.61	10,499.66	9,588.86	9,877.71	9,068.68	8,341.75	9,535
	medium	8,943.70	10,386.45	10,053.08	8,806.30	6,542.56	6,703.08	8,573
	low	16,701.51	26,552.62	22,163.87	15,753.69	19,504.57	15,425.77	19,350
Average Summer Use Per Capita Per Day	high	81	86	79	81	74	68	78
	medium	73	85	82	72	54	55	70
	low	137	218	182	129	160	126	159
Average NonSummer Use	high	1,134,900	1,111,470	1,064,230	1,061,110	1,036,970	1,101,880	1,085,093
	medium	205,960	202,380	196,300	199,260	200,900	202,410	201,202
	low	38,410	36,300	35,030	37,590	44,580	38,270	38,363
Average NonSummer Use Per Capita	high	9,829.47	9,626.54	9,217.39	9,190.36	8,981.29	9,543.48	9,398
	medium	11,598.32	11,396.72	11,054.33	11,221.02	8,859.54	8,926.13	10,509
	low	17,254.04	16,306.21	15,735.72	16,885.69	20,025.65	17,191.15	17,233
Avreage NonSummer Use Per Capita Per Day	high	40	40	38	38	37	39	39
	medium	48	47	45	46	36	37	43
	low	71	67	65	69	82	71	71
Ratio of Summer to NonSummer Use Per Capital Per Day	high	199%	217%	207%	214%	201%	174%	202%
	medium	154%	182%	181%	156%	147%	150%	162%
	low	193%	324%	281%	186%	194%	179%	226%
PremisID Count	high	4,296	4,245	4,149	4,318	4,266	4,116	4,232
	medium	648	633	644	649	637	657	645
	low	87	88	90	91	91	88	89
Average Annual Use Per PremisID	high	52,852	54,741	52,334	50,986	48,852	50,170	51,656
	medium	56,293	61,109	58,202	54,798	54,829	53,944	56,529
	low	86,885	108,420	93,744	79,846	96,703	82,511	91,352
Average Annual Use Per PremisID Per Day	high	144.80	149.97	143.38	139.69	133.84	137.45	142
	medium	154.23	167.42	159.46	150.13	150.22	147.79	155
	low	238.04	297.04	256.83	218.76	264.94	226.06	250
Average Summer Use Per PremisID	high	26,434	28,558	26,684	26,412	24,544	23,400	26,005
	medium	24,509	29,137	27,720	24,096	23,290	23,135	25,315
	low	42,736	67,170	54,822	38,538	47,714	39,023	48,334
Average Summer Use Per PremisID Per Day	high	216.67	234.08	218.72	216.49	201.18	191.80	213
	medium	200.90	238.83	227.22	197.50	190.91	189.63	207
	low	350.29	550.58	449.36	315.89	391.10	319.86	396
Average NonSummer Use Per PremisID	high	26,418	26,183	25,650	24,574	24,308	26,771	25,651
	medium	31,784	31,972	30,481	30,703	31,538	30,808	31,214
	low	44,149	41,250	38,922	41,308	48,989	43,489	43,018
Average NonSummer Use Per PremisID Per Day	high	109	108	106	101	100	110	106
	medium	131	132	125	126	130	127	128
	low	182	170	160	170	202	179	177

NJ American Water – Ortley Beach (PWSID 1507007)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,082	1,082	1,082	1,082	1,082	1,082	1,082
	medium	73	73	73	73	73	73	73
	low							
Average Annual Use (100 gallon)	high	280,980	298,410	288,400	281,380	18,240	135,520	217,155
	medium	37,530	37,930	32,790	27,760	7,300	19,290	27,100
	low							
Average Annual Per Capita	high	25,965.62	27,576.35	26,651.31	26,002.59	1,685.58	12,523.53	20,067
	medium	51,302.02	51,848.80	44,822.62	37,946.82	9,978.81	26,368.66	37,045
	low							
Average Annual Per Capita Per Day	high	71	76	73	71	5	34	55
	medium	141	142	123	104	27	72	101
	low	-	-	-	-	-	-	-
Average Summer Use	high	127,550	139,450	136,070	136,560	9,700	56,640	100,995
	medium	18,400	18,620	16,260	14,800	3,780	7,470	13,222
	low							
Average Summer Use Per Capita	high	11,787.01	12,886.70	12,574.35	12,619.64	896.39	5,234.15	9,333
	medium	25,152.07	25,452.80	22,226.77	20,231.01	5,167.11	10,211.19	18,073
	low							
Average Summer Use Per Capita Per Day	high	97	106	103	103	7	43	77
	medium	206	209	182	166	42	84	148
	low	-	-	-	-	-	-	-
Average NonSummer Use	high	153,430	158,960	152,330	144,820	8,540	78,880	116,160
	medium	19,130	19,310	16,530	12,960	3,520	11,820	13,878
	low							#DIV/0!
Average NonSummer Use Per Capita	high	14,178.61	14,689.64	14,076.96	13,382.95	789.19	7,289.37	10,734
	medium	26,149.95	26,396.00	22,595.85	17,715.80	4,811.70	16,157.47	18,971
	low							
Avreage NonSummer Use Per Capita Per Day	high	58	60	58	55	3	30	44
	medium	108	109	93	73	20	66	78
	low	-	-	-	-	-	-	-
Ratio of Summer to NonSummer Use Per Capital Per Day	high	166%	175%	178%	188%	226%	143%	179%
	medium	192%	192%	196%	227%	214%	126%	191%
	low							
PremisID Count	high	616	627	608	623	46	319	473
	medium	62	63	61	54	9	32	47
	low							
Average Annual Use Per PremisID	high	45,614	47,593	47,434	45,165	39,652	42,483	44,657
	medium	60,532	60,206	53,754	51,407	81,111	60,281	61,215
	low							
Average Annual Use Per PremisID Per Day	high	124.97	130.39	129.96	123.74	108.64	116.39	122
	medium	165.84	164.95	147.27	140.84	222.22	165.15	168
	low	-	-	-	-	-	-	-
Average Summer Use Per PremisID	high	20,706	22,241	22,380	21,920	21,087	17,755	21,015
	medium	29,677	29,556	26,656	27,407	42,000	23,344	29,773
	low							
Average Summer Use Per PremisID Per Day	high	169.72	182.30	183.44	179.67	172.84	145.54	172
	medium	243.26	242.26	218.49	224.65	344.26	191.34	244
	low	-	-	-	-	-	-	-
Average NonSummer Use Per PremisID	high	24,907	25,352	25,054	23,246	18,565	24,727	23,642
	medium	30,855	30,651	27,098	24,000	39,111	36,938	31,442
	low							
Average NonSummer Use Per PremisID Per Day	high	102	104	103	96	76	102	97
	medium	127	126	112	99	161	152	129
	low	-	-	-	-	-	-	-

Year-Long Users

	Density	09	10	11	12	13	14	6-Yr Avg
Population 13-14	high	93,263	93,263	93,263	93,263	93,263	93,263	93,263
	medium	115,711	115,711	115,711	115,711	115,711	115,711	115,711
	low	42,583	42,583	42,583	42,583	42,583	42,583	42,583
Average Annual Use (100 gallon)	high	13,576,440	13,418,500	13,061,850	12,797,337	12,779,594	12,275,807	12,984,921
	medium	27,451,120	30,452,040	27,805,860	28,927,057	27,344,033	27,322,489	28,217,100
	low	10,637,850	12,899,430	11,177,530	12,248,800	11,113,760	11,476,540	11,592,318
Average Annual Per Capita	high	14,557.13	14,387.78	14,005.37	13,721.75	13,702.72	13,162.55	13,923
	medium	23,723.92	26,317.39	24,030.50	24,999.46	23,631.37	23,612.76	24,386
	low	24,981.61	30,292.64	26,248.98	28,764.72	26,099.23	26,951.17	27,223
Average Annual Per Capita Per Day	high	40	39	38	38	38	36	38
	medium	65	72	66	68	65	65	67
	low	68	83	72	79	72	74	75
Average Summer Use	high	4,507,100	4,776,510	4,604,250	4,452,720	4,374,174	4,173,212	4,481,328
	medium	10,390,790	13,339,410	11,743,560	12,258,968	11,129,141	11,165,284	11,671,192
	low	4,582,680	6,700,300	5,615,300	6,158,710	5,297,470	5,625,990	5,663,408
Average Summer Use Per Capita	high	4,832.67	5,121.54	4,936.84	4,774.36	4,690.14	4,474.66	4,805
	medium	8,979.97	11,528.24	10,149.07	10,594.50	9,618.07	9,649.31	10,087
	low	10,761.83	15,734.79	13,186.81	14,462.93	12,440.42	13,211.91	13,300
Average Summer Use Per Capita Per Day	high	40	42	40	39	38	37	39
	medium	74	94	83	87	79	79	83
	low	88	129	108	119	102	108	109
Average NonSummer Use	high	9,069,340	8,641,990	8,457,600	8,344,617	8,405,421	8,102,595	8,503,594
	medium	17,060,330	17,112,630	16,062,300	16,668,089	16,214,893	16,157,205	16,545,908
	low	6,055,170	6,199,130	5,562,230	6,090,090	5,816,290	5,850,550	5,928,910
Average NonSummer Use Per Capita	high	9,724.46	9,266.24	9,068.53	8,947.39	9,012.58	8,687.88	9,118
	medium	14,743.95	14,789.15	13,881.43	14,404.97	14,013.30	13,963.45	14,299
	low	14,219.78	14,557.85	13,062.18	14,301.79	13,658.80	13,739.26	13,923
Avreage NonSummer Use Per Capita Per Day	high	40	38	37	37	37	36	38
	medium	61	61	57	59	58	57	59
	low	59	60	54	59	56	57	57
Ratio of Summer to NonSummer Use Per Capital Per Day	high	99%	110%	108%	106%	104%	103%	105%
	medium	121%	155%	146%	146%	137%	138%	141%
	low	151%	215%	201%	201%	181%	192%	190%
PremisID Count	high	17,395	17,440	17,512	17,437	17,464	17,134	17,397
	medium	35,226	35,376	35,482	35,358	35,376	35,121	35,323
	low	10,226	10,487	10,535	10,599	10,586	10,551	10,497
Average Annual Use Per PremisID	high	78,048	76,941	74,588	73,392	73,177	71,646	74,632
	medium	77,929	86,081	78,366	81,812	77,295	77,795	79,880
	low	104,027	123,004	106,099	115,566	104,985	108,772	110,409
Average Annual Use Per PremisID Per Day	high	213.83	210.80	204.35	201.07	200.48	196.29	204
	medium	213.50	235.84	214.70	224.14	211.77	213.14	219
	low	285.01	337.00	290.68	316.62	287.63	298.01	302
Average Summer Use Per PremisID	high	25,910	27,388	26,292	25,536	25,047	24,356	25,755
	medium	29,498	37,708	33,097	34,671	31,460	31,791	33,037
	low	44,814	63,891	53,301	58,107	50,042	53,322	53,913
Average Summer Use Per PremisID Per Day	high	212.38	224.49	215.51	209.31	205.30	199.64	211
	medium	241.78	309.08	271.29	284.19	257.87	260.58	271
	low	367.33	523.70	436.90	476.28	410.18	437.06	442
Average NonSummer Use Per PremisID	high	52,138	49,553	48,296	47,856	48,130	47,290	48,877
	medium	48,431	48,374	45,269	47,141	45,836	46,004	46,842
	low	59,213	59,113	52,798	57,459	54,943	55,450	56,496
Average NonSummer Use Per PremisID Per Day	high	215	204	199	197	198	195	201
	medium	199	199	186	194	189	189	193
	low	244	243	217	236	226	228	232

