SMALL PUBLIC WATER SYSTEMS IN THE 21st CENTURY

An Examination of the Changing Demographics of Small and Rural Water Systems As Reflected in the USEPA 2010 SDWIS Database

By

John E. Regnier, National Rural Water Association

**Executive Summary**

The USEPA 2010 SDWIS Pivot Tables were used to develop a 50-state database from which values for selected small system demographics were estimated. These data show that small systems serve an average of up to a quarter of the US population that is provided public drinking water and in many states 50% or more of the population. These systems have grown markedly in size, complexity, and sophistication, serving an average of about 500 meters or 1,300 to 1,500 people.

These changes have numerous impacts and implications including:

* Small systems should be considered as playing a significant and vital role nationally and in some states a predominant role in the provision of drinking water to the US population.
* Organizations that support the small system community may need to revise programs like training efforts to recognize the increasing size and accompanying sophistication of small systems.
* Programs such as capacity development based on the assumption that small systems in general are too small to be economically and operationally viable cannot be supported by current demographic data.
* Actions that affect small systems should be flexible enough to permit adjustment to fit local conditions recognizing the wide variation in system characteristics from one state to another.

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The proliferation of small and rural public water systems in the United States can probably be traced back as far as the USDA Water Facilities loan program established in 1937, with the first loan made in 1940 (Bowman, 2004). However, the real explosion in numbers of these systems began in the 1960s and continues today so that currently there are in excess of 40,000 community water systems serving less than 10,000 people per system. All of these systems as well as their larger counterparts and many non-community systems fall under the purview of the national Safe Drinking Water Act (SDWA) administered by the United States Environmental Protection Agency (USEPA) which has delegated implementation to the states unless the state has refused to accept this responsibility (primacy), Wyoming and the District of Columbia being the only entities that haven’t accepted primacy.

At the time of their initial development, these small utilities typically served relatively few households, but the usual pattern of development has been rather rapid expansion of these systems as consumers became aware of the availability of “city water” in areas heretofore supplied only by private wells and government sources of funding to support development and expansion of these systems increased. Unfortunately, early concepts about the size, capabilities, and perhaps importance of these small systems have tended to carry over to current times although not necessarily supported by the facts. For example, anyone who has spent significant time associated with the small system segment of the public water supply industry has probably heard or read statements to the effect that small systems serve only 10% of the population but account for 90% of the systems in the country. However, professionals familiar with small water systems are aware that many of them have undergone rapid increases in size since their original formation. Those with initial customer bases in the 100 to 200 hundred meter range frequently now serve several thousand households. This general knowledge among professionals suggests the need for a quantitative assessment of the current demographics of these systems and hence, the purpose of this paper.

Fortunately, the USEPA has for many years maintained a massive computerized record of pertinent information concerning the performance and nature of the water systems regulated by the SDWA. This information resource, the Safe Drinking Water Information System (SDWIS) is available for download through pivot tables beginning with 1998 (USEPA Website 1). It has been well known for some time that because of the multiple sources for the basic data and the large numbers of entries, this information may contain inaccuracies. In fact, the EPA states in its web site “**NOTICE:** EPA is aware of inaccuracies and underreporting of some data in the Safe Drinking Water Information System. We are working with the states to improve the quality of the data.” These inaccuracies will be discussed further in this report, but it is felt that such uncertainties don’t preclude the use of the data to provide usable estimates of general trends and the SDWIS/Fed Pivot Tables for 2010 provide the quantitative information that is the basis for this paper.

Specifically, the purpose of this paper is to document selected demographic parameters of small public water systems serving less than 10,000 people, indicate how these characteristics have changed with time, and assess the impact of these changed demographics on regulatory and other actions pertinent to small drinking water systems.

**Methods**

Beginning with 2010 water system data, it became possible using USEPA SDWIS pivot tables to access individual water system information at the state level. The advent of Microsoft Excel 2007 with its increased data handling capability made it possible to create state-by-state databases using summary information from the pivot tables. This was done with the 2010 Public Water System Inventory Data pivot table in which state data are embedded by EPA Region. A 50-state database was created with 16 fields related to system identification and characteristics plus additional fields providing contact information for each system in each state. In addition, a summary database was generated containing summary information for each state related primarily to system size and population served as detailed in the following listing.

2010 Census Population

Ratio CWS Population Served to 2010 Census Population (sums)

Ratio CWS Under 10,000 Population Served to 2010 Census Population (sums)

Ratio CWS Population Served to 2010 Census Population (calcs)

Ratio CWS Under 10,000 Population Served to 2010 Census Population (calcs)

Population Served by CWS (sum)

Meters Served by CWS

Population Served by CWS (calc) - Average Household Size Times Meters

Population Served by CWS Under 10,000 (sum)

Population Served by CWS Under 10000 (calc) - Average Household Size Times Meters

Ratio Population Under 10,000 to Total (calcs)

*Note: The following abbreviations and explanations apply to this listing. CWS refers to Community Water Systems; NTNC refers to Non-transient, Non-community Water Systems; TNC refers to Transient Non-community Water Systems; calc or calcs refers to populations calculated as indicated; and sum or sums refers to populations determined by summing population figures in the pivot tables.*

