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Technical Assistance Needs and Research Priorities for Small Community Water Systems

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Drinking water supplies in the United States are among the safest in the world. This is primarily due to the system of national drinking water regulation and monitoring that began with the passage of the Safe Drinking Water Act in 1974. Currently, approximately 94% of the U.S. population is served by community water systems that meet all existing health-based standards (U.S. Environmental Protection Agency 2002b). However, the burden of meeting these regulatory demands falls most heavily on the nation's smallest systems. These systems face numerous community, economic, and environmental challenges in operating and maintaining their systems and meeting regulatory guidelines (Cromwell et al. 1992; National Research Council 1996; Shanaghan 1994).

Numerous initiatives have been employed to improve small systems' viability. Technical assistance programs from non-governmental organizations, funding assistance from state and federal agencies, promotion of regional approaches to water delivery systems, and operator training programs are some of the efforts that have targeted different facets of the small system problem. The most recent amendments to the Safe Drinking Water Act (1996) included many provisions that address the needs of small systems. One of these provisions authorized nine Technical Assistance Centers to serve small systems, including the Midwest Technology Assistance Center (Midwest Technology Assistance Center 2003). MTAC's mission is to "provide small system administrators and operators with the information necessary to make informed decisions on planning, financing, and the selection and implementation of technological solutions to address their needs" (MTAC 2003).

As part of its mission, MTAC sponsored a study to establish benchmarks of economic and managerial capacity for small systems (Dziegielewski et al. 2000). This paper reports on that benchmark study; specifically, it reviews (1) the status of drinking water systems in the Midwest and (2) the expressed need of system managers for assistance.

Small Water Systems in the Midwest

Many of the problems of small drinking water systems are directly related to their institutional, economic, financial, and physical characteristics. The following review of water system characteristics was prepared to support the workshop discussion, provide insight into the challenges of small system management, and suggest potentially beneficial research and intervention activities. Much of the information presented came from the Environmental Protection Agency (EPA) Safe Drinking Water Information System (SDWIS) data and annual "Factoids" reports, which are available on the EPA website (U.S. Environmental Protection Agency 2003a; 2003b). A second source of data was information collected during the MTAC benchmark study. This study was designed to solicit participation from the many different constituencies that make up the small drinking water community using a variety of interactive approaches. Details on the data collection components of this project can be

found in the final project report, which is available on the MTAC website (http://mtac.sws.uiuc.edu/finalrep.asp).

Review of USEPA Data for Midwestern Water Systems

The most obvious challenge in improving the management of small systems is the sheer number of systems. There are nearly 55,000 public water systems in the 10 states in EPA Regions 5 and 7, the area generally considered to be the Midwest. Nearly 80% of these systems are non-community systems that serve very small transient and non-transient populations. These non-community systems serve only about 10% of the nearly 58 million people in the Midwest who use public water systems. The other 90% of public water system consumers are served by community water systems (CWS), broadly defined as those that serve more than 25 persons, or 15 connections, year round (Table 1).

Economies of size are significant in water system operation and have a profound effect on system management. EPA defines small systems as those serving 3,300 people or less. Although small systems serve only about 10% of the community systems population, they constitute more than 80% of the total number of systems. Nearly 6,000 very small systems serve populations of less than 500. These smallest systems are at a distinct economic disadvantage.

The type of source water available determines the kinds of challenges a system will face in providing safe, affordable, and sustainable water services to its customers. Although groundwater systems must respond to fewer regulatory requirements, they may also be at risk from inappropriate wastewater disposal and agri-chemical pollutants. The great majority of water systems in the Midwest are groundwater systems (Table 2). Smaller systems are most likely to use groundwater sources.

System ownership also influences the economics and performance of water systems (Table 3). Systems controlled by local governments generally operate outside of the scope of state regulatory bodies that oversee rates, revenues, and record keeping. Local government systems have also had better access traditionally to subsidized loans and grants. Control of expenditures by these systems is also under the direct control of local officials, who are in-turn responsible to voters.

Nearly 60% of all community water systems are operated by local governments, and these systems serve more than 80% of CWS customers. As systems get smaller, the percentage of private ownership increases. Nearly 60% of very small systems are privately owned, however, more than half of the population of very small systems is served by local government systems (Table 4).

SDWA standards stipulate the maximum level of contaminants (MCL), required treatment techniques (TT), and monitoring and reporting requirements (M/R). Ultimately, SDWA compliance is the measure of water system performance of greatest importance to consumers and regulators. EPA is required to issue an annual report of national compliance, which includes a review of violations by systems size. Table 5 compares the number of SWDA violations by system size.