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	41	41	41	41	41	41	41
	medium	143	143	143	143	143	143	143
	low	1	1	1	1	1	1	1
Average Annual Use (100 gallon)	high	15,870	17,190	14,670	15,520	2,620	11,990	12,977
	medium	55,310	60,350	56,080	55,780	7,460	36,240	45,203
	low		660					660
Average Annual Per Capita	high	38,764.41	41,988.67	35,833.26	37,909.49	6,399.67	29,287.04	31,697
	medium	38,763.49	42,295.73	39,303.14	39,092.89	5,228.27	25,398.46	31,680
	low	-	46,066.85	-	-	-	-	7,678
Average Annual Per Capita Per Day	high	106	115	98	104	18	80	87
	medium	106	116	108	107	14	70	87
	low	-	126	-	-	-	-	21
Average Summer Use	high	6,550	8,440	7,010	6,900	1,230	4,870	5,833
	medium	23,590	28,640	28,400	27,790	3,750	18,140	21,718
	low		150					150
Average Summer Use Per Capita	high	15,999.17	20,615.73	17,122.78	16,854.09	3,004.42	11,895.57	14,249
	medium	16,532.83	20,072.07	19,903.87	19,476.36	2,628.15	12,713.25	15,221
	low	-	10,469.74	-	-	-	-	1,745
Average Summer Use Per Capita Per Day	high	131	169	140	138	25	98	117
	medium	136	165	163	160	22	104	125
	low	-	86	-	-	-	-	14
Average NonSummer Use	high	9,320	8,750	7,660	8,620	1,390	7,120	7,143
	medium	31,720	31,710	27,680	27,990	3,710	18,100	23,485
	low		510					510
Average NonSummer Use Per Capita	high	22,765.24	21,372.94	18,710.48	21,055.40	3,395.24	17,391.47	17,448
	medium	22,230.66	22,223.65	19,399.27	19,616.53	2,600.12	12,685.21	16,459
	low	-	35,597.11	-	-	-	-	5,933
Avreage NonSummer Use Per Capita Per Day	high	94	88	77	87	14	72	72
	medium	91	91	80	81	11	52	68
	low	-	146	-	-	-	-	24
Ratio of Summer to NonSummer Use Per Capital Per Day	high	140%	192%	182%	159%	176%	136%	164%
	medium	148%	180%	204%	198%	201%	200%	189%
	low		59%					59%
PremisID Count	high	28	28	26	28	8	18	23
	medium	86	85	80	83	17	57	68
	low		1					1
Average Annual Use Per PremisID	high	56,679	61,393	56,423	55,429	32,750	66,611	54,881
	medium	64,314	71,000	70,100	67,205	43,882	63,579	63,347
	low		66,000					66,000
Average Annual Use Per PremisID Per Day	high	155.28	168.20	154.58	151.86	89.73	182.50	150
	medium	176.20	194.52	192.05	184.12	120.23	174.19	174
	low		180.82					181
Average Summer Use Per PremisID	high	23,393	30,143	26,962	24,643	15,375	27,056	24,595
	medium	27,430	33,694	35,500	33,482	22,059	31,825	30,665
	low		15,000					15,000
Average Summer Use Per PremisID Per Day	high	191.74	247.07	221.00	201.99	126.02	221.77	202
	medium	224.84	276.18	290.98	274.44	180.81	260.86	251
	low	-	122.95	-	-	-	-	20
Average NonSummer Use Per PremisID	high	33,286	31,250	29,462	30,786	17,375	39,556	30,286
	medium	36,884	37,306	34,600	33,723	21,824	31,754	32,682
	low		51,000					51,000
Average NonSummer Use Per PremisID Per Day	high	137	129	121	127	72	163	125
	medium	152	154	142	139	90	131	134
	low		210					210

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	1,885	1,885	1,885	1,885	1,885	1,885	1,885
	medium	8,289	8,289	8,289	8,325	8,325	8,325	8,307
	low	596	596	596	596	600	600	597
Average Annual Use (100 gallon)	high		218,950	202,590	183,650	192,070	178,960	195,244
	medium		1,586,930	1,524,690	1,457,190	1,378,510	1,335,000	1,456,464
	low		180,650	173,730	179,790	164,280	158,800	171,450
Average Annual Per Capita	high		11,614.75	10,746.89	9,742.17	10,188.83	9,493.38	10,357
	medium		19,143.90	18,393.07	17,504.09	16,558.97	16,036.31	17,527
	low		30,304.56	29,143.71	30,160.30	27,374.68	26,461.52	28,689
Average Annual Per Capita Per Day	high		32	29	27	28	26	28
	medium		52	50	48	45	44	48
	low		83	80	83	75	72	79
Average Summer Use	high		74,770	70,760	64,110	65,890	60,500	67,206
	medium		598,510	553,100	542,740	481,550	471,810	529,542
	low		72,360	68,390	70,120	60,560	57,510	65,788
Average Summer Use Per Capita	high		3,966.36	3,753.64	3,400.88	3,495.30	3,209.37	3,565
	medium		7,220.11	6,672.31	6,519.51	5,784.48	5,667.49	6,373
	low		12,138.60	11,472.62	11,762.83	10,091.37	9,583.14	11,010
Average Summer Use Per Capita Per Day	high		33	31	28	29	26	29
	medium		59	55	53	47	46	52
	low		99	94	96	83	79	90
Average NonSummer Use	high		144,180	131,830	119,540	126,180	118,460	128,038
	medium		988,420	971,590	914,450	896,960	863,190	926,922
	low		108,290	105,340	109,670	103,720	101,290	105,662
Average NonSummer Use Per Capita	high		7,648.39	6,993.25	6,341.30	6,693.53	6,284.01	6,792
	medium		11,923.79	11,720.76	10,984.57	10,774.48	10,368.83	11,154
	low		18,165.96	17,671.09	18,397.46	17,283.31	16,878.38	17,679
Avreage NonSummer Use Per Capita Per Day	high		31	29	26	28	26	28
	medium		49	48	45	44	43	46
	low		75	73	76	71	69	73
Ratio of Summer to NonSummer Use Per Capital Per Day	high		103%	107%	107%	104%	102%	105%
	medium		121%	113%	118%	107%	109%	114%
	low		133%	129%	127%	116%	113%	124%
PremisID Count	high		256	246	239	236	229	241
	medium		2,545	2,502	2,448	2,404	2,354	2,451
	low		274	271	274	272	271	272
Average Annual Use Per PremisID	high		85,527	82,354	76,841	81,386	78,148	80,851
	medium		62,355	60,939	59,526	57,342	56,712	59,375
	low		65,931	64,107	65,617	60,397	58,598	62,930
Average Annual Use Per PremisID Per Day	high		234.32	225.63	210.52	222.97	214.11	222
	medium		170.84	166.96	163.08	157.10	155.38	163
	low		180.63	175.64	179.77	165.47	160.54	172
Average Summer Use Per PremisID	high		29,207	28,764	26,824	27,919	26,419	27,827
	medium		23,517	22,106	22,171	20,031	20,043	21,574
	low		26,409	25,236	25,591	22,265	21,221	24,144
Average Summer Use Per PremisID Per Day	high		239.40	235.77	219.87	228.85	216.55	228
	medium		192.76	181.20	181.73	164.19	164.29	177
	low		216.47	206.85	209.76	182.50	173.95	198
Average NonSummer Use Per PremisID	high		56,320	53,589	50,017	53,466	51,729	53,024
	medium		38,838	38,833	37,355	37,311	36,669	37,801
	low		39,522	38,871	40,026	38,132	37,376	38,785
Average NonSummer Use Per PremisID Per Day	high		232	221	206	220	213	218
	medium		160	160	154	154	151	156
	low		163	160	165	157	154	160

NJ American Water – Raritan (PWSID 2004002)

Year Long Users					
	Density	11-12	12-13	13-14	3-Yr Avg
Population	high	307,369	306,936	306,131	306,793
	medium	291,626	291,630	291,583	291,612
	low	113,544	119,308	119,345	117,351
Average Annual Use	high	3,803,291,040	4,209,427,570	4,194,728,255	4,069,148,955
	medium	5,691,255,240	6,084,496,050	6,138,685,452	5,971,478,914
	low	2,926,478,430	2,889,082,730	3,037,040,382	2,950,867,181
Average Annual Per Capita	high	12,374	13,714	13,702	13,263
	medium	19,516	20,864	21,053	20,477
	low	25,774	24,215	25,448	25,146
Average Annual Per Capita Per Day	high	34	38	38	36
	medium	53	57	58	56
	low	71	66	70	69
Average Summer Use	high	1,542,875,740	1,474,148,510	1,408,116,677	1,475,046,976
	medium	2,597,940,590	2,357,181,570	2,348,503,576	2,434,541,912
	low	1,627,013,400	1,332,649,170	1,420,415,996	1,460,026,189
Average Summer Use Per Capita	high	5,020	4,803	4,600	4,807
	medium	8,908	8,083	8,054	8,349
	low	14,329	11,170	11,902	12,467
Average Summer Use Per Capita Per Day	high	41	39	38	40
	medium	73	66	66	69
	low	118	92	98	102
Average NonSummer Use	high	2,260,415,300	2,735,279,060	2,786,611,578	2,594,101,979
	medium	3,093,314,650	3,727,314,480	3,790,181,876	3,536,937,002
	low	1,299,465,030	1,556,433,560	1,616,624,386	1,490,840,992
Average NonSummer Use Per Capita	high	7,354	8,912	9,103	8,456
	medium	10,607	12,781	12,999	12,129
	low	11,445	13,046	13,546	12,679
Avreage NonSummer Use Per Capita Per Day	high	30	37	37	35
	medium	44	53	53	50
	low	47	54	56	52
Ratio of Summer	high	137%	108%	101%	115%
	medium	168%	126%	124%	139%
	low	250%	171%	176%	199%
Average Annual Use Per PremisID	high	62,600	67,433	68,445	66,159
	medium	67,998	71,341	72,909	70,749
	low	95,111	91,974	96,909	94,665
Average Annual Use Per PremisID Per Day	high	172	185	188	181
	medium	186	195	200	194
	low	261	252	266	259
Average Summer Use Per PremisID	high	25,395	23,615	22,976	23,995
	medium	31,039	27,638	27,893	28,857
	low	52,878	42,425	45,324	46,876
Average Summer Use Per PremisID Per Day	high	209	194	189	197
	medium	255	227	229	237
	low	435	349	373	385
Average NonSummer Use Per PremisID	high	37,205	43,818	45,469	42,164
	medium	36,958	43,703	45,016	41,892
	low	42,233	49,549	51,585	47,789
Average NonSummer Use Per PremisID Per Day	high	153	180	187	173
	medium	152	180	185	172
	low	174	204	212	196

NJ American Water – Strathmere (PWSID 0511001)

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	115	115	115	115	115	115	115
	medium	43	43	43	43	43	43	43
	low							
Average Annual Use (100 gallon)	high	27,570	28,190	25,930	28,030	24,240	30,480	27,407
	medium	33,870	39,900	32,800	31,840	34,500	33,320	34,372
	low							
Average Annual Per Capita	high	24,066.57	24,607.78	22,634.97	24,468.11	21,159.72	26,606.78	23,924
	medium	77,964.95	91,845.33	75,501.93	73,292.11	79,415.14	76,698.91	79,120
	low							
Average Annual Per Capita Per Day	high	66	67	62	67	58	73	66
	medium	214	252	207	201	218	210	217
	low	-	-	-	-	-	-	-
Average Summer Use	high	15,280	16,760	13,490	16,310	12,790	16,400	15,172
	medium	19,440	25,470	22,840	19,130	22,120	19,350	21,392
	low							
Average Summer Use Per Capita	high	13,338.31	14,630.24	11,775.77	14,237.42	11,164.72	14,315.98	13,244
	medium	44,748.70	58,629.09	52,575.12	44,035.12	50,917.76	44,541.53	49,241
	low							
Average Summer Use Per Capita Per Day	high	109	120	97	117	92	117	109
	medium	367	481	431	361	417	365	404
	low	-	-	-	-	-	-	-
Average NonSummer Use	high	12,290	11,430	12,440	11,720	11,450	14,080	12,235
	medium	14,430	14,430	9,960	12,710	12,380	13,970	12,980
	low							
Average NonSummer Use Per Capita	high	10,728.26	9,977.54	10,859.20	10,230.69	9,995.00	12,290.80	10,680
	medium	33,216.24	33,216.24	22,926.80	29,257.00	28,497.37	32,157.38	29,879
	low							
Avreage NonSummer Use Per Capita Per Day	high	44	41	45	42	41	51	44
	medium	137	137	94	120	117	132	123
	low	-	-	-	-	-	-	-
Ratio of Summer to NonSummer Use Per Capital Per Day	high	248%	292%	216%	277%	222%	232%	248%
	medium	268%	352%	457%	300%	356%	276%	335%
	low							
PremisID Count	high	55	49	48	51	50	46	50
	medium	52	50	43	52	54	46	50
	low							
Average Annual Use Per PremisID	high	50,127	57,531	54,021	54,961	48,480	66,261	55,230
	medium	65,135	79,800	76,279	61,231	63,889	72,435	69,795
	low							
Average Annual Use Per PremisID Per Day	high	137.33	157.62	148.00	150.58	132.82	181.54	151
	medium	178.45	218.63	208.98	167.76	175.04	198.45	191
	low	-	-	-	-	-	-	-
Average Summer Use Per PremisID	high	27,782	34,204	28,104	31,980	25,580	35,652	30,550
	medium	37,385	50,940	53,116	36,788	40,963	42,065	43,543
	low							
Average Summer Use Per PremisID Per Day	high	227.72	280.36	230.36	262.13	209.67	292.23	250
	medium	306.43	417.54	435.38	301.54	335.76	344.80	357
	low	-	-	-	-	-	-	-
Average NonSummer Use Per PremisID	high	22,345	23,327	25,917	22,980	22,900	30,609	24,680
	medium	27,750	28,860	23,163	24,442	22,926	30,370	26,252
	low							
Average NonSummer Use Per PremisID Per Day	high	92	96	107	95	94	126	102
	medium	114	119	95	101	94	125	108
	low	-	-	-	-	-	-	-

NJ American Water – Sunbury (PWSID 0329006)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium	1,040	1,040	1,040	1,040	1,040	1,040	1,040
	low							
Average Annual Use (100 gallon)	high							
	medium	159,540	181,170	185,240	195,030	179,070	181,180	180,205
	low							
Average Annual Per Capita	high							
	medium	15,343.60	17,423.84	17,815.27	18,756.81	17,221.88	17,424.80	17,331
	low							
Average Annual Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	42	48	49	51	47	48	47
	low	-	-	-	-	-	-	-
Average Summer Use	high							
	medium	60,130	82,350	86,050	85,790	72,520	80,350	77,865
	low							
Average Summer Use Per Capita	high							
	medium	5,782.94	7,919.93	8,275.77	8,250.77	6,974.54	7,727.58	7,489
	low							
Average Summer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	47	65	68	68	57	63	61
	low	-	-	-	-	-	-	-
Average NonSummer Use	high							
	medium	99,410	98,820	99,190	109,240	106,550	100,830	102,340
	low							
Average NonSummer Use Per Capita	high							
	medium	9,560.66	9,503.91	9,539.50	10,506.05	10,247.34	9,697.22	9,842
	low							
Avreage NonSummer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	39	39	39	43	42	40	41
	low	-	-	-	-	-	-	-
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium	120%	166%	173%	156%	136%	159%	152%
	low							
PremisID Count	high							
	medium	218	223	242	267	276	261	248
	low							
Average Annual Use Per PremisID	high							
	medium	73,183	81,242	76,545	73,045	64,880	69,418	73,052
	low							
Average Annual Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	200.50	222.58	209.71	200.12	177.75	190.19	200
	low	-	-	-	-	-	-	-
Average Summer Use Per PremisID	high							
	medium	27,583	36,928	35,558	32,131	26,275	30,785	31,543
	low							
Average Summer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	226.09	302.69	291.46	263.37	215.37	252.34	259
	low	-	-	-	-	-	-	-
Average NonSummer Use Per PremisID	high							
	medium	45,601	44,314	40,988	40,914	38,605	38,632	41,509
	low							
Average NonSummer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	188	182	169	168	159	159	171
	low	-	-	-	-	-	-	-

Year-Long Users

	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium							
	low	187	187	187	187	187	187	187
Average Annual Use (100 gallon)	high							
	medium							
	low	28,810	31,640	29,810	28,440	28,900	30,700	29,717
Average Annual Per Capita	high							
	medium							
	low	15,403.55	16,916.64	15,938.21	15,205.73	15,451.67	16,414.06	15,888
Average Annual Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	42	46	44	42	42	45	44
Average Summer Use	high							
	medium							
	low	10,690	12,540	11,070	11,050	9,990	11,760	11,183
Average Summer Use Per Capita	high							
	medium							
	low	5,715.52	6,704.64	5,918.69	5,907.99	5,341.25	6,287.60	5,979
Average Summer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	47	55	49	48	44	52	49
Average NonSummer Use	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	18,120	19,100	18,740	17,390	18,910	18,940	18,533
Average NonSummer Use Per Capita	high							
	medium							
	low	9,688.04	10,212.01	10,019.53	9,297.74	10,110.42	10,126.46	9,909
Avreage NonSummer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	40	42	41	38	42	42	41
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium							
	low	118%	131%	118%	127%	105%	124%	120%
PremisID Count	high							
	medium							
	low	45	47	47	46	45	46	46
Average Annual Use Per PremisID	high							
	medium							
	low	64,022	67,319	63,426	61,826	64,222	66,739	64,592
Average Annual Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	175.40	184.44	173.77	169.39	175.95	182.85	177
Average Summer Use Per PremisID	high							
	medium							
	low	23,756	26,681	23,553	24,022	22,200	25,565	24,296
Average Summer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	194.72	218.70	193.06	196.90	181.97	209.55	199
Average NonSummer Use Per PremisID	high							
	medium							
	low	40,267	40,638	39,872	37,804	42,022	41,174	40,296
Average NonSummer Use PremisID Per Day	high	-	-	-	-	-	-	-
	medium	-	-	-	-	-	-	-
	low	166	167	164	156	173	169	166

NJ American Water – Union Beach (PWSID 1350001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	185	185	185	185	185	185	185
	medium	6,030	6,030	6,030	6,030	6,030	6,030	6,030
	low	5	5	5	5	5	5	5
Average Annual Use (100 gallon)	high	17,410	18,850	20,020	18,450	14,230	18,140	17,850
	medium	1,280,290	1,313,740	1,251,860	1,238,260	864,580	970,840	1,153,262
	low	1,900	2,000	2,130	1,900	1,120	1,020	1,678
Average Annual Per Capita	high	9,386.50	10,162.87	10,793.67	9,947.21	7,672.02	9,780.08	9,624
	medium	21,233.62	21,788.39	20,762.11	20,536.55	14,339.06	16,101.39	19,127
	low	36,343.10	38,255.89	40,742.53	36,343.10	21,423.30	19,510.51	32,103
Average Annual Per Capita Per Day	high	26	28	30	27	21	27	26
	medium	58	60	57	56	39	44	52
	low	100	105	112	100	59	53	88
Average Summer Use	high	6,810	8,220	9,120	7,640	6,180	7,520	7,582
	medium	469,540	527,000	493,230	470,450	337,970	363,830	443,670
	low	660	650	800	570	350	370	567
Average Summer Use Per Capita	high	3,671.57	4,431.77	4,917.00	4,119.06	3,331.91	4,054.37	4,088
	medium	7,787.32	8,740.30	8,180.22	7,802.42	5,605.23	6,034.12	7,358
	low	12,624.44	12,433.17	15,302.36	10,902.93	6,694.78	7,077.34	10,839
Average Summer Use Per Capita Per Day	high	30	36	40	34	27	33	34
	medium	64	72	67	64	46	49	60
	low	103	102	125	89	55	58	89
Average NonSummer Use	high	10,600	10,630	10,900	10,810	8,050	10,620	10,268
	medium	810,750	786,740	758,630	767,810	526,610	607,010	709,592
	low	1,240	1,350	1,330	1,330	770	650	1,112
Average NonSummer Use Per Capita	high	5,714.93	5,731.10	5,876.67	5,828.15	4,340.11	5,725.71	5,536
	medium	13,446.29	13,048.09	12,581.88	12,734.13	8,733.83	10,067.26	11,769
	low	23,718.65	25,822.73	25,440.17	25,440.17	14,728.52	12,433.17	21,264
Avreage NonSummer Use Per Capita Per Day	high	24	24	24	24	18	24	23
	medium	55	54	52	52	36	41	48
	low	98	106	105	105	61	51	88
Ratio of Summer to NonSummer Use Per Capital Per Day	high	128%	154%	167%	141%	153%	141%	147%
	medium	115%	133%	129%	122%	128%	119%	125%
	low	106%	96%	120%	85%	91%	113%	102%
PremisID Count	high	42	43	43	43	34	45	42
	medium	1,892	1,885	1,917	1,920	1,432	1,552	1,766
	low	3	3	3	3	3	3	3
Average Annual Use Per PremisID	high	41,452	43,837	46,558	42,907	41,853	40,311	42,820
	medium	67,669	69,694	65,303	64,493	60,376	62,554	65,015
	low	63,333	66,667	71,000	63,333	37,333	34,000	55,944
Average Annual Use Per PremisID Per Day	high	113.57	120.10	127.56	117.55	114.67	110.44	117
	medium	185.39	190.94	178.91	176.69	165.41	171.38	178
	low	173.52	182.65	194.52	173.52	102.28	93.15	153
Average Summer Use Per PremisID	high	16,214	19,116	21,209	17,767	18,176	16,711	18,199
	medium	24,817	27,958	25,729	24,503	23,601	23,443	25,008
	low	22,000	21,667	26,667	19,000	11,667	12,333	18,889
Average Summer Use Per PremisID Per Day	high	132.90	156.69	173.85	145.63	148.99	136.98	149
	medium	203.42	229.16	210.90	200.84	193.45	192.15	205
	low	180.33	177.60	218.58	155.74	95.63	101.09	155
Average NonSummer Use Per PremisID	high	25,238	24,721	25,349	25,140	23,676	23,600	24,621
	medium	42,851	41,737	39,574	39,990	36,774	39,111	40,006
	low	41,333	45,000	44,333	44,333	25,667	21,667	37,056
Average NonSummer Use Per PremisID Per Day	high	104	102	104	103	97	97	101
	medium	176	172	163	165	151	161	165
	low	170	185	182	182	106	89	152

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium		322	322	322	322	322	322
	low		99	99	99	99	99	99
Average Annual Use (100 gallon)	high							
	medium		58,640	57,210	57,447	53,130	54,440	56,173
	low		20,600	18,520	19,950	18,220	23,980	20,254
Average Annual Per Capita	high							
	medium		18,199.06	17,755.25	17,828.74	16,489.05	16,895.44	17,434
	low		20,870.41	18,763.10	20,211.87	18,459.17	24,294.78	20,520
Average Annual Per Capita Per Day	high		-	-	-	-	-	-
	medium		50	49	49	45	46	48
	low		57	51	55	51	67	56
Average Summer Use	high							
	medium		25,700	22,850	21,779	19,161	20,327	21,963
	low		8,500	7,140	7,220	6,080	8,520	7,492
Average Summer Use Per Capita	high							
	medium		7,976.05	7,091.55	6,759.01	5,946.66	6,308.41	6,816
	low		8,611.58	7,233.72	7,314.77	6,159.81	8,631.84	7,590
Average Summer Use Per Capita Per Day	high		-	-	-	-	-	-
	medium		65	58	55	49	52	56
	low		71	59	60	50	71	62
Average NonSummer Use	high		-	-	-	-	-	-
	medium		32,940	34,360	35,668	33,969	34,113	34,210
	low		12,100	11,380	12,730	12,140	15,460	12,762
Average NonSummer Use Per Capita	high							
	medium		10,223.00	10,663.70	11,069.74	10,542.39	10,587.03	10,617
	low		12,258.83	11,529.38	12,897.10	12,299.36	15,662.94	12,930
Avreage NonSummer Use Per Capita Per Day	high		-	-	-	-	-	-
	medium		42	44	46	43	44	44
	low		50	47	53	51	64	53
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium		155%	132%	122%	112%	119%	128%
	low		140%	125%	113%	100%	110%	117%
PremisID Count	high							
	medium		98	99	104	105	100	101
	low		32	32	31	31	31	31
Average Annual Use Per PremisID	high							
	medium		59,837	57,788	55,237	50,600	54,440	55,580
	low		64,375	57,875	64,355	58,774	77,355	64,547
Average Annual Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		163.94	158.32	151.34	138.63	149.15	152
	low		176.37	158.56	176.31	161.03	211.93	177
Average Summer Use Per PremisID	high							
	medium		26,224	23,081	20,941	18,249	20,327	21,764
	low		26,563	22,313	23,290	19,613	27,484	23,852
Average Summer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		214.95	189.19	171.65	149.58	166.61	178
	low		217.73	182.89	190.90	160.76	225.28	196
Average NonSummer Use Per PremisID	high							
	medium		33,612	34,707	34,296	32,352	34,113	33,816
	low		37,813	35,563	41,065	39,161	49,871	40,694
Average NonSummer Use Per PremisID Per Day	high		-	-	-	-	-	-
	medium		138	143	141	133	140	139
	low		156	146	169	161	205	167

NJ American Water – Washington (Warren County) (PWSID 2121001)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high	2,460	2,460	2,460	2,460	2,460	2,549	2,475
	medium	6,822	6,822	6,822	6,822	6,864	6,864	6,836
	low	2,271	2,271	2,274	2,271	2,271	2,274	2,272
Average Annual Use (100 gallon)	high	248,510	251,800	246,530	243,580	237,870	237,110	244,233
	medium	1,211,700	1,215,470	1,186,110	1,164,527	1,118,290	1,101,150	1,166,208
	low	640,690	672,870	641,530	640,210	609,550	617,280	637,022
Average Annual Per Capita	high	10,100.15	10,233.87	10,019.68	9,899.78	9,667.71	9,301.71	9,870
	medium	17,762.33	17,817.59	17,387.20	17,070.82	16,292.36	16,042.65	17,062
	low	28,211.65	29,628.64	28,211.80	28,188.75	26,838.77	27,145.39	28,038
Average Annual Per Capita Per Day	high	28	28	27	27	26	25	27
	medium	49	49	48	47	45	44	47
	low	77	81	77	77	74	74	77
Average Summer Use	high	85,500	87,390	84,830	82,930	80,200	79,010	83,310
	medium	420,450	449,360	427,590	424,560	392,750	380,120	415,805
	low	233,750	257,450	239,350	241,370	223,430	225,990	236,890
Average Summer Use Per Capita	high	3,474.96	3,551.78	3,447.73	3,370.51	3,259.56	3,099.53	3,367
	medium	6,163.38	6,587.17	6,268.05	6,223.63	5,721.97	5,537.97	6,084
	low	10,292.77	11,336.36	10,525.61	10,627.63	9,837.73	9,938.09	10,426
Average Summer Use Per Capita Per Day	high	28	29	28	28	27	25	28
	medium	51	54	51	51	47	45	50
	low	84	93	86	87	81	81	85
Average NonSummer Use	high	163,010	164,410	161,700	160,650	157,670	158,100	160,923
	medium	791,250	766,110	758,520	739,967	725,540	721,030	750,403
	low	406,940	415,420	402,180	398,840	386,120	391,290	400,132
Average NonSummer Use Per Capita	high	6,625.19	6,682.09	6,571.95	6,529.27	6,408.16	6,202.19	6,503
	medium	11,598.94	11,230.42	11,119.16	10,847.19	10,570.39	10,504.68	10,978
	low	17,918.89	18,292.29	17,686.19	17,561.11	17,001.04	17,207.30	17,611
Avreage NonSummer Use Per Capita Per Day	high	27	27	27	27	26	26	27
	medium	48	46	46	45	43	43	45
	low	74	75	73	72	70	71	72
Ratio of Summer to NonSummer Use Per Capital Per Day	high	104%	106%	104%	103%	101%	100%	103%
	medium	106%	117%	112%	114%	108%	105%	110%
	low	114%	123%	119%	121%	115%	115%	118%
PremisID Count	high	465	468	470	470	473	479	471
	medium	2,072	2,067	2,058	2,054	2,039	2,018	2,051
	low	991	1,000	997	1,001	997	992	996
Average Annual Use Per PremisID	high	53,443	53,803	52,453	51,826	50,290	49,501	51,886
	medium	58,480	58,804	57,634	56,696	54,845	54,566	56,837
	low	64,651	67,287	64,346	63,957	61,138	62,226	63,934
Average Annual Use Per PremisID Per Day	high	146.42	147.41	143.71	141.99	137.78	135.62	142
	medium	160.22	161.11	157.90	155.33	150.26	149.50	156
	low	177.13	184.35	176.29	175.22	167.50	170.48	175
Average Summer Use Per PremisID	high	18,387	18,673	18,049	17,645	16,956	16,495	17,701
	medium	20,292	21,740	20,777	20,670	19,262	18,836	20,263
	low	23,587	25,745	24,007	24,113	22,410	22,781	23,774
Average Summer Use Per PremisID Per Day	high	150.71	153.06	147.94	144.63	138.98	135.20	145
	medium	166.33	178.19	170.30	169.43	157.88	154.40	166
	low	193.34	211.02	196.78	197.65	183.69	186.73	195
Average NonSummer Use Per PremisID	high	35,056	35,130	34,404	34,181	33,334	33,006	34,185
	medium	38,188	37,064	36,857	36,026	35,583	35,730	36,575
	low	41,064	41,542	40,339	39,844	38,728	39,445	40,160
Average NonSummer Use Per PremisID Per Day	high	144	145	142	141	137	136	141
	medium	157	153	152	148	146	147	151
	low	169	171	166	164	159	162	165

NJ American Water – West Jersey (PWSID 1427009)

Year-Long Users								
	Density	08-09	09-10	10-11	11-12	12-13	13-14	6-Yr Avg
Population 13-14	high							
	medium	743	743	743	743	743	743	743
	low	747	747	747	747	747	747	747
Average Annual Use (100 gallon)	high							
	medium	40,020	43,330	40,440	40,520	35,910	36,840	39,510
	low	73,380	73,470	67,190	68,300	66,560	66,710	69,268
Average Annual Per Capita	high							
	medium	5,384.44	5,829.78	5,440.95	5,451.71	4,831.46	4,956.59	5,316
	low	9,816.82	9,828.86	8,988.72	9,137.22	8,904.44	8,924.50	9,267
Average Annual Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	15	16	15	15	13	14	15
	low	27	27	25	25	24	24	25
Average Summer Use	high							
	medium	14,520	15,710	13,390	14,130	12,150	12,460	13,727
	low	25,970	28,420	24,540	25,570	24,260	22,280	25,173
Average Summer Use Per Capita	high							
	medium	1,953.57	2,113.68	1,801.54	1,901.10	1,634.71	1,676.41	1,847
	low	3,474.28	3,802.04	3,282.98	3,420.77	3,245.52	2,980.63	3,368
Average Summer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	16	17	15	16	13	14	15
	low	28	31	27	28	27	24	28
Average NonSummer Use	high	-	-	-	-	-	-	-
	medium	25,500	27,620	27,050	26,390	23,760	24,380	25,783
	low	47,410	45,050	42,650	42,730	42,300	44,430	44,095
Average NonSummer Use Per Capita	high							
	medium	3,430.86	3,716.10	3,639.41	3,550.61	3,196.76	3,280.17	3,469
	low	6,342.54	6,026.82	5,705.74	5,716.45	5,658.92	5,943.87	5,899
Avreage NonSummer Use Per Capita Per Day	high	-	-	-	-	-	-	-
	medium	14	15	15	15	13	13	14
	low	26	25	23	24	23	24	24
Ratio of Summer to NonSummer Use Per Capital Per Day	high							
	medium	113%	113%	99%	107%	102%	102%	106%
	low	109%	126%	115%	119%	114%	100%	114%
PremisID Count	high							#DIV/0!
	medium	73	75	72	69	69	72	72
	low	125	123	117	119	122	123	122
Average Annual Use Per PremisID	high							
	medium	54,822	57,773	56,167	58,725	52,043	51,167	55,116
	low	58,704	59,732	57,427	57,395	54,557	54,236	57,009
Average Annual Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	150.20	158.28	153.88	160.89	142.58	140.18	151
	low	160.83	163.65	157.34	157.25	149.47	148.59	156
Average Summer Use Per PremisID	high							
	medium	19,890	20,947	18,597	20,478	17,609	17,306	19,138
	low	20,776	23,106	20,974	21,487	19,885	18,114	20,724
Average Summer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	163.04	171.69	152.44	167.85	144.33	141.85	157
	low	170.30	189.39	171.92	176.13	162.99	148.47	170
Average NonSummer Use Per PremisID	high							
	medium	34,932	36,827	37,569	38,246	34,435	33,861	35,978
	low	37,928	36,626	36,453	35,908	34,672	36,122	36,285
Average NonSummer Use Per PremisID Per Day	high	-	-	-	-	-	-	-
	medium	144	152	155	157	142	139	148
	low	156	151	150	148	143	149	149

Passaic Valley Water Commission – Complete System (PWSID 1605002)

Year-Long Users								
	Density	2010	2011	2012	2013	2014	2015	6-Yr Avg
Population	high	265,973	265,747	266,175	266,175	266,371	265,254	265,949
	medium	40,561	40,577	40,577	40,577	40,577	40,051	40,486
	low	758	758	758	758	758	758	758
Average Annual Use (*1000)	high	5,812,477	5,695,465	5,941,946	5,822,821	5,969,125	5,970,130	5,868,661
	medium	1,133,051	1,058,785	1,089,423	1,060,831	1,071,971	1,087,354	1,083,569
	low	22,401	21,843	23,589	20,856	21,036	20,426	21,692
Average Annual Per Capita	high	21,854	21,432	22,323	21,876	22,409	22,507	22,067
	medium	27,934	26,093	26,849	26,144	26,418	27,149	26,765
	low	29,566	28,829	31,134	27,527	27,764	26,959	28,630
Average Annual Per Capita Per Day	high	59.87	58.72	61.16	59.93	61.39	61.66	60.46
	medium	76.53	71.49	73.56	71.63	72.38	74.38	73.33
	low	81.00	78.98	85.30	75.42	76.07	73.86	78.44
Average Summer Use	high	2,893,136	2,977,535	3,036,338	2,925,236	2,958,481	3,041,800	2,972,088
	medium	556,055	573,608	572,893	531,928	523,998	536,309	549,132
	low	11,130	11,958	13,181	10,079	9,958	9,886	11,032
Average Summer Use Per Capita	high	10,878	11,204	11,407	10,990	11,107	11,467	11,176
	medium	13,709	14,136	14,119	13,109	12,914	13,391	13,563
	low	14,690	15,783	17,397	13,303	13,143	13,048	14,561
Average Summer Use Per Capita Per Day	high	59.60	61.39	62.51	60.22	60.86	62.84	61.24
	medium	75.12	77.46	77.36	71.83	70.76	73.37	74.32
	low	80.49	86.48	95.33	72.89	72.02	71.50	79.78
Average NonSummer Use	high	2,919,341	2,717,930	2,905,608	2,897,585	3,010,644	2,928,330	2,896,573
	medium	576,996	485,177	516,530	528,903	547,973	551,045	534,437
	low	11,271	9,885	10,408	10,777	11,078	10,540	10,660
Average NonSummer Use Per Capita	high	10,976	10,228	10,916	10,886	11,302	11,040	10,891
	medium	14,225	11,957	12,730	13,035	13,505	13,759	13,202
	low	14,876	13,047	13,737	14,224	14,621	13,911	14,069
Avreage NonSummer Use Per Capita Per Day	high	60.14	56.04	59.81	59.65	61.93	60.49	59.68
	medium	77.95	65.52	69.75	71.42	74.00	75.39	72.34
	low	81.51	71.49	75.27	77.94	80.12	76.23	77.09
Ratio of Summer to NonSummer Use Per Capital Per Day	high	99.10%	109.55%	104.50%	100.95%	98.27%	103.87%	102.71%
	medium	96.37%	118.23%	110.91%	100.57%	95.62%	97.33%	103.17%
	low	98.75%	120.97%	126.64%	93.52%	89.89%	93.80%	103.93%
PremisID(Parcel) Count	high	35,538	35,825	36,531	36,531	37,439	37,224	3651466.67%
	medium	9,317	9,323	9,444	9,444	9,589	9,273	939833.33%
	low	124	124	127	127	127	117	12433.33%
Average Annual Use Per PremisID	high	163,557	158,980	162,655	159,394	159,436	160,384	161,146
	medium	121,611	113,567	115,356	112,329	111,792	117,260	115,716
	low	180,653	176,153	185,740	164,220	165,638	174,581	176,692
Average Annual Use Per PremisID Per Day	high	448.10	435.56	445.63	436.70	436.81	439.41	441.50
	medium	333.18	311.14	316.04	307.75	306.28	321.26	317.03
	low	494.94	482.61	508.88	449.92	453.80	478.30	484.09
Average Summer Use Per PremisID	high	81,410	83,113	83,117	80,075	79,021	81,716	81,929
	medium	59,682	61,526	60,662	56,324	54,646	57,836	59,549
	low	89,758	96,435	103,787	79,362	78,409	84,496	92,336
Average Summer Use Per PremisID Per Day	high	446.08	455.42	455.43	438.77	432.99	447.76	448.92
	medium	327.02	337.13	332.40	308.63	299.43	316.91	326.29
	low	491.83	528.41	568.70	434.86	429.64	462.99	505.95
Average NonSummer Use Per PremisID	high	82,147	75,867	79,538	79,319	80,415	78,668	79,218
	medium	61,929	52,041	54,694	56,004	57,146	59,425	56,167
	low	90,895	79,718	81,953	84,858	87,228	90,085	84,356
Average NonSummer Use Per PremisID Per Day	high	450.12	415.71	435.83	434.62	440.63	431.06	434.07
	medium	339.34	285.16	299.69	306.87	313.13	325.61	307.76
	low	498.06	436.81	449.06	464.98	477.96	493.62	462.22

Ridgewood (PWSID 0251001)

Year-Long Users

	Density	2011	2012	2013	2014	4-Yr Avg
Population	high	871	1,009	1,012	1,001	974
	medium	27,010	30,279	30,462	31,881	29,908
	low	9,254	11,189	10,803	11,265	10,628
Average Annual Use	high	8,252,500	7,952,000	7,737,400	7,725,100	7,916,750
	medium	149,920,700	149,269,200	131,490,600	133,763,600	141,111,025
	low	66,625,700	66,658,000	59,913,700	62,197,800	63,848,800
Average Annual Per Capita	high	9,472.05	7,877.50	7,642.94	7,716.12	8,177
	medium	5,550.52	4,929.77	4,316.51	4,195.71	4,748
	low	7,199.60	5,957.22	5,545.86	5,521.52	6,056
Average Annual Per Capita Per Day	high	25.95	21.58	20.94	21.14	22.40
	medium	15.21	13.51	11.83	11.50	13.01
	low	19.72	16.32	15.19	15.13	16.59
Average Summer Use	high	4,615,600	4,117,500	5,481,300	3,989,800	4,551,050
	medium	91,782,100	79,162,700	92,067,000	70,023,600	83,258,850
	low	41,774,900	39,213,700	43,281,500	36,547,300	40,204,350
Average Summer Use Per Capita	high	5,297.69	4,078.93	5,414.38	3,985.16	4,694
	medium	3,398.05	2,614.43	3,022.33	2,196.40	2,808
	low	4,514.21	3,504.52	4,006.32	3,244.43	3,817
Average Summer Use Per Capita Per Day	high	29.03	22.35	29.67	21.84	25.72
	medium	18.62	14.33	16.56	12.04	15.39
	low	24.74	19.20	21.95	17.78	20.92
Average NonSummer Use	high	3,636,900	3,834,500	2,256,100	3,735,300	3,365,700
	medium	58,138,600	70,106,500	39,423,600	63,740,000	57,852,175
	low	24,850,800	27,444,300	16,632,200	25,650,500	23,644,450
Average NonSummer Use Per Capita	high	4,174.36	3,798.58	2,228.56	3,730.96	3,483
	medium	2,152.47	2,315.34	1,294.18	1,999.31	1,940
	low	2,685.39	2,452.69	1,539.55	2,277.08	2,239
Avreage NonSummer Use Per Capita Per Day	high	22.87	20.81	12.21	20.44	19.09
	medium	11.79	12.69	7.09	10.96	10.63
	low	14.71	13.44	8.44	12.48	12.27
Ratio of Summer to NonSummer Use Per Capital Per Day	high	126.9%	107.4%	243.0%	106.8%	146.0%
	medium	157.9%	112.9%	233.5%	109.9%	153.5%
	low	168.1%	142.9%	260.2%	142.5%	178.4%
PremisID(Parcel) Count	high	549	659	635	675	630
	medium	11,557	13,010	13,041	13,649	12,814
	low	3,205	3,874	3,736	3,900	3,679
Average Annual Use Per PremisID	high	15,032	12,067	12,185	11,445	12,682
	medium	12,972	11,473	10,083	9,800	11,082
	low	20,788	17,207	16,037	15,948	17,495
Average Annual Use Per PremisID Per Day	high	41.18	33.06	33.38	31.36	34.75
	medium	35.54	31.43	27.62	26.85	30.36
	low	56.95	47.14	43.94	43.69	47.93
Average Summer Use Per PremisID	high	8,407	6,248	8,632	5,911	7,300
	medium	7,942	6,085	7,060	5,130	6,554
	low	13,034	10,122	11,585	9,371	11,028
Average Summer Use Per PremisID Per Day	high	46.07	34.24	47.30	32.39	40.00
	medium	43.52	33.34	38.68	28.11	35.91
	low	71.42	55.46	63.48	51.35	60.43
Average NonSummer Use Per PremisID	high	6,625	5,819	3,553	5,534	5,382
	medium	5,031	5,389	3,023	4,670	4,528
	low	7,754	7,084	4,452	6,577	6,467
Average NonSummer Use Per PremisID Per Day	high	36.30	31.88	19.47	30.32	29.49
	medium	27.56	29.53	16.56	25.59	24.81
	low	42.49	38.82	24.39	36.04	35.43

Roxbury (PWSID 1436002)

Year-Long Users									
	Density	2008	2009	2010	2011	2012	2013	2014	6-Yr Avg
Population	high	664	668	668	668	665	664	656	665
	medium	9,872	9,866	9,860	9,852	9,870	9,832	9,870	9,860
	low	1,481	1,480	1,482	1,480	1,492	1,490	1,488	1,485
Average Annual Use	high	12,032,000	14,212,000	13,536,000	13,969,000	14,091,000	13,221,000	11,994,000	13,293,571
	medium	140,997,000	133,727,000	133,079,000	126,853,000	127,869,000	124,549,000	121,124,000	129,742,571
	low	25,665,000	27,045,000	25,446,000	24,379,000	25,186,000	25,003,000	23,869,000	25,227,571
Average Annual Per Capita	high	18,120.48	21,275.45	20,263.47	20,911.68	21,189.47	19,911.14	18,283.54	19,994
	medium	14,282.52	13,554.33	13,496.86	12,875.86	12,955.32	12,667.72	12,271.94	13,158
	low	17,329.51	18,273.65	17,170.04	16,472.30	16,880.70	16,780.54	16,040.99	16,993
Average Annual Per Capita Per Day	high	49.65	58.29	55.52	57.29	58.05	54.55	50.09	54.78
	medium	39.13	37.14	36.98	35.28	35.49	34.71	33.62	36.05
	low	47.48	50.06	47.04	45.13	46.25	45.97	43.95	46.55
Average Summer Use	high	6,168,500	6,908,000	6,797,000	6,771,000	6,852,000	6,258,500	5,858,000	6,516,143
	medium	70,768,000	66,397,000	69,717,000	65,170,000	66,095,000	65,667,000	61,031,000	66,406,429
	low	13,464,000	12,799,000	13,418,000	12,581,000	13,184,000	12,804,000	11,981,000	12,890,143
Average Summer Use Per Capita	high	9,289.91	10,341.32	10,175.15	10,136.23	10,303.76	9,425.45	8,929.88	9,800
	medium	7,168.56	6,729.88	7,070.69	6,614.90	6,696.56	6,678.91	6,183.49	6,735
	low	9,091.15	8,647.97	9,053.98	8,500.68	8,836.46	8,593.29	8,051.75	8,682
Average Summer Use Per Capita Per Day	high	50.90	56.66	55.75	55.54	56.46	51.65	48.93	53.70
	medium	39.28	36.88	38.74	36.25	36.69	36.60	33.88	36.90
	low	49.81	47.39	49.61	46.58	48.42	47.09	44.12	47.57
Average NonSummer Use	high	5,863,500	7,304,000	6,739,000	7,198,000	7,239,000	6,962,500	6,136,000	6,777,429
	medium	70,229,000	67,330,000	63,362,000	61,683,000	61,774,000	58,882,000	60,093,000	63,336,143
	low	12,201,000	14,246,000	12,028,000	11,798,000	12,002,000	12,199,000	11,888,000	12,337,429
Average NonSummer Use Per Capita	high	8,830.57	10,934.13	10,088.32	10,775.45	10,885.71	10,485.69	9,353.66	10,193
	medium	7,113.96	6,824.45	6,426.17	6,260.96	6,258.76	5,988.81	6,088.45	6,423
	low	8,238.35	9,625.68	8,116.06	7,971.62	8,044.24	8,187.25	7,989.25	8,310
Avreage NonSummer Use Per Capita Per Day	high	48.39	59.91	55.28	59.04	59.65	57.46	51.25	55.85
	medium	38.98	37.39	35.21	34.31	34.29	32.82	33.36	35.19
	low	45.14	52.74	44.47	43.68	44.08	44.86	43.78	45.54
Ratio of Summer to NonSummer Use Per Capital Per Day	high	105.2%	94.6%	100.9%	94.1%	94.7%	89.9%	95.5%	96.4%
	medium	100.8%	98.6%	110.0%	105.7%	107.0%	111.5%	101.6%	105.0%
	low	110.4%	89.8%	111.6%	106.6%	109.8%	105.0%	100.8%	104.9%
PremisID(Parcel) Count	high	298	304	304	304	299	297	294	300
	medium	2,106	2,098	2,092	2,076	2,102	2,089	2,101	2,095
	low	351	352	358	353	362	361	360	357
Average Annual Use Per PremisID	high	40,376	46,750	44,526	45,951	47,127	44,515	40,796	44,292
	medium	66,950	63,740	63,613	61,105	60,832	59,621	57,651	61,930
	low	73,120	76,832	71,078	69,062	69,575	69,260	66,303	70,747
Average Annual Use Per PremisID Per Day	high	110.62	128.08	121.99	125.89	129.12	121.96	111.77	121.35
	medium	183.43	174.63	174.28	167.41	166.66	163.35	157.95	169.67
	low	200.33	210.50	194.73	189.21	190.62	189.75	181.65	193.83
Average Summer Use Per PremisID	high	20,700	22,724	22,359	22,273	22,916	21,072	19,925	21,710
	medium	33,603	31,648	33,326	31,392	31,444	31,435	29,049	31,699
	low	38,359	36,361	37,480	35,640	36,420	35,468	33,281	36,144
Average Summer Use Per PremisID Per Day	high	113.42	124.51	122.51	122.04	125.57	115.47	109.18	118.96
	medium	184.13	173.41	182.61	172.01	172.30	172.24	159.17	173.70
	low	210.19	199.24	205.37	195.29	199.56	194.35	182.36	198.05
Average NonSummer Use Per PremisID	high	19,676	24,026	22,168	23,678	24,211	23,443	20,871	22,582
	medium	33,347	32,092	30,288	29,712	29,388	28,187	28,602	30,231
	low	34,761	40,472	33,598	33,422	33,155	33,792	33,022	34,603
Average NonSummer Use Per PremisID Per Day	high	107.81	131.65	121.47	129.74	132.66	128.45	114.36	123.74
	medium	182.72	175.85	165.96	162.81	161.03	154.45	156.72	165.65
	low	190.47	221.76	184.10	183.13	181.67	185.16	180.94	189.61

Suez Water – Haworth (PWSID 0238001) and Franklin Lakes (PWSID 0220001)

Year-Long Users					
	Density	2014 (Apr-Dec)	2,015	2,016	3-Yr Avg
Population	high	424,085	425,707	427,266	425,686
	medium	285,571	285,485	285,296	285,450
	low	39,721	39,757	39,947	39,808
Average Annual Use	high	7,194,464,303	9,574,450,613	9,770,824,466	9,648,411,230
	medium	5,789,566,212	7,596,029,260	7,515,078,218	7,598,352,487
	low	1,355,890,424	1,763,075,642	1,754,251,244	1,771,637,767
Average Annual Per Capita	high	16,965	22,491	22,868	20,775
	medium	20,274	26,607	26,341	24,407
	low	34,135	44,346	43,914	40,799
Average Annual Per Capita Per Day	high	61.91	61.62	62.65	62.06
	medium	73.99	72.90	72.17	73.02
	low	124.58	121.50	120.31	122.13
Average Summer Use	high	3,359,145,822	3,497,972,811	3,562,195,016	3,473,104,550
	medium	3,095,750,082	3,449,804,716	3,404,015,601	3,316,523,466
	low	803,378,625	999,442,309	988,226,524	930,349,153
Average Summer Use Per Capita	high	7,921	8,217	8,337	8,158
	medium	10,841	12,084	11,932	11,619
	low	20,226	25,139	24,738	23,368
Average Summer Use Per Capita Per Day	high	65.46	67.91	68.90	67.42
	medium	89.59	99.87	98.61	96.02
	low	167.15	207.76	204.45	193.12
Average NonSummer Use	high	3,835,318,481	6,076,477,802	6,208,629,450	6,136,324,304
	medium	2,693,816,130	4,146,224,544	4,111,062,618	4,168,594,701
	low	552,511,800	763,633,333	766,024,720	792,588,836
Average NonSummer Use Per Capita	high	9,044	14,274	14,531	12,616
	medium	9,433	14,523	14,410	12,789
	low	13,910	19,208	19,176	17,431
Avreage NonSummer Use Per Capita Per Day	high	59.11	58.50	59.55	59.05
	medium	61.65	59.52	59.06	60.08
	low	90.91	78.72	78.59	82.74
Ratio of Summer	high	111%	116%	116%	114%
	medium	145%	168%	167%	160%
	low	184%	264%	260%	236%
Total Meter	high	66,044	66,397	66,833	66,425
	medium	86,013	86,195	85,805	86,005
	low	9,057	9,043	9,066	9,055
Average Annual Use Per PremisID	high	108,935	144,199	146,197	145,253
	medium	67,310	88,126	87,583	88,348
	low	149,705	194,970	193,494	195,645
Average Annual Use Per PremisID Per Day	high	398	395	401	398
	medium	246	241	240	242
	low	546	534	530	537
Average Summer Use Per PremisID	high	50,862	52,682	53,300	52,281
	medium	35,992	40,023	39,671	38,562
	low	88,702	110,523	109,001	102,742
Average Summer Use Per PremisID Per Day	high	420	435	440	432
	medium	297	331	328	319
	low	733	913	901	849
Average NonSummer Use Per PremisID	high	58,072	91,517	92,897	92,380
	medium	31,319	48,103	47,911	48,469
	low	61,003	84,446	84,493	87,527
Average NonSummer Use Per PremisID Per Day	high	380	375	381	378
	medium	205	197	196	199
	low	399	346	346	364

Appendix E. Project Methodology

Note: The following methodology was approved by NJDEP in February 2015 and used as the basis for the project. Methodology changes did occur at various points in the project where data were not available or improvements were identified based on experience with the modeling process. All such changes are discussed in detail within the report.

New Jersey Water Needs through 2040: Evaluation of Population and Water Use Rate Scenarios

Project Methodology

Overview

Water demand projections for urbanized areas are highly sensitive to forecasts of population,[2] industrial uses and per capital residential and commercial/business demands.

The first issue is with population forecasts. These are highly dependent on past population trends (including both natural growth and migration) and economic trends, and expectations as to how these trends will continue or change over time, but both are subject to significant variation over time. Trends involving larger populations tend to be more stable than projections involving individual municipalities or other small areas. Within such areas, available land, the economics of redevelopment to higher (or lower) densities, a shift from residential to non-residential land uses or vice versa, changes in household size due to demographic shifts (such as changes in ethnic makeup or the proportion of new immigrants), and changes in lifestyle preferences (such as the ongoing apparent interest in urban areas with high cultural amenities) all will play a role in short and long term population trends. Trends have shifted in the past (from urban growth to suburban and exurban growth) and are apparently shifting again toward urban growth; however, there is no guarantee that this shift will continue over the next twenty to thirty years. The only certainty in population forecasts is that they will be incorrect in detail, though they may be correct in general trend and scale.

Water use trends also change. Areas with large existing populations can see significant changes in total water demand based on relatively small changes in per capita water use. Residential trend shifts can be the result of new or updated building codes as applied over time, water rate schedules, changing household size, personal preferences for water-using or water-saving devices, etc. Commercial/office water use trends may likewise be affected by changes in building codes, but also by technology choices for lavatories and HVAC units to reduce water supply and sewer charges. Industrial uses are far harder to forecast, depending as they do on the presence/absence of specific industrial users, major process changes, technology upgrades, etc. Industries

[2] According to the U.S. Bureau of the Census, population projections are "estimates of the population for future dates. They illustrate plausible courses of future population change based on assumptions about future births, deaths, net international migration, and net domestic migration. Projected numbers are typically based on an estimated population consistent with the most recent decennial census as enumerated, projected forward using a variant of the cohort-component method." Forecasts include consideration of other factors such as policies, investment impacts, land availability, etc., to evaluate various possible assumptions and determine the most probable. They explicitly include the potential that trends may be changed through public policy.

tend to be concentrated in urban areas, while most of New Jersey's office development is in suburban areas such as the Interstate 287 corridor.

For all of these reasons, simple application of an aggregate per capita RIC (residential, industrial, commercial) water demand rate to a given population projection is not highly dependable. Past water supply plans have projected statewide and regional demands that were in some cases close to actual aggregate results and in some cases quite different, but in neither case was the accuracy of the projections a result of the methodology used.

How will New Jersey's water demand and use change in the future? No definitive prediction is possible, but reasonable scenarios can be developed that will aid in planning. Understanding viable scenarios is vital for useful water supply planning, especially for the urbanized areas of northeastern and central NJ supplied by reservoirs, but also for the lower Delaware Valley area.

Rutgers is developing a detailed evaluation of the variables involved in developing more solidly grounded scenarios for future water use. This two part study will address:

- Anticipated population growth statewide and within urbanized and urbanizing areas, with a set of reasonable scenarios based on reasonably viable assumptions. What are the anticipated or most likely demographic shifts? How might recent trends in regional economies, urban housing starts, energy costs and other likely drivers of development and redevelopment affect population projections?
- Anticipated water use rates and total water use within developed and developing areas (with the primary focus on areas with public community water supply, PCWS, systems), again with a set of reasonable scenarios based on reasonably viable assumptions. Also, peak demand is a key component of water availability analysis and an important factor is sizing water system capacities and infrastructure so detailed information is critical to NJDEP water supply planning, safe drinking water permitting, and asset management. Therefore, along with annual demands, trends in seasonal water use will be important. Industrial use forecasts will not be attempted due to the uncertainties involved. However, an assessment of the largest industrial consumptive water uses, where supplied by PCWS systems, will provide a sense of how water use within individual water systems might shift suddenly if the industry ceased or significantly increased operations. Individual industrial uses will be included where they constitute at least 5 percent of a PCWS system's demand.

The anticipated study will result in statewide water demand forecasts for PCWS systems, and will also include city-specific scenarios of increased water demand, both annually and seasonally, for at least the top five municipalities by population, as case examples useful for broader planning purposes. The results of this study will provide a set of input projections for use in water supply planning, which will occur through other projects.

Methodology

The proposed methodology builds on the ideas stated in the project scope of work. Additional research and discussions with experts in the field have aided in methodology development.

Population Projections

Step P-1: Existing Projections: Assemble existing population projections/forecasts from the three Metropolitan Planning Organizations (to 2040 from the North Jersey Transportation Planning Authority, Delaware Valley Regional Planning Commission, and the South Jersey Transportation Planning Organization) and the NJ Department of Labor and Workforce Development (population projections to 2035). Specific projections or forecasts from counties, the largest municipalities, and major water purveyors will also be collected, along with related information from planning organizations such as New Jersey Future, PlanSmart NJ and Regional Plan Association.

Status: Current population projections from MPOs/NJDOL have been compiled and reviewed.

Step P-2: Critical Variables: Compare the various projections and forecasts, evaluate the assumptions, assess the reasons for differences among the existing projections, and assess alternative assumptions (including but not limited to shifts in the proportion of residential development that occurs through redevelopment versus "green field" development).

Status: Complete. The NJDOL and MPO projection models use the following primary variables to project population change to the county level. The county-level results are then allocated to the various municipalities through a separate method that does not incorporate the same variables.

- Base population – The base population used in projection models is the 2010 Census counts by age and sex from U.S. Census of Population and Housing, which reflects the demographic characteristics of the latest decennial census. Age is defined by five-year groups (cohorts) from 0 to age 84, with an open category for age 85 and over. The 2005 populations by age and sex cohort are from the 2005 American Community Survey, which is considered less accurate than the Census data.
- Fertility (Births) – Fertility rate is live births per 1,000 female population. It is used in population projection models to compute births to women in each five-year interval. The statewide population projection model provided by the New Jersey Department of Labor and Workforce Development (NJDOL) assumes that New Jersey's race-specific fertility rates are projected to remain at the current level of 1.7 births per white woman, 2.1 births per black woman, 1.9 births per Asian woman, and 2.6 births per Hispanic woman throughout the projection years. However, DVRPC's model uses the number of live births per 1,000 women by five-year age cohort in New Jersey in 2000. New Jersey Department of Health (NCHS) and National Vital Statistics System of the Centers for Disease Control and Prevention (CDC) are the preferred sources of recent annual birth and fertility data.
- Mortality (Deaths) – Mortality rate is the number of deaths per 100,000 standard population. It is used to calculate survival rates, which represent the percentage of persons who are likely to survive to the next five year cycle. The recent mortality data are provided by the NCHS and CDC.
- Migration – Migration is the most volatile component in the population projection models. The cohort-component model used by DVRPC assumes that migration in future years will be the same as the average five-year migration rate experienced by each five-year age/sex cohort between 2000 and 2010. However, the economic-demographic model applied by NJDOL assumes employment growth to be the major determinant of migration in and out of the state for persons under 65 years of age.

Step P-3: Historic Trends: Evaluate the ranges and trends for the key variables to provide a basis for scenario development and the "outer bounds" of likely future trends.

Status: Complete.

- Fertility Rate – The general fertility rate for New Jersey was 61.0 births per 1,000 women of childbearing age (15-44) in 2011, which decreased 0.3% from the rate in 2010 (61.2), and 2.9% from the rate in 2009 (62.8). As shown in Figure 1 below, the fertility rate in New Jersey is always lower than in United States, but the trend is similar. The fertility rate in NJ has steadily declined since 2007 (65.8), likely due in part to economic forces, as fertility often declines in times of economic stress. However, the fertility rate in 2011 declined to the lowest rate for New Jersey from 1990 and 2011, indicating that a broader trend exists that will continue even after economic conditions significantly improve. Fertility among specific age cohorts also has shifted, with a reduction in teenage pregnancies and an increase in 30-44 age cohorts. Overall fertility rates are also affected by migration rates among the various age cohorts. New Jersey has a smaller share of female population within the primary child-bearing years than the nation as a whole (19.7% vs. 39.7% in 2010). The difference between US and NJ rates has increased from 1994 to 2011 but is similar to that of 1991-1992. The causes for these shifts will be examined.

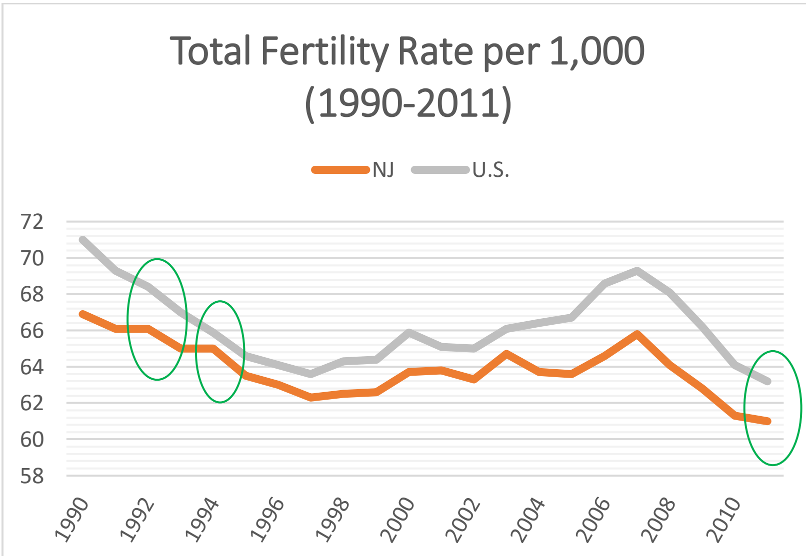


Figure 1: Fertility Rate

- <u>Mortality Rate</u> – According to **Figure 2**, the mortality rate has been gradually declining since 1995. It was 685.4 per 100,000 population in 2011, down 0.1% from the rate in 2010 (686.1). The lower the mortality rate, the higher the survival rate. New Jersey has a lower mortality rate than United States.

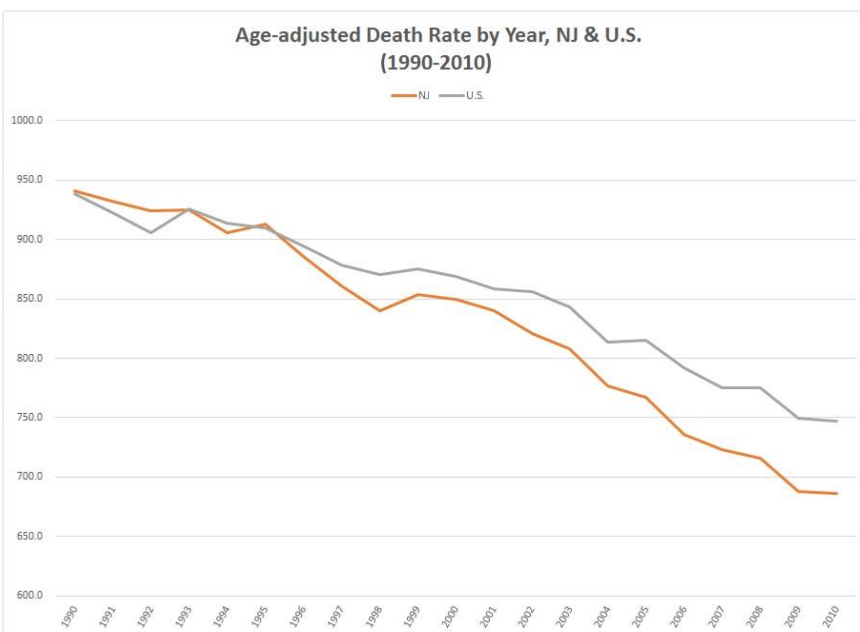


Figure 2: Death Rate

- Net Migration – In general, Net Migration is composed of domestic migration (i.e., from state to state) and migration between nations. However, determining these two types of migration is difficult, and so Net Migration can be calculated simply as the difference between actual population change and natural increase (reflecting births and deaths). As shown in **Figure 3**, New Jersey has experienced net out-migration since 2003 to 2008, which was coincident with time of economic crisis. Moreover, after 2003, the net gains in international migration were no longer large enough to offset the net losses of domestic migration. The changes of net migration sharply affect population, since the natural increase is much steadier and predictable.

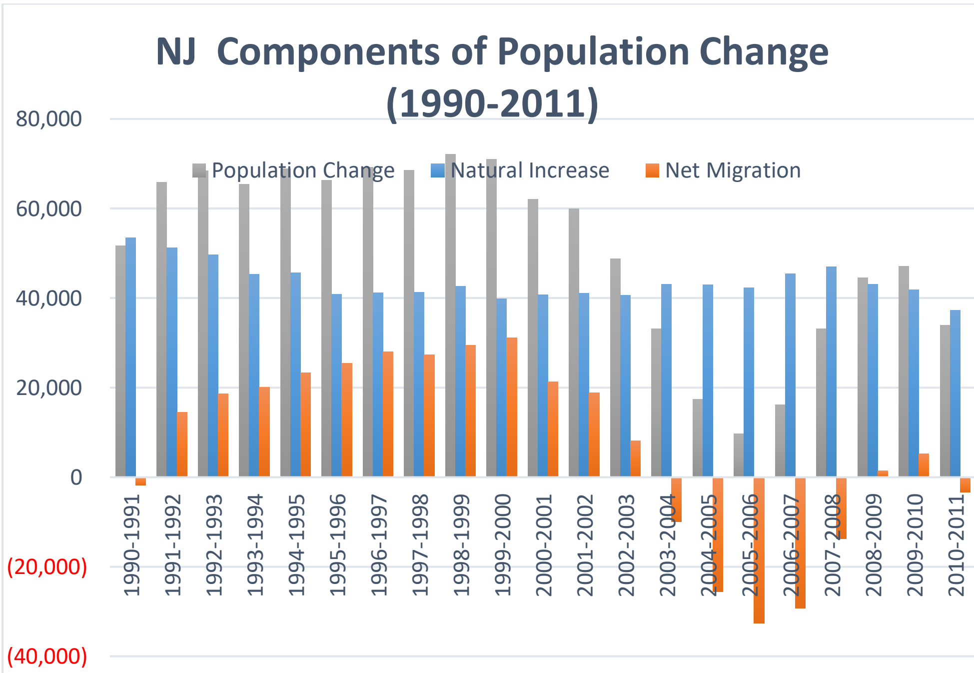


Figure 3: Components of Population Change (Source: NJ Public Health Data Resource)

- Employment/Unemployment – The employment pattern in New Jersey is similar to United States, as shown in **Figure 4**. The total employment sharply declined from 2007 to 2010 and has been recovering, though slower than for the nation as a whole. Since the economic-demographic model assumes employment growth to be the decisive factor of migration, Figure 5 explores the relationship between net migration and employment change in New Jersey from 2001 to 2011. No obvious relationship could be found between them, but it seems the trend of employment change is just opposite to the change of net migration. However, regional and county employment and migration relationships may be different, especially in areas that are relatively isolated from the remainder of the state, such as the Atlantic/Cape May county area.

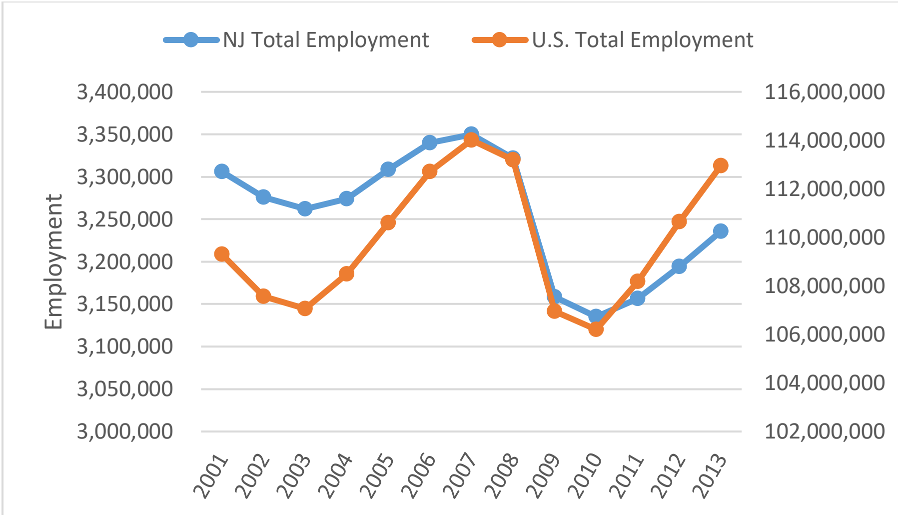


Figure 4: Total Employment in NJ & U.S.

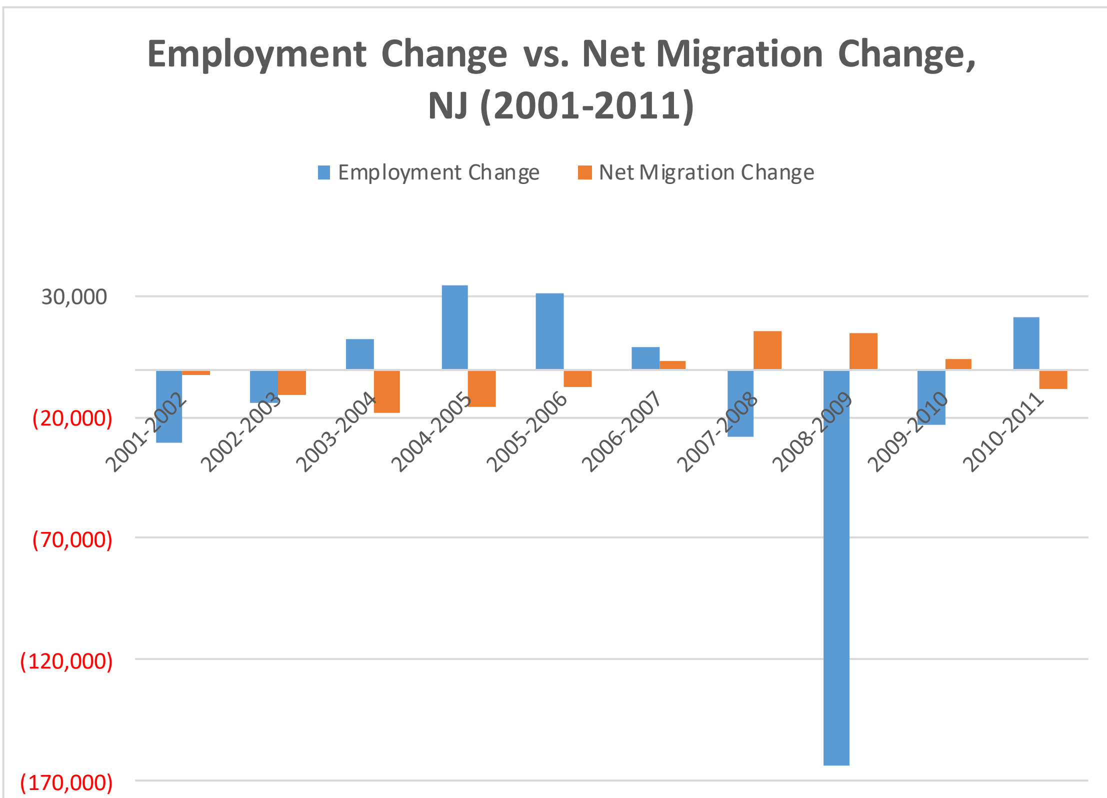


Figure 5 Change of Employment and Net Migration

Step P-4: Sensitivity Analyses: Using the available population projection models, determine the sensitivity of 2040 population projections to modifications in the primary variables, within the historic range of each variable and with attention to situations where the simultaneous modifications of multiple variables may result in invalid evaluations (e.g., where historic high migration rates into New Jersey are unlikely to occur at the same time as an historic low employment growth rate). Assess the potential for regions to have different results based on local circumstances, such as the evolution of the casino industry in Atlantic City.

Status: General approach developed. The base population, fertility rate, mortality rate, and employment are all the independent variables, which are recorded by different departments of New Jersey. The historical net migration is dependent on the base population, births, and deaths, as migration is not directly measured but rather is inferred from the values of the independent variables. For each fertility and mortality rates, NCHS also provides an upper and a lower limit (95% confidence interval) for them, which could be used to conduct the sensitivity test. Through control variable method, we may find how changes to the fertility rate and mortality rate will affect the final population projections.

	Fertility Rate	**Mortality Rate**
Sensitivity Test 1	**Constant**	**Upper/Lower Limit**
Sensitivity Test 2	**Upper/Lower Limit**	**Constant**

Step P-5: Selection of Scenarios and Projections: Recommend one projection, or a combination of sub-region projections or a subset of the evaluated projections that would be best utilized for NJ Water Supply Planning needs, based on study findings and best professional judgment. Discuss critical uncertainties to demonstrate the potential impacts of such uncertainties on water demand forecasting.

Status: General approach developed. Historic data can be used to find the range and trend for each variable, which also can be used to develop different state and county level population projection scenarios. Scenario 1 provides a high alternative for the population projection through 2040 in New Jersey. It assumes the upper limit fertility rate, lower limit mortality rate, and upper limit net migration that total fertility stays 0.4 children above and the mortality stays 5.4 deaths below the level in the medium scenario. Scenario 2 represents the medium alternative and scenario 3 reflects the low alternative, which assumes the lower limit of fertility rate and net migration rate, and upper limit of mortality rate. Using the various scenarios and associated forecasts, a set of forecasts will be selected for use in water demand projections, with a qualitative and quantitative assessment of uncertainties.

	Base Population	**Fertility Rate**	**Mortality Rate**	**Net Migration**
Scenario 1	Constant	Increase	Decrease	Increase
Scenario 2	Constant	Constant	Constant	Constant
Scenario 3	Constant	Decrease	Increase	Decrease

The resulting population projections will be disaggregated to the municipal level by applying the same proportional populations as estimated by the MPO projections (i.e., if a municipality has 0.05% of 2040 regional population within the MPO model, it would also receive 0.05% of the scenario populations). The same approach will be used to disaggregate population projections to Transportation Assessment Zone (TAZ) for the NJTPA area, or census tract in other areas, where necessary (i.e., where PCWS service areas split a municipality).

Step P-6: Build-out Analyses: Assemble readily available build-out evaluations (e.g., Highlands Region, Rutgers Center for Neighborhood and Brownfields Redevelopment, counties preparing Wastewater Management Plans), land preservation trends, available inventories of approved but not built residential projects, etc., and evaluate potential effects of these alternative approaches to development on population forecasts. It is recognized that limitations on available land may redirect growth locally but not greatly alter regional forecasts.

Status: To be used where available as part of the evaluation of water demands for specific PCWS. Evaluation of available data has resulted in a conclusion that build-out analyses only exist in a few portions of the state. Land availability constraints may be a factor for population growth in some suburban municipalities, but are not relevant in urban municipalities where essentially all development occurs on previously developed parcels. Only the NJTPA methodology uses indicators of land availability, but the results are not replicable with new county level projections, as many municipal and TAZ allocations were created through "off model" modifications based on local information regarding development approvals, land constraints and other factors.

Water Demand Rates

Step D-1: Statewide Data Acquisition: The NJDEP will provide available data on:

- Land Use Data in GIS (NJDEP LULC datasets)
- Listing of Public Community Water Supply (PCWS) Systems
- PCWS service areas in GIS (NJDEP, Highlands Council)
- PCWS water allocation permit withdrawal data (NJWaTr)
- PCWS Safe Drinking Water Program data on current and committed demands, contracted water supplies, firm capacity, etc.
- Water loss data (NJDEP, DRBC)

Status: NJDEP LULC data available online. NJWaTr database provided through 2010 data. PCWS service areas and PCWS Safe Drinking Water Program data provided.

Step D-2: Evaluation of PCWS Service Areas and Populations: Rutgers will determine the population served for each PCWS. The analysis will identify spatial clusters of populations that can be used to adjust the estimated PCWS system current demand for municipalities. It will also be used to identify the populations associated with water demands from each residential area within the case example PCWS systems, for the estimation of per capita demands in various development categories. Finally, it will be used to help assign future residential demands for all PCWS.

Status: General approach developed. The PCWS service area information from NJDEP will be combined with 2010 Census data to evaluate the population densities within each portion of the service areas. Dasymetric analysis of population clustering will be used to assign Census tract population to residential areas based on the relative density of residential development (e.g., low, moderate and high density single-family dwellings; moderate and high-density multi-family dwellings), using NJDEP LULC polygons. The dasymetric analysis is conducted using ArcGIS mapping software.

Step D-3: Identification of Case Example PCWS Systems: Identify and gain cooperation from a stratified sample of 10-15 PCWS systems, based on annual average daily demands (over 50 MGD, 20-50 MGD, 5-19 MGD, 2-5 MGD), that collect and compile demands from residential, industrial and commercial (RIC) water uses based on individual metering.

Status: General approach developed. This study will select a stratified sample of PCWS systems to act as representative systems for the rest of the state. The selections will be based on systems of varying capacity, geographic location, demographic makeup, and built environment characteristics. Ideally 10-15 PCWS systems will be chosen that represent a range of capacity based on annual average daily demands. Smaller systems are not included in this analysis because they have relatively few customers and therefore will not provide a robust data set of customer demands. The vast majority of NJ water customers are served by the larger systems, and therefore the priority is on gathering information valid for use in such systems. To the extent that such statistics over- or under-estimate customer demands for the smallest systems, the net impact on NJ water withdrawals will be minimal. Other than capacity, the characteristics that will be considered when selecting sample PCWS systems are as follows:

Variables	Unit Of measure	Source
Housing Density	Residential Units per acre (units/acre)	2010 U.S. Census
Precipitation	Annual / Monthly Precipitation (inches/ year or inches/month)	PRISM (Oregon State University)
Household age / year built	Household age (years)	Most recent American Community Survey (MOD IV data are very incomplete)
Household Size	Average number of people per household (persons/unit)	2010 U.S. Census
Land use patterns	Concentrations of different Land Use types	2007 LU/LC data (2012 if available, expected in 2015)
Topography	Topographic Variability (e.g., percent of service area greater than 10% slope)	USGS 10-meter Digital Elevation Module
Region	Metropolitan Planning Organization regions, Physiographic Provinces	MPO Counties; State Geophysical Province Map

Step D-4: Data Collection from Case Example PCWS Systems: Collect from these utilities water demands by user by municipality to the extent feasible. Assemble available information on water use rate trends and water loss rates and trends by PCWS system.

Status: General approach developed. This study is highly dependent on the data available from the case example PCWS systems. The intent is to acquire monthly data for the years 2000-2011 (to match data from NJWaTr that will be available) preferably for the period 2000-2011, but at least the last five years, to allow for examination of demand rates during wet and dry years:

- monthly water usage (incoming sources);
- monthly metered water released to the distribution system from the treatment system or well;
- monthly metered water delivered to customers by geographic area and user type (anonymous, without street address or personal information). **Notes**: (1) quarterly meter reading is not sufficient for this project; (2) it is recognized that systems with manual or drive-by meter reading will not have synoptic ("same day") data, and so the data will be organized in a manner that most closely approximates a monthly reading. Preference will be given to systems with radio meter reading allowing for synoptic readings;
- service area delineations from each PCWS system (for cross check to NJDEP GIS information);
- total number of customers; and
- water loss rates (e.g., non-revenue water).

To ensure a sufficient number of sample PCWS, at least five additional PCWS systems will be identified as backups. It will be critical to understand and develop demand relationships based on total demand per capita (i.e., combined Residential, Industrial and Commercial demand, including both revenue and non-revenue water), and also the per capita demand based on delivered water (i.e., excluding non-revenue water) for specific homogeneous development types. Preference will be given to geographically-coded data on a customer basis. However, it would be acceptable also for a purveyor to provide aggregated data based on this methodology, if there are confidentiality concerns. Water demands compiled by government-owned systems are public data.

Step D-5: Data Evaluation from Case Example PCWS Systems: Develop a database and analytical approach that will result in average water demand rates for various categories of land development, for peak and low annual and seasonal periods over the period of record.

Status: General approach developed. The analysis will include:

- Delivered water demands for each case example PCWS system disaggregated by development category, including but not limited to: low, moderate and high density single-family dwellings; moderate and high-density multi-family dwellings; office/commercial; industrial. Using the combined demand data and dasymetric evaluation, analyze how household size affects per capita water demand.

- Seasonal water demand trends will be evaluated for each of the case example PCWS systems, using both total flows and customer meter data, which should show seasonal differences in water losses and customer uses, respectively. Multiple years of data will be used to assess wet and dry years. Time series data will be evaluated for any unique trends among the PCWS systems. Water demand restrictions will be identified for all seasons evaluated, to assess the impact on status and trends. This analysis may identify trends associated with distinct demographic/economic characteristics or geographical locations, such as suburban vs. urban, or inland vs. shore communities. Additionally, this analysis will identify any differences that arise in seasonal peaking factors for specific usages due to different geographic locations. For example one might expect towns with commercial use that is strongly tied to seasonal tourism to have a significantly different seasonal peaking factor than a town with little to no tourism.

- Industrial water uses and trends to the extent feasible. Individual industrial uses will be evaluated where they make up at least 5% of a sample PCWS system's total demand, as such uses pose a significant risk to the PCWS system. If the data allow, the volatility of industrial demand will be evaluated for each PCWS system. Relative to commercial and residential water demand, industrial demand is more responsive to changing economic conditions. Charting time series data for industrial use may reveal varying degrees of volatility or stability among PCWS systems. Determine the variability in the user base (i.e., which demands were eliminated, change more than 25%, or were added during that period) to assess volatility within industrial uses.

- Comparison of disaggregated water use rates among case example PCWS systems to determine the extent to which the various rates are similar or distinct in current levels or trends (i.e., whether trends in various areas are similar in nature but with some areas lagging others, or whether trends are distinct to specific types of areas or systems).

Step D-6: Land Use Categorization for All PCWS Systems: Assemble available information on population, employment, residential units and office/commercial space (each by major category), and also major industries, by municipality. Where available, evaluate residential and office/commercial unit age distributions (i.e., using NJDEP LU/LC data) to help determine the extent to which building code requirements were applicable as units were constructed.

Status: General approach developed. Use Census tract data (as interpreted through dasymetric analysis), LULC data and PCWS system service areas to evaluate relative population, land use and housing age distributions within each PCWS system service area.

Step D-7: Current Water Demands for All PCWS Systems: Determine residential, commercial and industrial water demand rates by PCWS system and by municipality.

Status: General approach developed. A comprehensive understanding of current PCWS water demand in New Jersey will be critical for projecting future demand. This study will examine purveyor flows and service area delineations to determine total PCWS flows, municipal-level demands, and delivered water based on homogeneous development categories (e.g., single-family homes, multi-family homes, office use) within the service areas.

The NJDEP Bureau of Water Allocation and Well Permitting (BWAWP) has developed a statewide database of water withdrawals and discharges from 1990-2010. Data for the year 2011 are anticipated to be available by the end of 2014. Only sites that have the capacity to withdraw greater than 100,000 gallons a day are included in this database, as this is the cutoff volume for water allocation regulation by the NJDEP (N.J.A.C. 7:19 et seq.). Withdrawals are classified by five different categories of use: potable, commercial, industrial, agricultural, and power-generating. From this database we can extract water withdrawals for the self-supplied PCWS systems with water allocation permits.

To calculate total PCWS flows, systems with a capacity smaller than 100,000 gallons per day (don't require water an allocation permit) must be accounted for, along with water that is received by one PCWS system from another water supply source under contract. The NJDEP Division of Water Supply and Geoscience maintains an online database of public water system deficits and surpluses. The underlying database includes information for systems of every size, including systems that are too small to require a water allocation permit and those that receive water through contracts. Therefore, water flow information for PCWS systems that was not included in the BWAWP database can be extracted from this database. Additionally this database will be used to cross check the data for permitted systems acquired from the BWAWP database.

Once total purveyor flows have been calculated, municipal demands may be determined or estimated. In some cases, purveyors service areas may be entirely within a single municipality, or for multi-municipality systems, the purveyors may meter the total delivered water to each municipality. In either case, that information will be sufficient. For all other multi-municipal PCWS, the number of connections and/or service area delineations can be used to estimate individual municipal-level demands. If the service connections data for each PCWS are available by municipality, then demand for a given municipality can be estimated as follows. For each PCWS that has connections in the municipality, the number of connections in the municipality will be divided by the total connections of the PCWS, then multiplied by the average flow for that PCWS. Average flows for each PCWS will be calculated by dividing total flow by total connections. This method assumes equal flows for each connection within a PCWS. The dasymetric analysis of population clustering may be applied to adjust results.

Step D-8: Peak Season Water Use for All PCWS Systems: Evaluate seasonal aggregate per capita water use patterns (annual use vs. summer peak use) for all PCWS systems using peak annual and monthly demand data. Draw conclusions where possible on trends in seasonal water use patterns for urban versus suburban water systems.

Status: General approach developed. Divide the total annual demand and peak monthly demands by the population for each PCWS system. Compare peak season per capita water demands among PCWS systems with consideration of the relative land area in non-residential development as a proxy for non-residential water demand.

Step D-9: Water Demand Trend Analysis: Develop water conservation scenarios for application to future demands in all PCWS systems.

Status: General approach developed. Several aspects of water use trends will be analyzed using the customer demand and PCWS flow data over multiple years. Overall water demand trends will be evaluated in addition to the following aspects.

- **Comparison Rates** – Through a literature search and consideration of available open-source water demand forecast models, examine water demand rates for similarly situated PCWS systems in other states with similar development patterns. Identify water demand trends and contributing factors.

- **Non-Revenue Water and Water Losses –** Non-revenue water is water is the difference between the water that is delivered by the purveyor and what is actually received at the customer meter. These differences can be explained by "real" water losses (e.g., leakage, firefighting, water main flushing) and "apparent" losses (e.g., metering inaccuracy, unmetered demand locations). As infrastructure ages, non-revenue water loss is expected to increase until the infrastructure is replaced or repaired. The percentage of water lost will be calculated for each PCWS system by subtracting total system water by total metered water and dividing the result by total system water. The percent loss will be plotted over time to identify trends. Detailed information on system water losses will be requested from the Delaware River Basin Commission for the year 2013 for the New Jersey PCWS systems under their jurisdiction. While 2012 information is available, the most recent available year will be used, with the assumption that the provided information will become more accurate as PCWS systems gain experience with the reporting requirements and IWA/AWWA Manual M36 process. Information on infrastructure repair or replacement is required to analyze the variability of water loss within a system. For the most part, this information will not be available statewide, but will be sought regarding the case example PCWS systems. Scenarios for water loss rates will be developed based on declining, stable and enhanced asset investment policies.

- **Industrial Use** – An initial assumption of static industrial demand will be used, along with alternative scenarios of industrial demand loss or gain. Based on the results regarding industrial uses from the case example PCWS systems, a measure for volatility of industrial demand may be applied to the PCWS system, based on the land use mapping in Step D-6, for PCWS systems that have relatively large portions of their service area within industrial areas.

- **Seasonal peaking factors** – An initial assumption will be made that seasonal water demand patterns will for each PCWS systems will match the results from the case example PCWS systems based on a comparison of each PCWS system to similar systems from the case examples. Alternative scenarios will be based on the potential for increased outdoor uses versus increased use of water conserving fixtures and behaviors.

- **Conservation and efficiency trends** – The implementation of water conservation and efficiency measures must be taken into account in this study. In general, conservation is a result of user behaviors, while efficiency is a result of new technology. A review of applicable regulations and building codes that have been applied in New Jersey will be conducted. A more detailed analysis will be applied to the case example PCWS systems. Census data on housing age will provide a general sense of the proportion of residential development within the service areas for the case example PCWS systems. Building permit data will be acquired as available from the New Jersey Department of Community Affairs. The available building permit data shows new construction, additions, and alterations that can be disaggregated by commercial and residential use. This dataset can be used to estimate what buildings would have been subject to new regulations and building codes when they were altered or first built. However, the available data on additions and alterations does not include the type of alteration or addition. This limits the usefulness of these data as it is impossible to tell if an alteration or addition included any aspect that would be subject to water conservation regulation. Based on the available information, an estimate of "market penetration rates" will be developed for conservation retrofits on older housing. Scenarios will be developed for potential conservation trends based on future retrofits. In addition, the scenarios will address potential changes in residential lawn irrigation rates based on trends in the installation of irrigation systems with moisture/rainfall controls, and the retrofit of existing systems with such controls. Finally, the replacement of home appliances with more efficient devices will be more rapid than home retrofits. Information will be sought from the appropriate trade associations and the USEPA Water Sense program regarding this issue. Water efficiency rates will also be affected by industrial and office building renovations, as much of the office space in New Jersey was built in the 1980s and is now considered substandard.

Step D-10: Water Demand Trend Projections: Forecast water demand rates for residential and office/commercial uses, using generalized rates that are applicable to groups of PCWS systems, municipalities or both, with high, moderate and low forecasts with clearly identified assumptions and conditions.

Status: General approach developed. After focused analysis of the case example PCWS systems, the findings of the analysis will be extrapolated to all PCWS systems. Each PCWS system will have associated water use trends as they relate to conservation, non-revenue water loss, and seasonal peaking. Each municipality and PCWS system in New Jersey will be assigned an appropriate trend based on the most relevant case example PCWS systems (as individual systems, similar systems or regional aggregates of systems) considering similar geographic location, demographic makeup, and built environment characteristics. In this manner, the estimates generated for each municipality and PCWS system will more accurately portray variation in water use trends throughout the state.

Three scenarios will be developed for forecasting water demand to the year 2040.

	Water Conservation	Non-Revenue Water	Population Growth Rate
Scenario 1	Constant	Increase	Increase
Scenario 2	Constant	Constant	Constant
Scenario 3	Increase	Decrease	Decrease

Scenario 1 reflects conditions that are expected to increase water demand. Water conservation is held constant because it is not expected to regress in any scenario. Non-revenue water and population growth are increased from the current rate. Scenario 2 represents what will happen if water conservation, non-revenue water, and population growth (relative to MPO projections) are all held constant. Scenario 3 represents conditions that are expected to decrease water demand. Water conservation is increased and non-revenue water loss and population growth rate are both decreased. The decreases and increases among each category will be selected based on variations that are observed in the data from 2000-2010. For each municipality, the population of each scenario will be multiplied by the forecast per capita water use of that given scenario. This approach will provide a useful range of demand projections for each municipality. Municipal demand can then be aggregated to the county and state level as needed. The most appropriate scenario for each municipality will depend on the nature of the municipality, and so no single scenario can be considered the "most probable" statewide. Urban municipalities are more likely to see significant improvements in water conservation because most water uses are indoor and redevelopment is more likely in urban areas. Suburban municipalities will see gradual shifts due to home retrofits and business/industrial renovation and conversions. Relatively rural municipalities are more likely to see population growth associated with outdoor water uses, resulting in at best static water conservation. Recently developed areas are likely to have static indoor and outdoor water conservation, as little redevelopment or rehabilitation is likely and newer buildings already incorporate NJ requirements for water-conserving fixtures.

Step D-11: Water Demand Projections for All PCWS Systems: Develop water demand projections for all PCWS in New Jersey for each scenario, with an uncertainty analysis. Recommend a "most probable" scenario and water demand for each PCWS system.

Status: General approach developed. For each demand scenario, develop water demand projections for each PCWS system using the dasymetric analysis of population clusters, PCWS service area delineations, the municipal water demand projections and the relevant residential, commercial and industrial land uses of each municipality within the PCWS service area, so that a realistic proportion of municipal water demand is allocated to each PCWS service area within the municipality. Aggregate all demands up to the PCWS system level. Based on Step D-10, aggregate the "most probable" water demand projection at the PCWS level to the statewide level.