Ratio Population Under 10,000 to Total (sums)

Total Meters Served by CWS Serving Under 10,000 People

Total CWS Under 10,000

Average Meters per CWS Serving Under 10,000 People

Total NTNCs

Total TNCs

Total CWS

In the previous note mention is made of populations calculated by multiplying average household size by the number of meters involved. This was done in an attempt to evaluate the impact of errors in the SDWIS data referenced earlier. As an example of these errors, in Alabama if the populations associated with CWS are determined by summing the pivot table populations served by each system, the resulting total is greater than the 2010 Census population estimated for the entire state (5,537,162 versus 4,802,902). Personal communication with the Alabama Department of Environmental Management indicated that this discrepancy probably arises because of their practice of estimating their populations served by multiplying an assumed household size of 3 persons times the number of meters involved. Inasmuch as census data provide more exact estimates of household size for each state, it was decided to calculate populations where appropriate by multiplying census household size figures for each state times meters and compare ratios determined using these calculated values with ratios determined using populations derived by summing pivot table values. These differences, which turned out to be relatively minor, are discussed further in subsequent paragraphs.

**Results**

Population Served

A key parameter of small system demographics is the number of people served by these systems. As previously mentioned, it is suspected that there is a widespread conception that small systems serve only about 10% of the population. Data derived from this analysis do not support this. The parameter of population served can be addressed in several ways, but in this treatment two statistics were deemed to be important; the amount of the total population served by Community Water Systems (CWS) and the fraction of this served-population that is accounted for by small systems serving less than 10,000 people.

The ratio of the CWS population served to the 2010 Census population was calculated for each state and was found to range from 0.50 to 1.42 if summed values were used for CWS population and from 0.46 to 1.37 if calculated CWS values were used as previously discussed. The values above 1.00 in either case obviously reflect the errors known to occur in the pivot table data. Averages for the ratios using the summed and calculated figures respectively are 0.89 and 0.76, leading one to suspect in spite of the errors involved, that CWS probably serve 80 to 90% or more of the population in states on average. The scatter plot below in Figure 1 in which the ratios for each state are plotted does not seem to be inconsistent with this observation.

Figure 1

In the population served category, the parameter of more concern to small systems is how much of the population served by CWS is accounted for by those systems serving 10,000 or fewer people. This was determined by calculating the ratio of the population served by CWS supplying 10,000 or less people to the total population served by CWS in each state. These values ranged from 0.06 to 0.71 with an average of 0.26 for population values determined by summing pivot table values. These results are shown graphically in scatter plot in Figure 2 which plots the above ratios for each state.

Figure 2

It is interesting to note that although the average ratio is only 0.26 (26%), in numerous states this average is exceeded significantly, approaching and occasionally exceeding 0.50 (50%). This observation does not change significantly if the ratios are calculated using the 2010 Census total population figures as shown in Figure 3.

Figure 3

System Size

System size can be expressed in many ways, but commonly by number of meters served. This parameter was measured for each state and ranged from 121 to 1275 meters/CWS serving less than 10,000 people. The average number of meters served was 469. The scatter plot distribution of these values is shown in Figure 4 and clearly depicts the wide variation in sizes of systems between the states.

Figure 4

The wide variation in size of small systems across states is perhaps not surprising inasmuch as the number of these small systems also shows wide variation from state to state. These numbers vary from a low of 73 to a high of 4319 with an average of 919 CWS per state serving fewer than 10,000 people. The corresponding scatter plot shown in Figure 5 shows a very similar dispersion pattern to that in Figure 4.

Figure 5

Geographical Influence

To evaluate possible geographical influences on the values of parameters discussed, the state values were ordered by USEPA Region. There are 10 of these regions and fortunately they progress from the lowest identifying number on the East Coast to the highest on the West Coast so that evaluating data as they may change from Region 1 to Region 10 provides at least a qualitative measure of possible geographical effects. These 10 regions and the states they include follow.

* Region 1 - Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
* Region 2 New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands
* Region 3 - Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia
* Region 4 - Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
* Region 5 - Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
* Region 6 - Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
* Region 7 - Iowa, Kansas, Missouri, and Nebraska
* Region 8 - Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
* Region 9 - Arizona, California, Hawaii, Nevada, American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, and Republic of Palau)
* Region 10 - Alaska, Idaho, Oregon, and Washington

Figures 6, 7, and 8 present scatter plots of the same data shown in Figures 1, 2, and 4, but with the data organized by US EPA Region with the data for Region 1 appearing at the far left of each chart and the data for Region 10 at the far right. These chart comparisons don’t suggest any geographical influence on the ratio of population served by all CWS to the 2010 census population, but a possible association between the population served by systems serving less than 10,000 people and state location is suggested as well as a similar association between the size of these small systems and state location. Because of the aforementioned uncertainties in the basic data from which these charts are derived, it doesn’t seem justified to attempt any quantification of these probable associations, but the likelihood seems strong that small systems in the middle to western part of the US represented by the center portions of the horizontal axes in these plots are generally larger and serve more of the total CWS populations.