The proportion of total violations for the very small size category (73%) is much larger than the proportion of systems in this category (57%). Monitoring and Reporting (M/R) violations dominate all size categories (nearly 60% of all violations), and more than 80% of M/R violations are accounted for by very small systems. EPA considers MCL and TT violations to be the most serious and classifies these as health-based violations. These violations appear to occur in proportion to the number of systems in each size category. It should also be noted that violations by the few very large systems have the potential to affect a much larger number of people.

Survey Responses of Midwestern Water Systems

Additional details of the characteristics of small public water systems in the Midwest can be found by reviewing the 350 responses to the MTAC benchmarking study mail survey. Some of the characteristics of responding systems are:

Population served:
50% serve 500 customers or less
Water source:
57% groundwater; 23% purchased water
Ownership structure:
55% municipal
Age of systems:
44% built between 1951 and 1975; 20% pre-1951

Information from the survey responses was used to prepare the infrastructure, financial, and

Table 1. Number of Public and Community Water Systems and Population Served in the Midwest

System type	Number of systems	Population served by systems	Percent of CWS	Percent of population served
Public Water Systems	54,472	57,596,201	--	--
Community Water Systems	11,683	52,008,475	100	100.0
Small (≤3300)	9,750	6,278,475	83	12.1
Very Small (≤500)	5,899	1,090,037	50	2.1
Very Small (≤100)	2,359	141,086	20	0.3

Source: U.S. Environmental Protection Agency, 2003b

Table 2. Dependence of Midwest Community Systems on Groundwater. Number of Surface and Groundwater Systems in the Midwest with Percent of Populations Served

System	Ground-water systems[a]	Surface water systems[a]	Percent groundwater systems	Population served by groundwater systems
Community system	9,532	2,001	82.6	56.8
Small systems	8,513	1,237	87.3	80.0
Very small systems	5,648	469	92.3	89.8

Source: U.S. Environmental Protection Agency, 2003b
[a]Number of groundwater and surface water systems do not sum to totals above because some systems did not report water source.

Table 3. Ownership Structure of Community Water Systems in the Midwest

Ownership type	Number of systems	Population served	Percent of systems	Percent of population served
Local government	6,947	41,660,580	59.5	80.1
Private	4,443	9,748,141	38.0	18.7
Public/Private	146	242,148	1.3	0.5
State government	96	220,650	0.8	0.4
Federal government	31	130,808	0.3	0.3
Unknown	15	3,280	0.1	0.01
Native American	5	2,868	0.04	0.01
Total	11,683	52,008,475	100.0	100.0

Source: U.S. Environmental Protection Agency, 2003b

Table 4. Ownership of Very Small Community Water Systems

Ownership type	Number of systems	Population served	Percent of systems	Percent of population served
Private	3,472	460,466	58.86	42.24
Local government	2,259	595,312	38.29	54.61
Public/Private	101	20,295	1.71	1.86
Sate government	39	9,581	0.66	0.88
Unknown	13	1,049	0.22	0.10
Federal government	12	3,017	0.20	0.28
Native American	3	317	0.05	0.03
Total	5,899	1,090,037	100.0	100.0

Source: U.S. Environmental Protection Agency, 2003b

management "profiles" of small systems in the Midwest. In terms of infrastructure characteristics 40% of systems had no water treatment; another 10% reported chlorination only, and 80% operate storage reservoirs. Also, 24% of systems had no water meters; these were mostly mobile home parks or homeowner associations serving less than 100 people. The miles of transmission and distribution line per 100 connections were significantly greater for smaller systems. In terms of system growth, 59% reported increased population served over the past 5 years; 8% reported decreases.

With respect to the financial profile: 17% of systems reported total revenues that were less than total costs, 47% had no debt; 61% of systems were serving less than 500 customers, and more than 35% of the systems with less than 500 customers had no reserve fund. Also, 30% of systems received technical assistance in financial analysis, and 36% have used capital financing/grants/loans. In terms of water rates, the mean monthly charge was $25.80/6,000 gallons/month. Also, rates charged by municipal systems and groundwater systems were lower than average rates while systems serving 101-500 customers charged the highest rates. An interesting finding was that 51% of responding systems had no rate increase in the past 5 years.

Finally, with respect to the management profile, 50% had one or less full-time employee including 10% of systems that had no paid employees. Other noteworthy management characteristics indicate that: 30% had at least one M/R or MCL violation between 1996 and 1999, only 17% of systems reported "unaccounted for" water, 80% reported preparing some type of financial report or statement. However, 56% did not report enough information to calculate net revenues; most systems reported only revenues, and many systems did not report cost data. Only one-third of systems used financial indicators, while 30% received assistance in financial analysis, and 86% of systems serving over 1,000 people used contract services.

Implications for Operational and Financial Characteristics

Several summarizing statements can be made regarding the existing circumstances of small water supply systems in the Midwest:

-The very large number of small systems greatly increases the difficulty of regulatory monitoring and the provision of technical assistance.

-The dominance of private systems in smaller size range may make it more difficult to organize efforts to provide assistance.

-Greater reliance on groundwater makes small systems less likely to require expensive treatment but more difficult to assist if groundwater sources are affected by pollution or lowered water tables—two common problems in rural agricultural areas of the Midwest.

-The greater occurrence of safe drinking water violations in smaller systems requires investigation and remediation.

-Many aspects of the small-system profile point to the difficulties of effective operations and management: aging systems, one or less employees, low population densities, inadequate

Table 5. Number of Violations by System Size in United States for 2002

Description	System size					
	Very small	Small	Medium	Large	Very large	All
MCL violations	2,959	1,066	341	322	5	4,693
TT violations	1,279	662	226	222	19	2,408
M/R violations	59,415	12,787	4,488	3,363	582	80,635
Other violations	8,805	2,127	492	311	24	11,759
Total violoations	72,458	16,642	5,547	4,218	630	99,495
Percent total violations	72.8	16.7	5.6	4.2	0.6	100
Percent health-based viol.	59.7	24.3	8.0	7.7	0.3	100
Percent systems	57	27	9	6	1	100
Percent population served	2	8	10	36	45	100

Source: U.S. Environmental Protection Agency, 2003a[a]

[a]The Factoids report does not contain a size breakdown for violations by individual state. However, the percent of Midwestern systems with violations (26%) compares well the percent nationally (22%) as does the percent of the population served in the Midwest (23% in the Midwest versus 20% nationally).

record keeping, infrequent rate increases, expanding service populations, and lack of access to technical assistance.

These conditions point to the limited capacity of small water supply systems to deal with the mandates of the SDWA and maintain an adequate level of water supply services. System managers, technical assistance providers, and regulatory officials are all aware of these circumstances, and they presented numerous suggestions for how they might be addressed during the benchmark study. Some of these are discussed in the following section.

Expressed Needs of Small Water Systems

In each component of the benchmarking project, water system managers, technical assistance providers, regulatory officials, consultants, and researchers presented their experiences with managing and improving small systems. These comments were reviewed to identify problems and needs that could define the technical assistance, training, and research response from MTAC and other technical and financial assistance organizations.

Financial Issues

Financial issues, especially water rates, dominated the discussion in all research contacts. For example, the first question of the mail survey asked respondents to list and rank anticipated management decisions. The highest ranked decision was to increase water rates, followed by the need to expand water service to new areas, to locate funding assistance and the need to adjust rate structures. Other concerns cited by survey participants centered on infrastructure issues and restructuring actions.

The discussion and comments about water rates also focused on the chronic under-pricing of water services, often driven by local decision makers' desire to keep rates as low as possible. Financial performance was also hampered by poor record keeping, co-mingled community accounting systems, and the use of water system revenues to address other community needs. Finally, study participants reported that small systems almost inevitably lacked reserve funds to help them through difficult periods.

Infrastructure and Operational Issues

Numerous comments from participants pointed to the need for most small systems to replace antiquated and inadequate infrastructure. Aging transmission and distribution lines were cited as the system component most in need of replacement. It was also reported that small systems find it difficult to find and retain trained, certified water systems operators and knowledgeable municipal or water board decision makers who understand the consequences of poorly financed water systems. Finally, managers are uncertain as to how and when

to consider restructuring alternatives such as purchasing treated water from a nearby system, selling their system to a larger entity, or pursuing some form of contract or remote management.

Financial Assistance Issues

Contradictory viewpoints were expressed on the topic of financial assistance. One perspective was that grants or low interest loans used to rescue failing systems actually provide a perverse incentive for poor management. The other viewpoint was that the highly structured loan repayment programs set up by lenders such as the USDA Water and Wastewater Program were instrumental in promoting fiscal responsibility and good record keeping. Study participants also found it difficult to locate and access funding assistance. Technical assistance organizations that provide financial information and training did receive high marks whenever they were mentioned by study participants. However, they were mentioned very infrequently in the study components, and private consultants (accountants, engineering firms, bankers, etc.) were cited most frequently as the providers of assistance on financial matters.

Communication Issues

A failure to communicate effectively appears to be at the core of many small system problems. Failure to communicate a water system's financial position to consumers makes it difficult to earn their support for new fees or rate increases to support needed system expenditures. A similar failure in communication with elected officials and water boards prevents these decision makers from responding to urgent systems needs in a timely fashion. Poor communication between water systems prevents the exploration of cost-saving cooperative efforts, such as sharing of personnel or expensive equipment, development of emergency interconnections, and money-saving bulk purchasing of supplies. Finally, a surprising number of comments expressing distrust of government agencies and other water systems were recorded during the study.

Community Issues

Many respondents linked water system performance to community capacity or the resources and abilities within the community itself. Poor water system management was often a reflection of poor community management. Communities with a high percentage of low-income residents or senior citizens on fixed incomes are often the most vulnerable. Community commitment is critical to the operation of effective community water systems, and virtually all best-performing water systems are run by an individual or group of individuals who are willing and able to demonstrate leadership and commitment.

Implications for Training and Research

Technical Assistance and Training

The shortcomings and difficulties in managing small water systems point to a continuing need for technical assistance and training. Our research indicates four areas where technical assistance and training are most needed.

Development and implementation of water rates

The topic of water rates dominated participant feedback. System managers, technical assistance staff, and regulatory officials all commented on the difficulties of establishing full-cost pricing and the inability of many systems to raise adequate revenues. Standardized methods of rate calculation would provide water managers and governing boards with an externally validated way of translating costs and revenue requirements into customer charges.

Financial management training

Accurate records are required to prepare effective water rates and calculate financial performance measures. Only four out of 10 participating systems prepared monthly financial reports, and only half reported using an annual budget. Training and assistance to develop standardized record keeping procedures would benefit small systems. This financial training would be most effective if it included village/system clerks as well as appointed or elected "decision makers." Improved systems to access information on funding sources for small water systems would also be beneficial.

Improved communications

The management and financial needs of small water systems are rarely well understood by members of the communities they serve or even

their own rate-setting bodies. The actions taken to provide safe and reliable water are largely invisible, particularly when efficiently done. Consequently, consumers will only learn to value these services when system costs and needs are clearly communicated. Water system operators could benefit from training in techniques that help them to communicate system needs to the community decision makers and to the public. Even very small communities would benefit from careful preparation of periodic public awareness events and press releases to the local media.

Improved delivery of technical assistance services

Only 30% of survey respondents had used the services of technical assistance providers. There appears to be a need to explore avenues for enhanced opportunities for technical assistance to small water systems. Two possible improvements were suggested by study participants: (1) development of a system for coordinating technical assistance from different sources and (2) development and implementation of "peer-to-peer" technical assistance within states or small regions that cross state boundaries.

Research Needs

While the existing knowledge base on the physical, financial, and management aspects of small water systems is substantial, several areas of additional research may be beneficial.

Case studies of best-performing systems

The development of a peer-to-peer assistance programs would require a method to identify a set of best small water systems. One repeated observation from the MTAC benchmarking study was that most small systems already provide safe, affordable water services. Case studies could demonstrate the paths and techniques that these best performing systems used to achieve sustainability. Troubled systems can learn from their example.

Consumer perception of water prices and costs

Consumer opposition to periodic water rate increases is a serious obstacle to the improved financial management of small water systems. Research on the consumer perceptions of the costs of water supply in their community as well as the acceptability and affordability of water rates would be beneficial to system managers and governing bodies. Misconceptions and unreasonable expectations about the real costs of water system operations are likely to underlie much of the opposition to increased water rates. It is important to emphasize that any study of consumer perception should be supported by an analysis of system water rates to ensure that system managers and decision makers in study communities are indeed following a path of least-cost for the provision of water supply services.

Criteria for sustainability and restructuring alternatives

Caught between aging systems, a history of inadequate rates, and myriad other problems described by participants in the MTAC benchmarking report, a substantial number of small community systems are currently facing the possibility of restructuring. System managers need a set of criteria that would help them to determine whether to make the substantial financial investment required to maintain independent services or to turn over some or all of their operations to external service providers. System managers would also benefit from knowledge of their restructuring options and avenues for entering into negotiations with other providers.

Purchased water contracts and regionalized alternatives

Increased regulatory stringency, depletion and pollution of local water sources, and economies of scale in water treatment all suggest that purchased water arrangements will become an increasingly attractive option for improving water services to small communities. Participants in the benchmarking study reported both successful and problematic institutional arrangements for purchased water services and other regionalized arrangements. Documentation of these arrangements and the lessons learned during their development would be beneficial for system managers who are considering such actions.

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