Figure 6

Figure 7

Figure 8

Non-Community Systems

The US EPA defines non-community systems as either non-transient (NTNCWS) or transient (TNCWS). Exact definitions from EPA are (USEPA Website 2):

NTNCWS - A public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.

TNCWS - A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time.

As has been shown in previous paragraphs, these systems don’t supply a significant portion of the public water delivered in this country, but they are part of the small community segment of the industry as they generally serve fewer than 10,000 people. The numbers of NTNCWS is about the same magnitude as small CWS, the average per state being 357 with a minimum per state of 14 and a maximum of 1499. However, TNTCWS are more numerous because of their nature, the corresponding numbers for this category being 1646, 2 and 9,492. As with most of the parameters discussed in this evaluation, there is a wide variation in the numbers of both NTNCWSs and TNCWSs per state as is shown in the scatter plots of Figures 9 and 10.

Figure 9

Figure 10

However, when these same parameters are plotted by region (East to West), a curious demarcation in values seems to take place at Region 6 (Midwest) with the dispersion in the western half of the country being much less and the and the numbers of systems being fewer. The reason for these differences is not known.

Figure 11

Figure 12

**Discussion**

It is apparent from the data presented in the previous section that the nature of small public water systems has changed significantly since the rapid proliferation of these systems that began in the 1960s. To facilitate discussion of these changes, the current values of selected demographic parameters of these systems as reflected in the 2010 SDWIS Pivot Tables are summarized in Table 1.

Table 1

System Characteristics

**Characteristic Average Minimum Maximum**

Percent of 2010 Census Population Served by CWS 89 50 142

Percent of CWS Population Served by Small Systems 26 6 71

Size of Small Community Systems – Meters Served 469 121 1275

Number of Small Community Systems 919 73 4419

Number of Non Transient Non Community Systems 357 14 1499

Number of Transient Non community Systems 1656 2 9492

It seems obvious from these numbers and the accompanying scatter plots from the previous section that small community water systems no longer play a minor role in the provision of drinking water to significant numbers of the US population. Although the specific values of the numbers in the table are questionable because of known data errors in the pivot tables, the general magnitude of the numbers should be valid. It is quite probable that these small systems serve as much as a quarter of total served population on average and in numerous states this fraction may be 50 % or more. This observation is supported by personal experience of the author and communication with other professionals in the small system community. Water utilities that served 100 or 200 meters twenty or thirty years ago now frequently serve several thousand meters. In fact, although it is not indicated in this analysis, systems that a few years ago were clearly in the small system category currently serve far in excess of the arbitrary “small” cutoff of serving 10,000 or fewer people.

The scatter plots used in the previous section bring out clearly an additional attribute of these small systems – namely, the wide variability in system characteristics from one state to another. Moreover, it appears that for some parameters, geographical location plays a role in the magnitude of the parameter, e.g. meters served by small systems as reflected in Figure 8. Clearly, the “one size fits all” approach in actions affecting them is no longer appropriate for small systems if it ever was.

Finally, these data clearly emphasize the fact that although non community systems, especially transient ones, are large in number, they account for relatively little of the total public water supplied to US consumers. Curiously, the numbers of these systems per state seems to take a sharp drop at about midway in the country moving from East to West. The reason for this change, if it is not an artifact, is unknown.

**Summary and Conclusions**

A significant shift in the role of small systems in the total picture of the provision of public drinking water to the US population has occurred since the appreciable expansion of the number of these systems that began in the 1960s. Systems that initially served as few as 100 to 200 meters now frequently serve several thousand meters. Data from this study suggest that these utilities may now collectively supply a quarter or more of the population and in many states a much larger fraction, perhaps as much as 50 % or more. The data studied suggest an average size for these small utilities in the 400 to 500 meters served range. However, this may be somewhat misleading in regard to changes in the characteristics of small systems because this evaluation was limited to systems serving 10,000 or fewer people and it is known that many systems that were formerly in the “small” category now serve enough customers to have moved into the larger size classifications.

The characteristics of these systems vary widely from state to state, indicating that regulatory and other actions tailored to the assumption that a single approach will suffice for the small system community will not be realistic. Environmental justice considerations require that more localized approaches be used.

The impact and implications of these changes are numerous and several are presented in the following bullet list.

* Small systems should be considered as playing a significant and vital role nationally and in some states a predominant role in the provision of drinking water to the US population.
* Organizations that support the small system community may need to revise programs like training efforts to recognize the increasing size and accompanying sophistication of small systems.
* Programs, such as capacity development, based on the assumption that small systems in general are too small to be economically and operationally viable cannot be supported by current demographic data.
* Actions that affect small systems should be flexible enough to permit adjustment to fit local conditions recognizing the wide variation in system characteristics from one state to another.

**References**

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**USEPA Website 1**, http://water.epa.gov/scitech/datait/databases/drink/sdwisfed/index.cfm

**USEPA Website 2,** http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm