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On Managing Texas Rural Water Supply Systems: A Socioeconomic Analysis and Quality Evaluation

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RESEARCH PROJECT COMPLETION REPORT

ON MANAGING TEXAS RURAL WATER SUPPLY SYSTEMS: A SOCIOECONOMIC ANALYSIS AND QUALITY EVALUATION

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R.N. Singh

Section One:

Introduction

Research Objectives

The study reported here is aimed at evaluating the effectiveness of nonprofit, rural water supply corporations or water systems (hereafter referred to as RWSs) in Texas from a sociological perspective. Specifically, the study has attempted to:

1. Provide an overview of the organizational structure and functioning of RWSs, identifying their existing as well as emerging needs, problems, and suggested solutions. It explores socioeconomic characteristics and patterns of RWSs in Texas. It outlines a history of state and federal regulations and practices through which these systems are structured and actually function.

2. Evaluate the quality and effectiveness of the management of selected RWSs located in different geographical regions of Texas. The evaluation of effectiveness of systems is accomplished through a systematic set of procedures and techniques. These procedures are tested for reliability and validity through empirical data. In addition, the differential levels of program effectiveness of RWSs are elaborated upon by correlating them with relevant socioeconomic variables.

3. Indicate policy and research implications of data for dealing with the future of rural water systems.

Expected Contributions

The rural populations in the U.S. started experiencing steady increases during the 1970s and early 1980s (Goodwin et al., 1984). Although the rural population growth at the national level showed a few differential trends during mid to late 1980s (Figures 3 and 4 in Appendix A), the state of

Texas registered a population influx in many nonmetropolitan areas during the last decade (U.S.D.A., 1990: 11). Overall, a significant portion of Texas' population still resides in rural areas (Texas Department of Water Resources, 1984: 7). However, it appears that a larger number of studies have focused on water-management related problems and issues for urban areas than those for rural communities in Texas (e.g., Knudson, 1986; Meier and Thorton, 1973; Murdock et al., 1988; Texas Department of Water Resources, 1985; Texas Water Development Board, 1990;[1] and U.S. Army Corps of Engineers, 1989). While rural water problems have been examined carefully in several parts of the country,[2] we could not find a single study in Texas systematically examining water-related needs and issues confronting rural communities. The need to study rural water supply has become even more important now because of the challenge faced by small community systems in complying with the provisions of the 1986 Safe Drinking Water Act (SDWA). These small systems, with their limited customer and revenue bases, will face formidable expense in installing new water treatment methods (Jensen, 1990; Long and Stukenberg, 1987: 38; Texas Water Development Board, 1990: 14). The present study is a timely probe into the phenomena of rural water supply.

The study is aimed at developing and using a methodology to evaluate the program effectiveness of RWSs. In recent years, interest has mounted for employing the research techniques of social sciences in efforts to assess the effectiveness of public programs.[3] The 1970s and 1980s, decades of rapid-paced growth of RWSs in Texas and elsewhere, were marked by the proliferation of public expenditures. The study uses a set of indicators to identify effectiveness and efficiency of rural water projects. Such measures for analysis and appraisal of these projects may contribute to more informed and intelligent planning for the future. The study is also expected to provide a critical

probe and insight into an evaluation methodology that may be used in future studies investigating public programs. To this end, the research reported here is exploratory in nature and may set grounds for more critical studies in the area. The study, for example, develops a baseline against which to measure future changes and trend in rural water supplies in Texas as well as in other parts of the country.

Organization of the Report

The remaining three-section organizational design of this report emerged from the objectives of the study stated earlier. The second section presents an overview of the history, organizational structure, and functioning of the RWSs in Texas. The third section includes a systematic outline of methodology employed for evaluating the effectiveness of RWSs in Texas. It presents the major findings from surveys conducted in two phases. Data from both phases are presented and interpreted. Finally, the fourth section is meant to provide a summary of conclusions and implications of the study. Selected notes, elaborating on particular points, are given just before listing the references used in the study. Selected figures and tables as well as data collection instruments used during the two phases of research are enclosed in two appendices.

Section Two:

Overview of Texas Rural Water Systems

The major objective of this section is to provide a general understanding of the history, organizational structures, and operational procedures involved in the functioning of rural water systems (RWSs) in Texas. This section will, therefore, provide a background to the next section on an in-depth effectiveness analysis of selected systems.

Methods and Procedures Used

The following procedures were employed in preparing an historical and operational profile of the RWSs.

First, extensive reviews of literature relevant to rural water and content analyses of available reports (e.g., from the U.S. Bureau of Census) were made.

Second, secondary data on RWSs were collected from records provided by such agencies as Farmers Home Administration (FmHA), U.S. Environmental Protection Agency, Texas Rural Water Association, and Texas Department of Health. Several officials of these agencies were intensively interviewed through open-ended questions on history, goals, organizational structures, and operational problems and needs of RWSs in Texas.

Third, a survey of the 18 district offices of FmHA in Texas was conducted. A questionnaire (Appendix B) was mailed to the executive directors of all districts. Information was requested on the following matters: (1) number of RWSs in the district, (2) ethnic composition of customers is these systems, (3) status of loans to systems, and (4) operational problems and needs of systems.

Fourth, Delphi procedures[4] were employed to identify and rank goals, operational procedures, needs, problems, and perceived solutions of problems. A group of experts, comprised of key officials from agencies mentioned earlier,

was selected. A total of 14 experts was interviewed in two rounds. The data collected during the second round were restricted to items on which experts had a low level of consensus during the first round. Standard deviation on items represented a degree of consensus among respondents, while a mean response on items was an indicator of the degree of their relative importance.

Characteristics of Rural Water Systems

The history of rural[5] water supply in the world is not laudable. A U.N. study in 1975, for example, established that 80 percent of the world's rural population had no reasonable access to a safe water supply, and 85 percent had no sanitary water disposal system (Tebutt, 1983: 3). While the rural conditions in the U.S. are not as pathetic, concerns about water quality and health continue to be expressed about rural people, particularly those belonging to lower-income classes (Brown and Ingram, 1987). Statistics compiled by the U.S. Department of Agriculture (1971) revealed that about one-fifth of the rural population in 1970 had no access to public water and sanitation system. Rural housing, particularly occupied by lower-income people and blacks, is also known for having inadequate plumbing and water availability (Figures 5 and 6, Appendix A).

The rural water corporations (similar to rural electric cooperatives) were established under the USDA's Rural Development program by the 1961 Consolidated Farmers Home Administration Act and its 1965 amendments. Since then, the federal government has provided low-interest loans and grants to develop water facilities for rural communities. The policy has been based upon a desire to slow rural-to-urban migration by providing rural residents with employment opportunities and community services that are comparable to those in urban areas (Goodwin et al., 1979).

The state of Texas perhaps has the largest number of nonprofit rural water corporations in the U.S. There are approximately 900 such systems in the state. Over 90 percent of these serve communities of 2500 people or less. In addition, there are over 400,000 individually owned and operated wells and approximately 4,500 private-utility companies selling water in rural Texas (Jensen, 1985). The geographical distribution of private and public sources of rural water supply is summarized in Table 9 and Figure 7 (Appendix A). Our estimates, based on secondary data provided by FmHA and Texas Rural Water Association, show that Region #7 (South Texas and the Lower Gulf Coast) has the highest ratio of rural households using water from nonprofit RWSs (Figure 8, Appendix A).

While families below the poverty level are spread around all geographical regions of Texas, the regions with a greater proportion of nonwhite population have a higher predominance of families without plumbing (Figures 9, 10, 11, and Tables 10 and 11, Appendix A). It is interesting to note, however, that geographical Region #2 (High Plains and Trans-Pecos) not only has the highest average of population engaged in agriculture, but also has the lowest proportion of families (including those belonging to nonwhite ethnic origin) without plumbing (Figures 9 and 12, and Table 12, Appendix A).

Goals of RWSs

Almost all executive directors of FmHA and most of the experts in our Delphi survey reached a consensus that the first and the primary goal of RWSs is to provide water supply to rural residents. Water supply to nonresidential entities (e.g., industrial, business, schools, etc.) was considered to be a minor or secondary goal of these systems.

The second major goal of RWSs is to keep the cost of water supply to a "reasonable" level. This is considered to be a challenge. The actual cost of water supply in rural areas is higher than in metropolitan areas.[6] Regnier et al. (1986: 41), therefore, point out that recent federal and state legislation recognizes these differences by including variances that make allowances for the financial and operational inability of many small systems to meet water quality regulatory requirements.

Third, RWSs are aimed at providing quality water on a regular and sustaining basis. The water quality can be monitored more easily by these systems than for privately owned wells.

Fourth, RWSs may have prospects of developing additional services (e.g., sewerage and fire protection) in the long run.

Fifth, a RWS provides people with a sense of community. It generates a source of identity among rural residents and helps them to seek resources to meet essential needs such as water. Unlike private utility companies, which serve their clients for profit, the RWSs are "community systems" whose major orientation is to develop communities and improve their quality of life.

The ranking of the above-stated goals and roles of RWSs may vary among rural residents as well as professionals in the field and may also change over time. However, the above goals were ranked by our respondents in terms of importance for the current rural population in Texas.

Operational Procedures

Establishing a RWS involves several procedures. The first of these is for individuals interested in forming a RWS to organize a nonprofit corporation. Generally speaking,

a minimum number of housing and commercial units and a demonstration of financial feasibility are needed to acquire the loan from FmHA in order to cover the construction costs. The water may be extracted from aquifers, piped and treated from surface reservoirs, or bought from public (e.g., a municipal) and/or private sources. Since the RWS is a public corporation, it is fully subjected to all major inspections and regulations[7] by FmHA, U.S. Environmental Protection Agency, Texas Department of Health, Texas Water Commission, and so forth. Some of the state requirements (see TRWA's Tariff for Texas Water Supply Corporations, 1989), for example, mandate that RWSs must (1) employ or contract services of a certified operator of the system, (2) submit water samples periodically for analysis, (3) file periodic reports of operations and accounts, and (4) treat water for quality. The corporation is managed by a board of directors whose qualifications, election methods, and responsibilities are prescribed by the articles of incorporation.

Problems and Solutions

Selected problems and suggested solutions are summarized below. All problems and solutions are presented in a rank order (from most important to least important) based on the Delphi survey of experts.

1. Inadequacy of Water Supply

Most of the water professionals believe that a large number of RWSs are poorly planned. Many of these systems are currently inadequate in meeting water demands of residential and commercial customers. Many will become inadequate in a few years, because they were built with short-sighted rather than long-range planning. Some of the experts estimated that over one-half of RWSs in Texas have already overextended themselves by continuing to add customers over the past years. Several systems now have to turn down new applicants

for water connections, because the water pressure in pipes is already low and the water supply cannot be increased.

Additional funding and technical assistance are needed for adequately planning the RWSs in Texas. Increased efforts are needed for constructing new water impoundments and/or adding to the existing storage. RWSs continuously need to update their plans.

2. Increasing Costs of Water Supply

RWSs in Texas are self-supporting enterprises through water-sale revenues and are, therefore, not subsidized through local taxes or bonds. Experts in the study strongly felt that costs of operating these systems continue to go up. The systems have limits in continuously raising water rates,[8] and without additional financial resources many will face serious crises.

One of the major ways many of the RWSs can be saved from financial bankruptcy is to convert them into either Municipal Utility Districts (MUDs) or Special Utility Districts (SUDs).[9] Another way of cutting down operation costs is to consolidate contiguously located RWSs in several regions of Texas (e.g. northeast Texas).[10] Finally, realistic rate setting is needed in order to cover all costs of operation.

3. Poor Management

RWSs at large have inefficient systems of managing accounts and records. Many systems do not employ certified operators on full-time, regular, or stable bases. Several of them do not conduct auditing of records and accounts on a regular basis. It is often customary for managers to blame directors (and vice versa) whenever issues of inefficiency arise.

RWSs need close scrutiny of their management skills as well as procedures. They need periodic evaluations of their operations. Additional regulations are needed to hold RWSs accountable for recordkeeping and management practices used. Most of the experts in the study believed that all RWSs should join Texas Rural Water Association and attend its meetings and workshops in order to update their knowledge and management skills.

4. Power Struggle Among Directors

Many RWSs are plagued by conflicts and power struggles among community members who are in leadership positions. Technical staff members are often handicapped by arbitrary decisions made by the governing boards.

The integrity and functional autonomy of technical-professional staff members need to be protected through reforms in the governing structures of RWSs.

5. Water Quality Problems

RWSs are cited more often by the Texas Department of Health than urban systems for violations of water quality requirements.[11] Many RWSs suffer from inadequate and irregular chlorination, water contamination and inadequate water treatment facilities.

RWSs need technical as well as financial assistance for complying with the new regulations of the Safe Drinking Water Act (SDWA, 1986).[12] The systems may need drastic modifications in their operational and maintenance procedures in order to prevent increasing trends in water pollution.

6. Water Loss

It is estimated that over half of all RWSs in Texas report an annual water loss of over 20 to 25 percent of the total amount of water supplied.[13] Leak detection in RWSs is generally inadequate and technologically primitive.

RWSs need technical assistance from state and federal agencies in detecting as well as controlling water loss.

Section Three:

Evaluating Effectiveness of Texas Rural Water Systems

This section reports the major findings of empirical research on RWSs in Texas. Methodological procedures used in the study are described, and data are presented and interpreted.

The study was conducted in two phases. Officials of selected RWSs were surveyed during the first phase, January 1989 to April 1989. Residents, or consumers, from selected RWSs were surveyed during the second phase, December 1989 to March 1990. Research methods employed during the two phases along with the major findings are summarized below.

Phase I. Survey of Officials of RWSs

This phase of the study was concerned with the following objectives:

1. To develop a scale of effectiveness providing indicators and evaluation of the RWSs program in Texas.

2. To test the reliability and validity and resulting reformulation of the effectiveness scale through empirical data.

Construction of the Effectiveness Scale

The growing emphasis for accountability by federal and state agencies is currently requiring additional attention to the program evaluation of RWSs. Several factors have contributed to the demand for accountability. Among these are increasing problems of RWSs (stated in the last section of this report) and growing public expectations of the quality and availability of water in rural communities. One of the major goals of the present study was to develop or construct a measurement instrument, or scale, that would identify and indicate differential levels of effectiveness among various RWSs. A well-designed instrument for assessing

effectiveness can provide crucial information for planning and intervention.

A scale measuring effectiveness of RWSs was constructed through a sequence of procedures summarized below.

First, an initial list of typical indicators of program effectiveness was developed through a systematic review of literature relevant to organizational effectiveness and rural water management (e.g., Hall, 1988; Parsons, 1977;[14] Ruthman, 1987). In all, 38 scale items were constructed under four areas of RWS management activities. The areas were: (1) goals, nature, and scope of service delivery; (2) quality of water-service delivery; (3) organizational and operational management; and (4) level of maintenance. Scale items were classified under these four categories on the basis of conceptual relevance and face validity of each.

Second, eight judges were selected from professionals in the areas of geology, agricultural economics, rural sociology, civil engineering, and marketing. Five of these judges were working in federal and state agencies dealing with the rural water work. Every judge was asked to indicate the level of importance for each of 38 items, from the most important to least important. Items under each of the four categories then were ranked on the basis of mean (showing level of importance) and standard deviation (showing level of consensus) scores of every item received from judges. Items which were consistently low on consensus and/or importance were either modified or dropped from further usage. Twenty-two items (7 for service delivery, 3 for service quality, 9 for management, and 3 for maintenance) then were incorporated into the final scale (Table 1).

Table 1

Variables Included in Scale on Effectiveness of Rural Water Systems

Variable Number	Variable Label	Mean	Std. Dev.
	I. Service Delivery		
01	Whether goals of RWS well-defined	2.21	.56
02	Whether new connections available to prospective customers	1.65	.87
03	Whether any customers denied access to water	1.48	.52
04	Whether use of service increasing, decreasing, or staying the same	1.56	.59
05	Whether water supply adequate or inadequate in meeting demands	1.75	.65
06	Whether there are perceived problems of water delivery by officers of water system	1.91	.75
07	Whether there are customer complaints about delivery	1.39	.39
	II. Quality of Service		
08	Whether admit to be in violation of EPA/Texas Health Dept. water quality standards	1.47	.49
09	Whether received customer complaints on water quality	1.64	.53
10	Whether mention specific water quality problems	1.43	.57

Table 1 (continued)

Variable Number	Variable Label	Mean	Std. Dev.
	III. Management		
11	Whether or not have certified staff	1.08	.49
12	Whether operation costs higher/equal/ lower than income	2.33	.81
13	Whether operation costs increasing/decreasing/ staying stable	2.69	.54
14	Whether test water quality regularly	1.88	.66
15	Whether report customer complaints on water quality	1.31	.41
16	Whether report specific problems of water quality	1.66	.51
17	Level of water loss reported	2.93	.81
18	Condition of records of accounts and operation	2.81	.79
19	Regularity of chlorination of water	1.99	.69
	IV. Maintenance		
20	Level of maintenance of the water system	2.03	.72
21	Whether a regular schedule of maintenance followed	1.77	.53
22	Whether alternative source of maintenance explored	1.15	.39

Empirical Reformulation of the Scale

Next, 150 RWSs in Texas were selected randomly from a computer list of about 900 water corporations provided by the Texas Rural Water Association. One official (operator or manager) from each water system was interviewed by telephone. A questionnaire (Appendix B), consisting of closed and open-ended questions on the effectiveness scale as well as on other socioeconomic variables, was used for data collection. In all, 122 telephone interviews were completed, 108 of which were usable for the study. Officials of 28 RWSs were unable to participate in the study due to a variety of reasons. Three interviewers took about four months in completing the interviews, each of which took about 45 minutes average time.

Data from 108 officials were subjected to analysis through the Statistical Package for Social Sciences (SPSSX) program. Responses of officials on the 22 effectiveness scale items were subjected to factor analysis to determine which of these items should be included in the final scale to assess effectiveness of RWSs. Empirical verification of the scale provides clues to its reliability and validity.

Factor analysis. The factor analysis (using principal components analysis with oblique rotation) was performed on the variables conceptually incorporated into the scale. Oblique rotation (Spanier, 1976) was used, because the factors (subscales) were considered to be interrelated. The factor pattern matrix coefficients, or loadings, shown in Table 6 were used to determine how well each of the scale items correlated with the given subscale and, therefore, served as an initial indicator of the validity of the subscale. The communality scores of each variable, showing the proportion of variance in the variable explained by all the factors, also is presented in the table. A variable was considered a component of a factor (subscale) if that

variable had a factor loading of .50 or above. It should be noted that Variables 1, 10, 12, 13, and 22 did not load on any of the three subscales; these were deleted from further consideration in the scale. Also, the fourth subscale on maintenance, as shown earlier in Table 1, was merged with the third subscale on management in Table 2. Variables 20 and 21, which conceptually were believed to indicate maintenance, loaded strongly on the management subscale, and were, therefore, incorporated in that subscale.

Reliability and validity of the scale. The mean scores, standard deviations, and Cronbach's alpha for the three subscales and the overall effectiveness scale are shown in Table 3. The alphas support the reliability of the subscales and the overall scale and justify the incorporation of the three subscales into the overall scale.

Support for internal consistency among items is indicated by data in Table 4, which show intercorrelations among these factor-analysis derived subscales as well as the correlations of the subscales with the overall effectiveness scale. As indicated in the table, intercorrelations among the three subscales and the overall scale are quite strong.

A partial demonstration of the validity of three subscales and the overall effectiveness scale is accomplished through procedures of construct validation. We have attempted to see if the subscales and the overall scale are correlated with measures of other theoretically related variables. Thirty- four variables are selected for this purpose, and their correlations (in terms of Gamma and Pearson's r values) with the levels of effectiveness scale are given in Table 13 (Appendix A). Many correlation coefficients, given in Table 13 (Appendix A), are indicative of consistently predictable relationships between levels of effectiveness of RWSs (as measured through the overall

Table 2

Communality and Subscale Factor Loadings of Scale on Effectiveness of Rural Water Systems

Variable	Communality	Factors		
		1	2	3
		Service Delivery	Quality of Service	Management and Maintenance of RWS
02	.79	.82		
03	.69	.79		
04	.71	.69		
05	.82	.71		
06	.84	.82		
07	.92	.79		
08	.97		.89	
09	.79		.73	
11	.70		.69	
14	.83		.91	
17	.90		.89	
15	.62			.76
16	.76			.85
18	.69			.94
19	.82			.89
20	.79			.79
21	.86			.81

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .79
Bartlett Test of Sphericity = 2901.18, p = .00.

Table 3

Descriptive Statistics and Reliability Coefficients for Subscales and the Overall Effectiveness (of RWSs) Scale

Subscale	No. of Items	Mean	Std.Dev.	Alpha
Service Delivery	6	15.45	7.16	.85
Quality of Service	5	16.91	6.71	.79
Management and Maintenance of RWS	6	20.32	4.02	.91
Overall Effectiveness Scale	17	52.28	16.64	.86

Table 4

Intercorrelations Between Subscales and Overall Effectiveness Scale of RWSs

Subscale	2	3	4
1. Service Delivery	.64	.55	.69
2. Quality of Service		.79	.81
3. Management and Maintenance of RWS			.86
4. Overall Effectiveness Scale			

All correlations significant at .001 or less.

scale) and socioeconomic variables. These correlations are elaborated under the following heading.

Explaining Differential Levels of Effectiveness

Data in Table 13 (Appendix A) show that those RWSs that have a relatively higher level of operational effectiveness than others are likely to: (1) have not actually committed violations of the Texas Department of Health codes of water quality; (2) have relatively fewer residential water connections; (3) have not denied water connections to potential customers; (4) be relatively smaller systems in terms of number of miles of pipes; (5) be single-county systems; (6) have both farm and nonfarm (rather than predominance of either) populations; (7) have relatively fewer or no water wells (i.e., those that use surface water or buy water from sources other than ground water); (8) have balanced budget in terms of their operating costs and income; (9) admit to not having committed EPA violations of water quality standards; (10) have relatively complete set of official records of accounts and other operations; (11) dislike stricter federal and state regulations of rural water supply; and (12) have a larger percentage of whites and a lower percentage of blacks and Hispanics in RWSs. Variables that have no significant direct relation to levels of effectiveness of RWSs included (1) job title or position of respondent in RWS, (2) number of years respondent had held that position, (3) number of commercial connections, (4) whether or not new connections were available, (5) whether or not customers pay for pipes, (6) total number of full- time and certified staff members, (7) whether water use is increasing or decreasing or staying stable, (8) type of rate structure, (9) whether or not system rations water, (10) source of maintenance of RWS, (11) whether or not maintenance schedule is followed, (12) source of funding of RWS, (13) whether or not the RWS is a member of Texas Rural

Water Association, (14) whether or not FmHA has sold the system's loan to some other organization, (15) whether or not the RWS wishes to merge into a MUD, and (16) whether or not an RWS has made future projections of its growth.

Explaining Water Quality Violations

By using chemical-analyses data provided by the Texas Department of Health for 1988-89, we were able to identify exactly which of the 108 RWSs completing the survey had actually been cited for violations of primary and secondary water quality standards. Of 108 RWSs, 35 had received citations during the stated period. An attempt was made to see which of the socioeconomic characteristics of RWSs best explained why some of these systems had violated the standards. Bivariate data in Table 14 (Appendix A) show that those RWSs which had violated standards were likely to: (1) be relatively larger in size, particularly in terms of the number of residential connections, miles of pipe used, and the number of full-time staff members; (2) have denied water connections to prospective customers; (3) be multi-county systems; (4) be the ones whose loans had already been sold by FmHA to another agency/bank; (5) be the ones who relied on financial sources other than customers for their operation; (6) have a lower percentage of whites and a higher percentage of blacks and Hispanics as customers; and (7) have a lower level of operational effectiveness.

The correlation matrix, given in Table 5 (also see Figure 1) is indicative of intercorrelations among the major variables, some of which are indicated in the preceding paragraph. A few generalizations based on those intercorrelations are stated below.

1. RWSs that have a higher percentage of nonwhite populations are more likely to violate Texas Department of Health regulations and be less

Table 5

Correlation Matrix Showing Intercorrelations Among Variables in the RWS Officials' Survey

	1	2	3	4	5	6	7	8	9
1									
2	-.39**								
3	.36**	.14							
4	.32**	.01	.61**						
5	-.23*	-.36**	.15	.28					
6	-.11	.24*	.14	-.05	-.09				
7	-.01	-.25*	-.07	.09	-.18	-.27*			
8	-.14	.24	.27*	.31*	.04	.09	.21		
9	.22	-.09	.48**	.32**	.18	.02	-.08	.50**	
10	-.31**	.38**	.21	.19	.16	.16	-.21	-.06	-.16

*Significant at the .01 level
**Significant at the .001 level

List of Variables
1 Whether received Health Department citations
2 Racial composition in RWS.
3 Number of resident connections
4 Miles of pipe
5 Whether customers denied water
6 Condition of records
7 Operation cost
8 Number of certified employees
9 Number of full-time staff
10 Effectiveness of RWS as perceived by managers

Figure 1

A Path-Like Model Showing Significant Intercorrelations (at .01 or less) Among Levels of Effectiveness of Rural Water Systems (RWSs) and Selected Variables

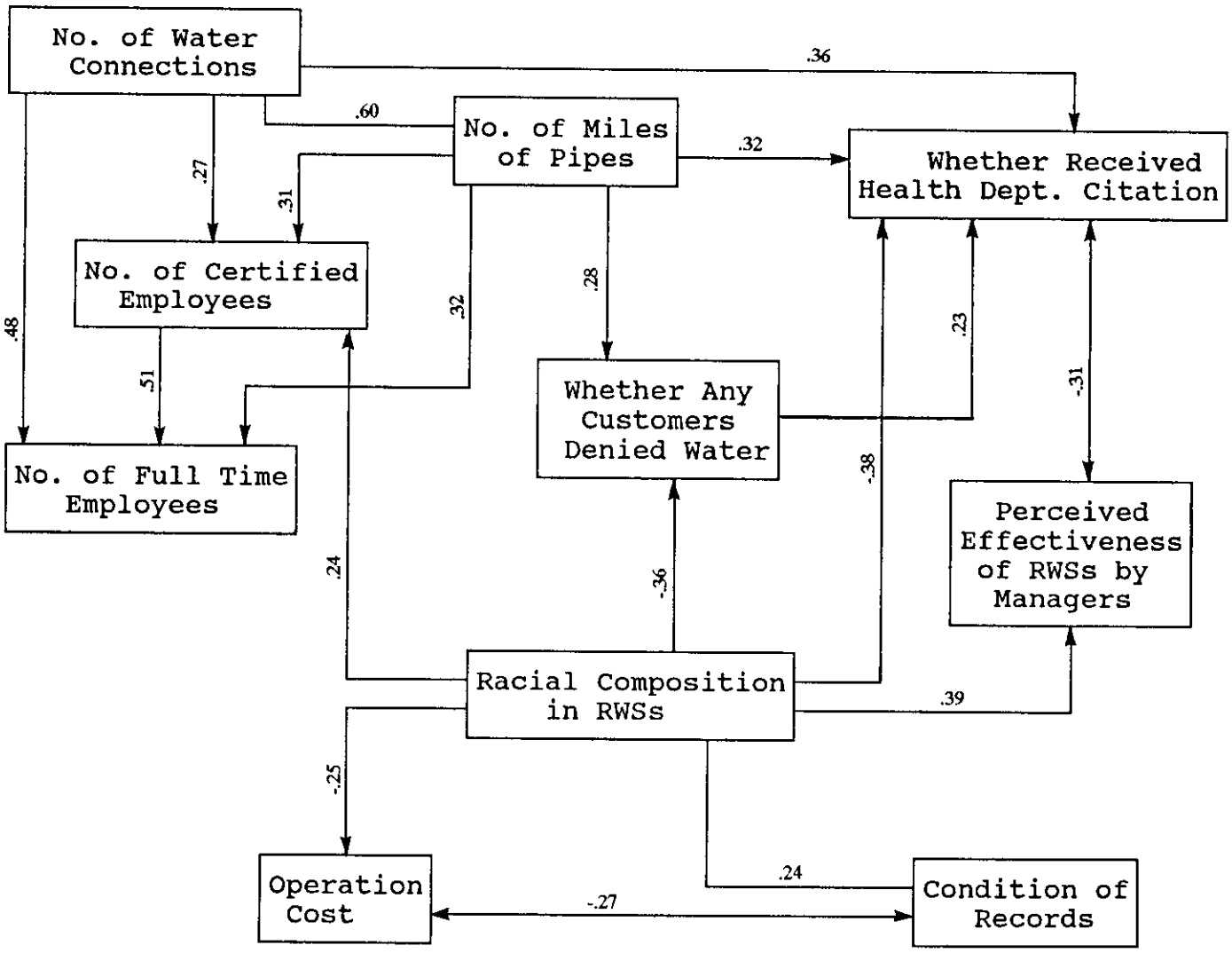

Table 6

Summary of Regression Analysis of Effects of Selected Variables on Citations Given by Texas Department of Health to RWSs

Dependent Variable: Whether RWSs Received Health Dept. Citations			
Independent Variables	Beta	F	P
Perceived Effectiveness of RWSs by Managers	-.36	42.75	.00
No. of Water Connections	.11	4.32	.36
No. of Miles of Pipe	.19	5.39	.20
Whether Any Customers Denied Water	.16	3.06	.32
Racial Composition of Consumers in RWS	-.23	13.71	.00
R2=	.38		
Constant=	3.73	181.42	.00

majority of them had received water from their system for less than ten years. However, 32 percent knew someone who had been denied a water connection. While most of the water users planned to continue using water, only a few favored mergers of their RWS into a municipal district, a special utility district, or contiguous systems. A vast majority of consumers paid less than $50 for their average monthly water bill. However, over 41 percent complained of water bills being "too high." About 45 percent of respondents stated that a RWS helped their community in ways other than just providing water, and over 42 percent believed that their system provided them a sense of community. However, relatively fewer customers participated in the RWS's operation. A large number of consumers complained of various problems they had with their RWS. However, most of them were rather positive in their evaluation of the RWS's effectiveness, and over 44 percent were optimistic about its future. Over 72 percent of respondents were male; a majority belonged to the middle-age groups and had three to four members in their family; a majority were white and homeowners; and over three-fourths of them had a family income of under $30,000.

Factors Related to Water Users' Perceived Effectiveness

An attempt was made to estimate how the water users' perception of the RWSs effectiveness would correlate to selected socioeconomic factors. Data on bivariate correlations are given in Table 16 (Appendix A). Inter-correlations among all major variables are given in Table 7 and depicted in Figure 2. Finally, the regression analysis of the effects of selected variables (those statistically significant in bivariate correlations) on the consumers' perception of effectiveness is presented in Table 8. The major trends in relationships, shown in these tables and figure, are summarized below.

Table 7

Correlation Matrix Showing Intercorrelation Among Variables in the Consumers' Survey

	1	2	3	4	5	6	7
2	-.08						
3	.02	.32**					
4	.29*	.28*	.21				
5	.03	-.47**	-.38**	-.41**			
6	.03	.40**	-.32**	-.34**	.73**		
7	-.07	-.34**	.31*	-.10	.18	.21	
8	.20	.50**	.32**	.38**	-.32**	-.20	-.37**
9	.20	.56**	.59**	.42**	-.40**	-.35**	-.46**
10	.21	.52**	.22	.22	-.28*	-.24	-.38**
11	.11	.52**	.14	.26*	-.43**	-.44**	-.32**
12	.13	-.37**	-.17	-.19	.53	.56**	.22
13	.01	.06	.01	.08	-.25*	-.42**	-.09
14	.04	-.45**	-.10	-.17	.49**	.46**	.25*
15	-.21	.45**	-.19	-.31**	.51**	.50**	.35**
16	.15	.56**	.24*	.28*	-.36**	-.33**	-.50**

*Significant at the .01 level
**Significant at the .001 level

List of Variables

1. Location of water system in geographical regions of Texas
2. Consumer's degree of knowledge of water system
3. Continuation of water system usage
4. Favor consolidation with MUD, SUD, or contiguous system(s)
5. Purpose of water usage
6. Average monthly water bill
7. Water charges too high/low

Table 7 (continued)

Correlation Matrix Showing Intercorrelation Among Variables in the Consumers' Survey

	8	9	10	11	12	13	14	15
2								
3								
4								
5								
6								
7								
8								
9	.58**							
10	.67**	.55**						
11	.52**	.33**	.44**					
12	-.22	-.37**	-.29*	-.34**				
13	-.13	.08	.04	.16	-.36**			
14	-.36**	-.42**	-.38**	-.41**	.51**	-.34**		
15	-.46**	-.47**	-.53**	.31**	.35**	-.34**	.64	
16	.65**	.54**	.58**	.48**	-.32*	.01	-.51**	-.52**

List of Variables (continued)

8. Whether attend annual water system meeting
9. Whether water system growing
10. Whether water system provide members a sense of community
11. Participation or position held in water system
12. Age of respondent
13. Respondents' ethnic group or race
14. Own or rent residence
15. Family annual income
16. Evaluation of water system's effectiveness

Figure 2

A Path Model Showing Significance (p= .01 or less) Among Consumers' Assessment Levels of Effectiveness of Rural Water Systems (RWSs) and Selected Variables.

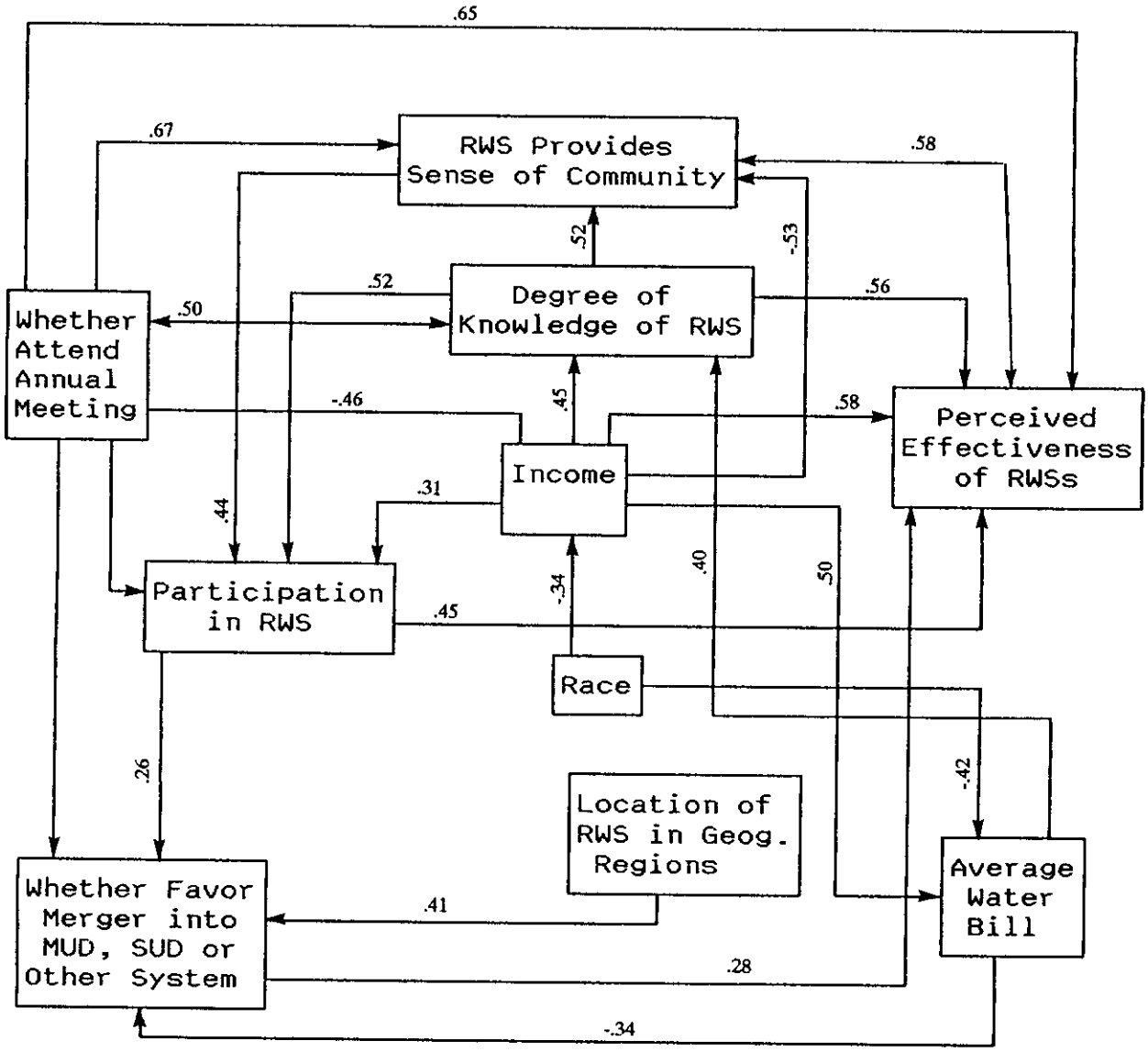

Table 8

Summary of Regression Analysis of Effects of Selected Variables on the Consumers' Perceived Effectiveness of Rural Water Systems

Dependent Variable: Perceived Effectiveness of Rural Water Systems by Customers			
Independent Variables	Beta	T	P
Location of Systems in Four Geographical Regions	1.48	1.16	.16
Degre of Knowledge of System's Organization	-.21	-2.17	.03
Average Monthly Water Bill	.01	.09	.92
Whether Attend Annual Meeting	-.39	-4.04	.00
Perception of Whether or Not System Provides Sense of Community	.25	.38	.76
Annual Income of Consumer	.11	1.05	.21
Ethnic Group of Consumer	.03	.40	.56
R2=	.56	(F= 14.89; P< .00)	
Standard Error	.35		

Data show that those water users who perceived their RWSs had a relatively higher level of effectiveness were likely to: (1) be knowledgeable of the structure and operation of these systems (in fact, the degree of knowledge came out to be one of the two significant correlates of perceived effectiveness through regression analysis given in Table 8); (2) have claimed that no one in their system had been denied a water connection; (3) plan to continue using water from the same RWS; (4) favor consolidation of the RWS with a MUD, SUD, or contiguous RWSs; (5) have used water for purposes other than household and have received lower water bills on the average than other consumers; (6) have considered water charges by the RWS as being moderate and/or fair; (7) have attended one or more annual meetings of (regression analysis shows this as the most significant variable affecting consumers' perceived effectiveness) and participated in decision making in the RWS in the past; (8) have stated that the RWS helped local residents in ways other than water and provided them with a sense of community; (9) have expressed confidence in the RWS as a growing system; (10) be relatively young; (11) be white; (12) have owned home; and (13) have belonged to a relatively higher-income group in the community.

Various intercorrelations given in Table 7 and Figure 2 also indicate that the income level and race of the water users seem to affect several variables. For example, the nonwhite water users belonged to relatively lower-income groups, paid lower water bills, had lower knowledge of the RWS, and were less likely to attend its annual meetings. Also, respondents who had lower income levels were likely to express a feeling that an RWS is mainly for providing water and not a sense of community. Finally, respondents who had a higher level of knowledge of the RWS were likely to have not only a more positive attitude toward its effectiveness but

were also relatively more active in participating in its meetings and decision-making processes.

Section Four:

Summary, Conclusions, and Implications

Summary

The study was aimed at identifying a set of procedures useful for evaluating the nonprofit rural water supply systems (RWSs) in Texas. Indicators and methods of evaluation were developed from a sociological perspective. The research process included a sequence of two major phases.

The first phase consisted of providing a general description of problems and needs of RWSs in Texas. Several procedures were employed for achieving that goal. First, an extensive review of rural-water relevant studies in the U.S. was conducted. Major reports by EPA and other agencies on rural water issues were reviewed. Second, secondary data on RWSs were collected from agencies such as EPA, FmHA, U.S. Bureau of Census, Texas Department of Health, and Texas Rural Water Association. Officials of these agencies were intensively interviewed through open-ended questions on 2history, goals, organizational structures, and operational problems and needs of RWSs in Texas.

The second phase of study was aimed at developing and testing a program effectiveness scale for evaluating management operations of RWSs in Texas. An initial list of typical indicators of program effectiveness was developed through a systematic review of literature relevant to organizational effectiveness and rural water management. In all, 38 scale items were constructed under four areas of RWSs' management activities. The areas were: (1) goals, nature, and scope of servic2e delivery by RWS, (2) quality of water-service delivery, (3) organizational and operational management or RWSs, and (4) level of maintenance of RWS. Scale items were classified under these four categories on the basis of conceptual relevance and face validity of each. The scale was empirically tested by collecting data from 108 RWSs that had been randomly

selected from a list of about 900 RWSs in Texas. In addition, the "consumer evaluation model" of program was used through personal interviews of 98 residents in four water systems located in four geographical regions of Texas in order to evaluate the RWSs.

The study was, therefore, able to identify not only detailed characteristics and problems of RWSs in Texas, but was also useful for critically evaluating these rural programs from a management point of view. The two-phase exploration of RWSs' program evaluation provided a relatively comprehensive and an in-depth analysis of the structure and functioning of these systems.

RWSs in Texas are now experiencing financial as well as organizational problems. The differential levels of the effectiveness of these systems were found to be significantly correlated to a variety of structural, operational, and sociodemographic variables. Similar variables were also found to be correlated to RWSs' violations of the Texas Department of Health water quality standards. Data from the consumer survey shed additional light on the management of RWSs.

Conclusions

A few generalizations are stated below as propositions based upon the findings of this study. Effort is made to interpret each proposition by commenting on possible interconnections among variables involved.

Proposition 1. The higher the proportion of nonwhite (i.e., black and Hispanic) water users in RWSs, the lower is the operational effectiveness of those systems.

It seems that the racial composition in RWSs affected several aspects of these systems. RWSs that had a preponderance of whites had better condition of their office

records, had larger number of certified employees, had lower operation costs, and had received fewer citations from the Health Department for violations of water quality standards as compared to ones that were serving predominantly nonwhite populations. RWSs that served a larger proportion of whites also were less likely to deny water connections to their customers. It is interesting to note that although the number of certified operators in RWSs did not directly correlate to their operation effectiveness, the two variables did relate to each other through the variable of racial composition in RWSs. In other words, racial composition in RWSs served as a intervening variable between the number of certified employees and operational effectiveness in these systems. RWSs that had a preponderance of nonwhite water users were also found to be financially depressed in terms of income levels of users as well as their operating budgets.

Proposition 2. The larger the size of RWSs, the lower is the operational effectiveness of those systems.

It appears that the principle of "economies of size" does not apply to evaluating the operational effectiveness of RWSs. Systems that were larger in size (in terms of number of full-time employees and number of miles of water pipes used) actually received a larger number of citations for violating Health Department standards and were also involved in denying water to a larger number of customers than was the case with RWSs of smaller size.

Proposition 3. The greater the water users feel a sense of community through their RWS, the greater the perceived effectiveness they are likely to have of their system.

Our data from the consumer survey show that those water users who had a relatively positive attitude toward their RWS, particularly by considering it as a community, also

gave a positive evaluation of its effectiveness. Residents who believed that their RWS provided them a sense of community were found to possess a higher degree of knowledge of the structure and functioning of their RWS, and were active in taking part in its organizational activities. It is important to note that residents who were white and who belonged to relatively higher income brackets had more positive attitude toward their RWS.

Research Implications

The measurement of organizational and operational effectiveness of RWSs through the overall scale as well as its three subscales appears quite useful, reliable, and valid. While conceptually it was believed that the scale measuring the effectiveness would incorporate four components (service delivery, service quality, operation, and maintenance), factor analysis procedures produced three subscales combining components of operation and maintenance. The effectiveness scale still needs to be tested in other situations in order to further establish its accuracy, reliability, and validity.

The operation of a RWS may be viewed as a process. Defining the effectiveness of its operation as a process has several implications for measuring the concept, the most important of which is that it would be best studied with a longitudinal design. Each RWS, for example, may be studied in terms of several phases (initiation, planning, operation, and maintenance) of its activities and accomplishments. All individuals (including officials of agencies involved in its funding, planning, and supervision), actors (its officials and board members), and consumers or water users should be involved, directly or indirectly, in the evaluation process.

Policy Implications

Data in this study have demonstrated that relatively larger RWSs (in terms of number of residential connection and mileage of pipes) have far more serious operational and water quality problems compared to smaller systems. This finding raises a question about the rationale for consolidating RWSs with larger systems to reduce operating costs and to increase efficiency. Research is needed for comparing the effectiveness levels of consolidated and small systems in order to indicate whether the former is a viable option.

While several researcher in the past have advocated a number of general types of solutions and strategies for dealing with rural water problems (see Austin et al., 1982; Brown and Ingram, 1987; Gessaman and Janovec, 1982), we need to develop more specific and practical solutions for those problems. For example, instead of simply saying that we need to implement some sort of consolidation of contiguously located RWSs so that they can become economically effective (see, for example, Goodwin and Doeksen, 1984), we need to explore specific styles and degrees of consolidation. Data from the study, for example, show that relatively larger RWSs have their own kinds of management problems and the principle of "economies of scale" may not work for RWSs in the same way that it works for larger urban water systems. Moreover, a RWS provides people with a sense of community and many rural people are hesitant about merging their water system into a city or even contiguous RWSs. Therefore, it is possible to develop a plan for a "partial consolidation" whereby the RWSs involved in a consolidation effort may only pool or share some technical-staff and technological resources and, at the same time, preserve their independent name or sense of identity.

Data show that RWSs with larger proportions of nonwhite

and relatively lower-income populations have greater problems of system inefficiency. Federal and state programs may need to specifically address improvements in RWSs with those types of populations.

Data show that a rural water system often provide a sense of community to its customers. Efforts need to be made toward preserving and promoting that feeling. Findings of the study indicate a serious need for public education whereby residents may become well informed and knowledgeable of the system's operation. That may also provide them incentives for greater participation in the system's activities (e.g., public meetings) and in the decision-making process.

NOTES

1 A review of Texas Water Development Board's (1990) recent draft of state's water plan revealed that there was hardly a mention of rural water management problems in Texas. The Board, therefore, appears to have an urban bias in its plans of water resources for the 1990s and the upcoming century.

2 Several studies of regional as well as national relevance to rural water supply have appeared over the past years. For example, Austin et al., 1977; Austin et al., 1982; Cairncross et al., 1980; Cartee and Williams, 1973; Chicoine et al., 1984; Gessaman and Jamorec, 1982; Myoung and Schreiner, 1984; Ross et al., 1973; Sargent and Sargent, 1979; and Subcommittee on Water Resources, 1979.

3 For example, Caro, 1981; Cronbach, 1980; Judd and David, 1981; Rossi and Williams, 1972; and Weiss, 1972. However, "little research has been conducted which is directly applicable to assessment of the management of rural water systems. Little information has been compiled that can be used by individuals and community decision-makers as they try to assess alternative methods of supplying water to rural areas..." (Subcommittee on Water Resources, 1979: 38).

4 In general, the Delphi procedures (see Singh and Webb, 1979) consist of the following:

(a) A research problem is identified.
(b) A "panel of experts" is selected in the problem area.
(c) Each responding "expert" is contacted and given a set of questions or items offered on open-end design to elicit a broad range of responses.
(d) Responses from the first round are statistically analyzed to determine degrees of consensus among respondents.
(e) In a second round, the respondents are provided with response patterns acquired during the first round, and asked to reconsider their earlier responses if necessary. It is suggested that in cases where a person's response is outside the group interquartile range, justification for the extreme response is clearly stated,
(f) The process continues in several rounds until some "desirable" degree of consensus among respondents is acquired. However, most of the group's responses are realized by the end of the second round.

Specific advantages are summarized as follows:

(a) The Delphi approach relies on the rationality of group judgment, or "n-heads are better than one." It is a process of eliciting and refining the opinions of a group of individuals. The individuals remain anonymous to each other; their opinions are continually refined and reiterated; and feedback to participants is controlled.
(b) The Delphi approach is a variant of the panel or committee approach for arriving at a consensus or majority opinions. Its design eliminates or prevents face-to-face confrontation, specious persuasion, and the bandwagon effect of a majority agreement. It replaces direct discussion with a series of carefully controlled questionnaires that report back edited and new information to the participants, where they act in privacy and react to the successive inputs.
(c) The Delphi approach uses some form of statistical index as a representative of the group opinion. Thus, there is no particular attempt to arrive at unanimity among the respondents, and a spread of opinions on the final round is the normal outcome. This is a further device to reduce group pressure toward conformity.
(d) The Delphi approach is very useful in such areas as "Quality of Life Indicators" where objective measures are not easily accessible.
(e) The Delphi approach provides flexibility for the research in various ways. There is no "cut and dried" set of steps to follow and it provides variations of possibilities during each phase of inquiry.

For additional details on the use of Delphi procedures in evaluation water resources projects, see Singh and Webb, 1979.

5 The term "rural" is defined here (in consistency with FmHA's use of the term) as those scattered-countryside households, small unincorporated towns, and incorporated towns up to 10,000 in population.

6 A large number of studies recognize the theoretical as well as applied value of "economies of size" in terms of which the reality of smallness of RWS's size actually increases the cost of water for each rural resident (Andrews, 1971; Regnier et al., Whitlatch and Asplund, 1981: 310; and Texas Department of Water Resources, 1984: 7).

7 For example, Texas Rural Water Association's Tariff (1989).

[8] Structures of water rates may differ from one water system to another depending on such factors as system size. The most common rates in RWSs in Texas are: (1) fixed rates (or flat rates) irrespective of the amount of water used, (2) uniform rates based upon meter readings, (3) decreasing rates through which the charges go down as the water consumption increases, and (4) step rate whereby the rates go up as the consumption goes up. Many RWSs use a combination of these rates in figuring out their bills.

[9] Conversions into MUDs or SUDs are recent legal options available to RWSs in Texas. These options may provide water systems with additional revenue sources (see Jensen, 1985). These options have become significant because federal grants (e.g., from FmHA) for helping RWSs to reduce operation costs have been drastically reduced.

[10] While consolidation of RWSs into larger and economically efficient systems is a viable option, it poses social-psychological threats to community leaders. Experts believe that we need an educational program for rural communities in order to spread awareness of the rationality of integrating water systems.

[11] However, the Department of Health is often unable to take strict actions against water systems that do violate quality standards.

[12] For several recent analyses of the impact of SDWA (1986), see Brown (1990); Jensen (1990); Sykes and Doty (1988); and Wade et al., (1988).

[13] The acceptable water loss is about 10 to 12 percent annually.

[14] Examples of evaluation criteria based upon Parsons' (1977) theoretical scheme include the following:

(a) Adaptation, consisting of a water system's ability to adjust itself to the reality and demands of its present as well as changing environment. Adaptation will be measured in terms of such questions as mentioned below.

In what manner and to what extent does a rural water system adapt its organization and functioning to demographic composition, financial management stra-tegies, and socioeconomic characteristics of people it serves? Does a water system take into account the emerging financial needs of people while planning its activities? How are the water

system's programs geared toward serving special populations, interest groups, and organizations (such as industries, farmers, businesses)? What changes or modifications are needed in organizational structure and functioning of a water system in order to enhance its effectiveness?

(b) Goal attainment refers to defining a water system's major goals and mobilizing resources to obtain them. It will be measured in terms of the following types of questions.

What are the major stated (or manifest-overt) and unstated (latent-covert) goals of a rural water system? How are these goals ranked by community 2leaders and board members in a water district? In what way and to what degree is a rural water system achieving its targeted goals? What are the major problems related to its goal attainment? What steps may be taken for enhancing its effectiveness in achieving its objectives?

(c) Integration, consisting of the degree to which a water system is coordinated and aligned with other organizations, institutions, and community activities or programs in its immediate environment. Integration of water systems with its environment may be indicated, for example, by the following questions.

Is the rural water system a special-interest project, or isolated from other organizations and services in the area? To what degree and in what sense is it integrated into other programs in the local community? Is the water system a source of conflict and controversy (rather than solidarity) in the local community? In what manner are the leading actors in the water system coordinated with the community leadership structure?

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APPENDIX A

Additional Figures & Tables

Figure 3

Nonmetro Population Change by Metro Adjacency, 1980-1988
Remote (nonadjacent) nonmetro counties lost the most.

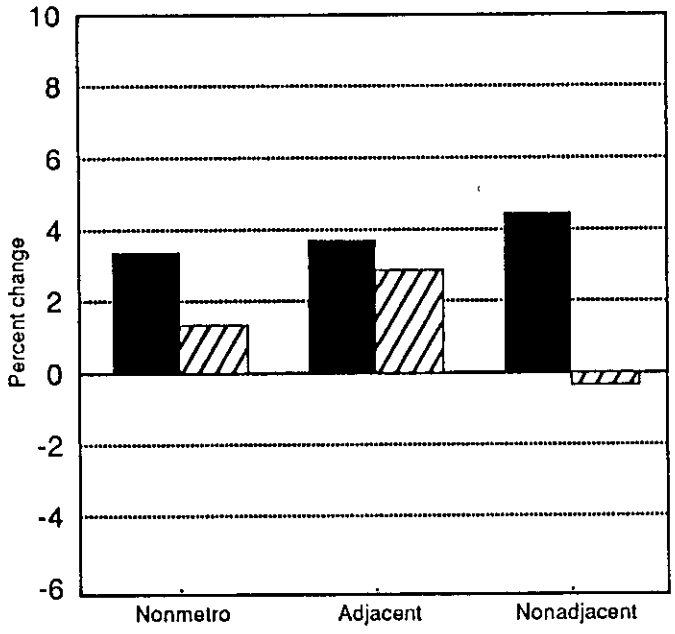


Figure 4

Population Change by Nonmetro County Type, 1980-1988
Retirement counties grew fast despite losses elsewhere.

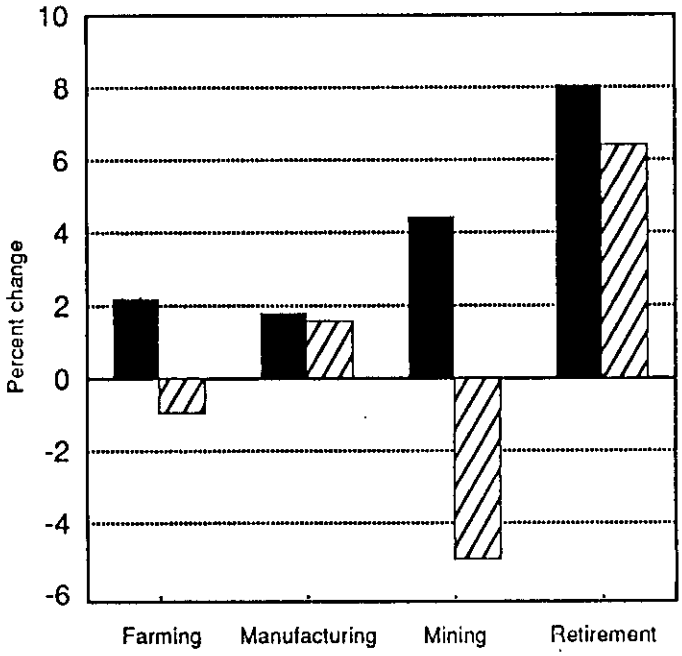


Figure 5

Percentage of Rural (FmHa Area) Occupied Housing Without Complete Plumbing (Austin et al., 1975)

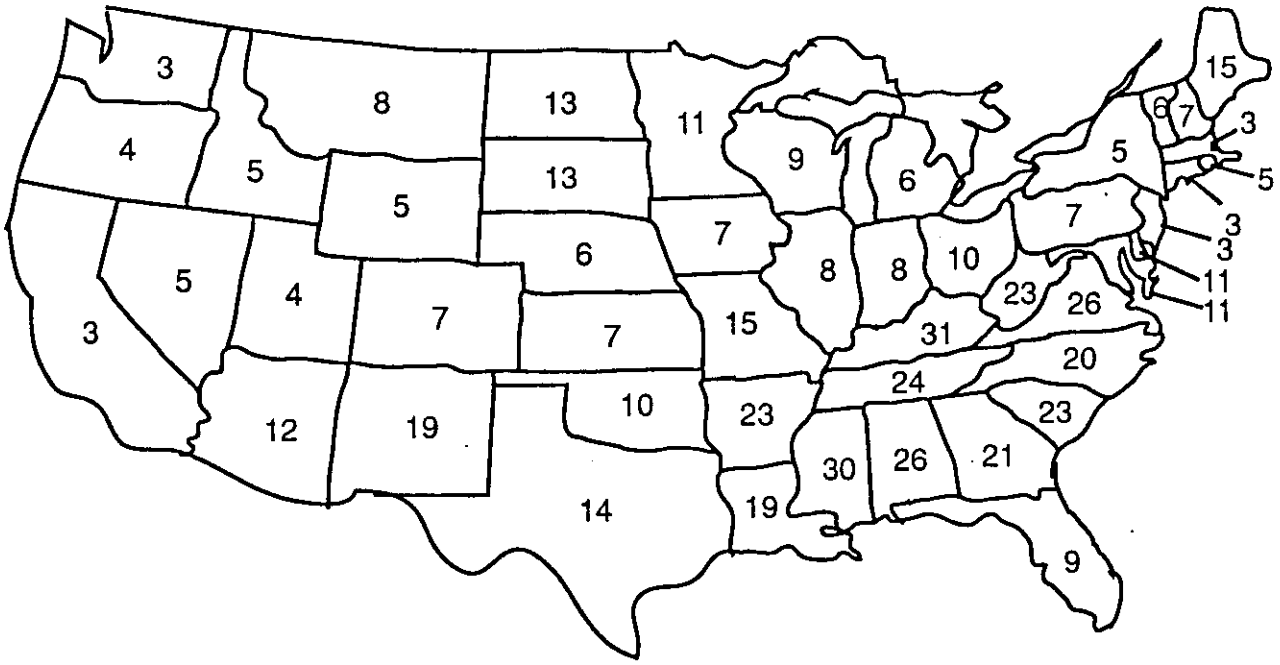


Figure 6

Percentage of Rural Black Head of Household Housing Units Lacking Complete Plumbing (Austin et al., 1975)

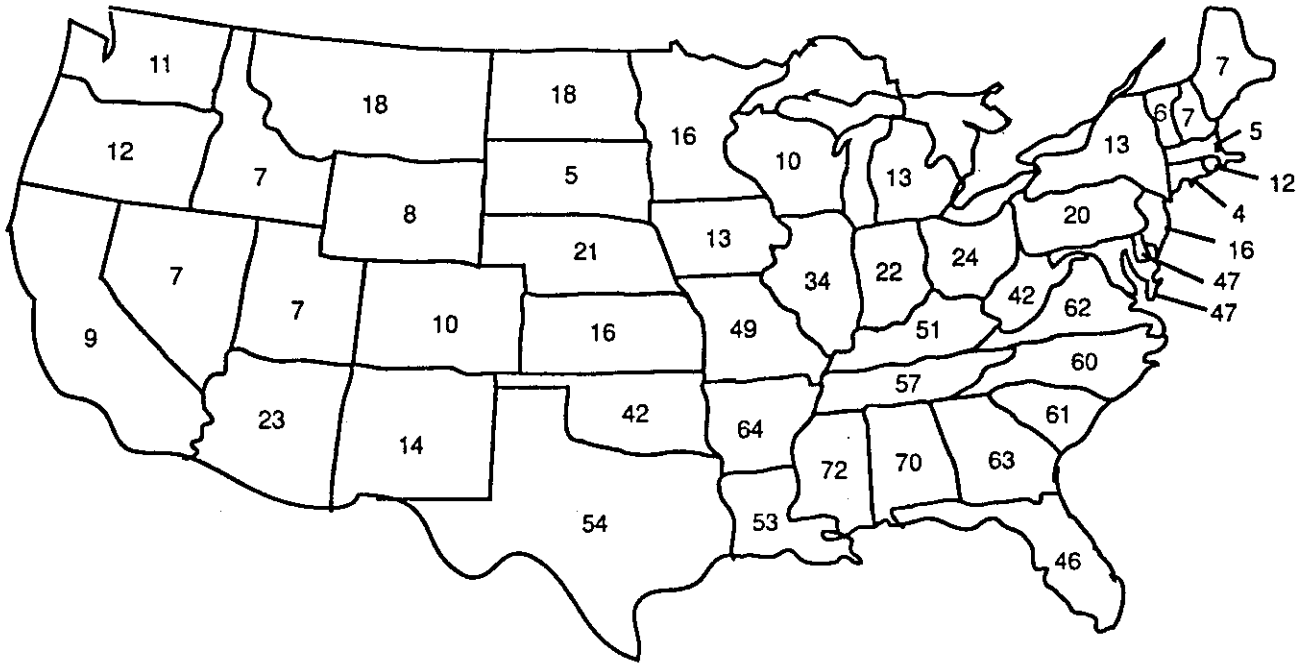
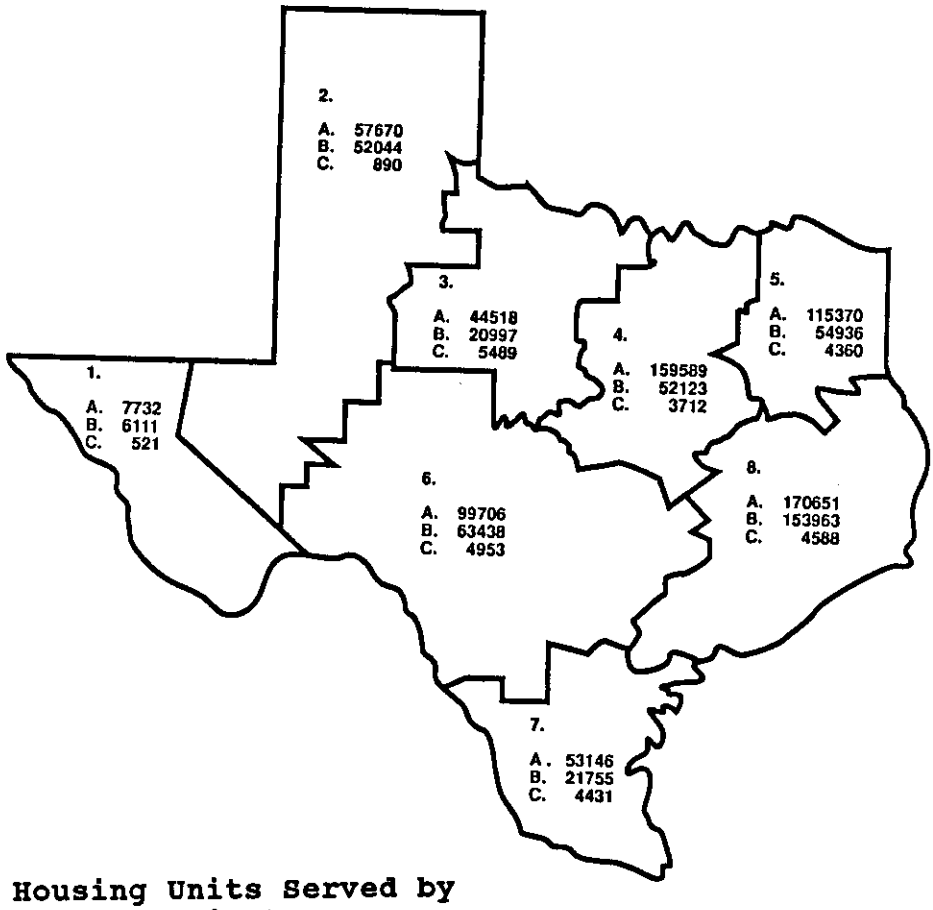


Figure 7

Water Sources for Rural Housing Units by Eight Geographical Regions in Texas, 1980



a. Number of Housing Units Served by Public Systems or Private Co.
b. Number of Individual Wells
c. Number Served by Other Sources

Source: Gillham (1990)

Figure 8

Percentage of Rural Households Uning Water from Nonprofit Water Corporations by Eight Geographical Regions in Texas, 1980

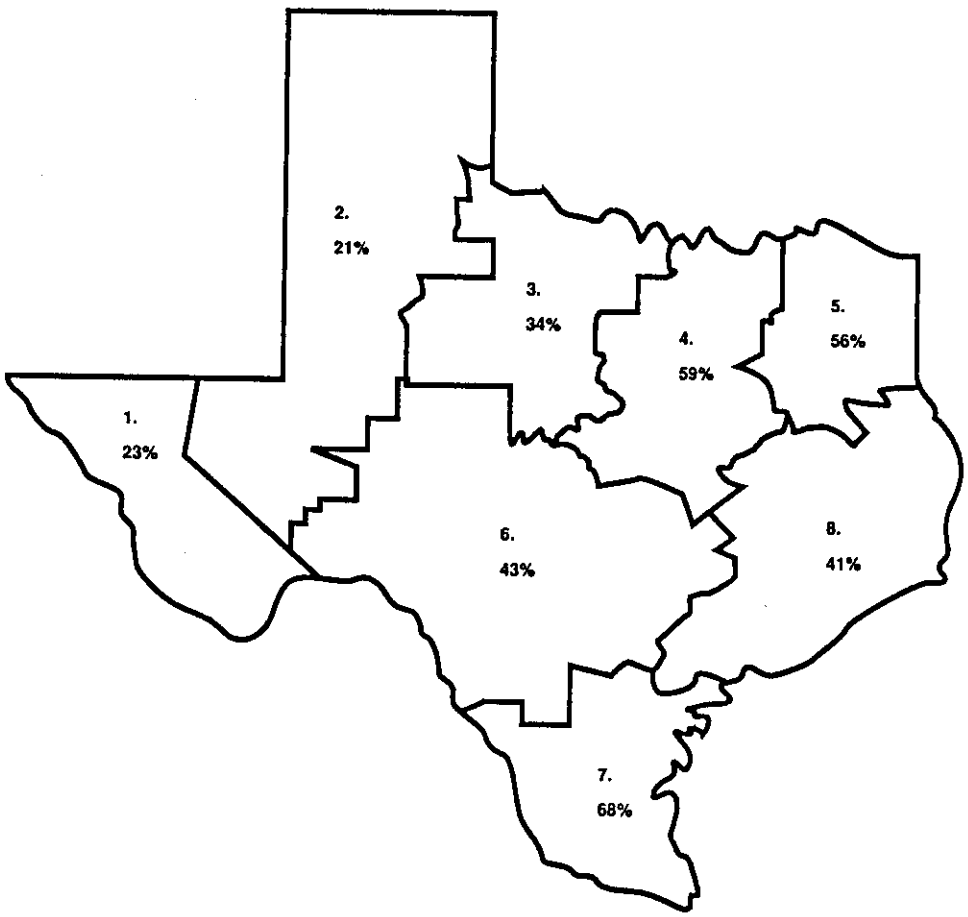
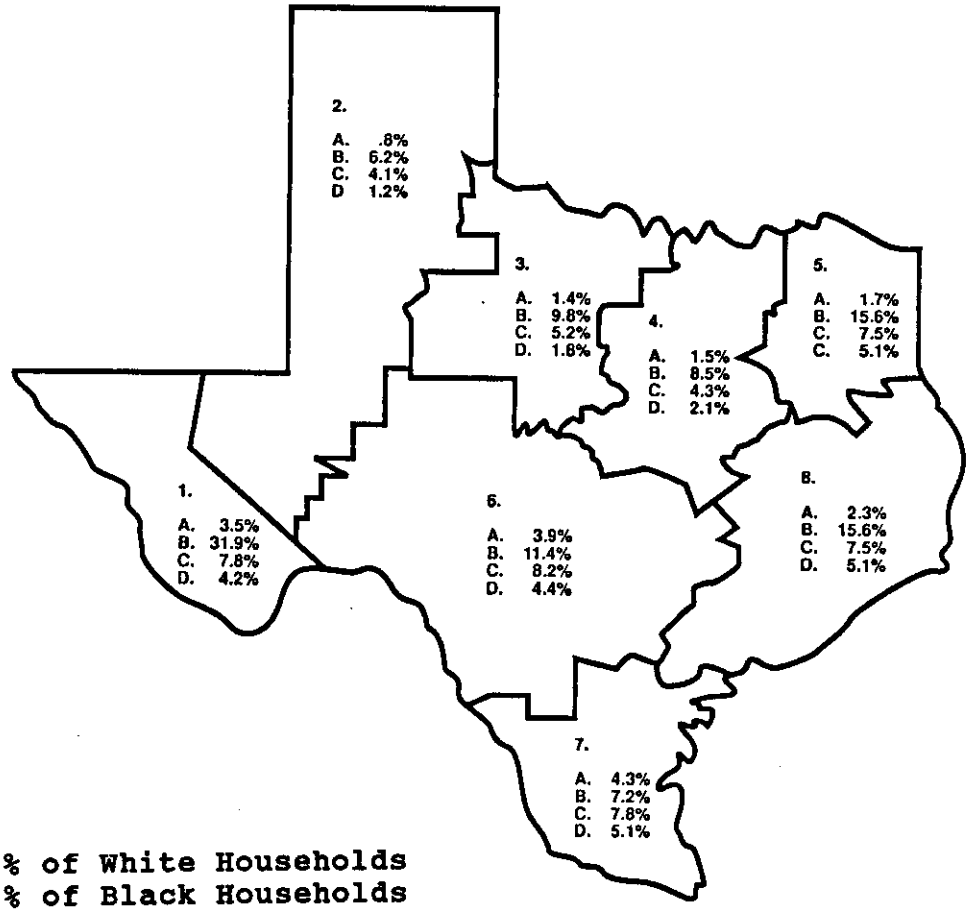


Figure 9

Percentage of Households in Texas Completely Without Plumbing, by Race and Geographical Regions, 1980



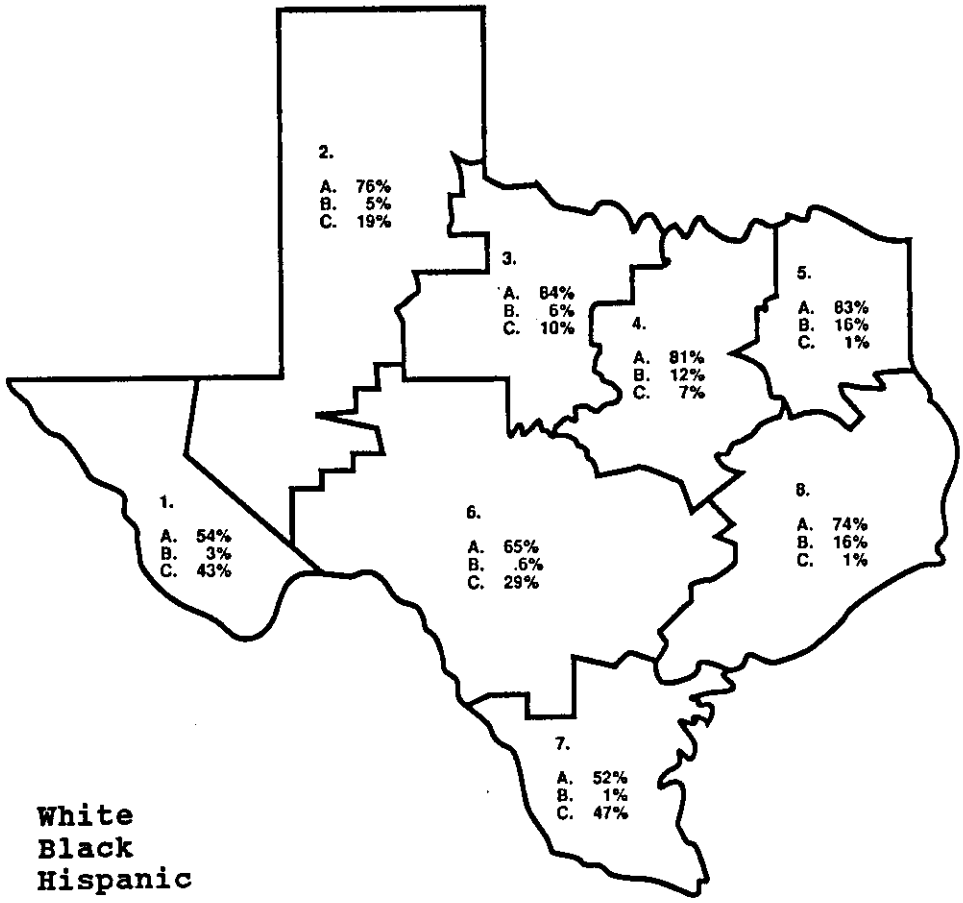
a. % of White Households
b. % of Black Households
c. % of Hispanic Households
d. % of All Households

LEGEND

I Upper Rio Grande and Far West Texas Region
II High Plains and Trans-Pecos Region
III West Central Texas Region
IV North Texas Region
V Northeast Texas Region
VI South Central Texas Region
VII South Texas and Lower Gulf Coast Region
VIII Southeast Texas and Upper Gulf Coast Region

Figure 10

Percentage of White, Black and Hispanic Populations in Texas by Regions, 1980

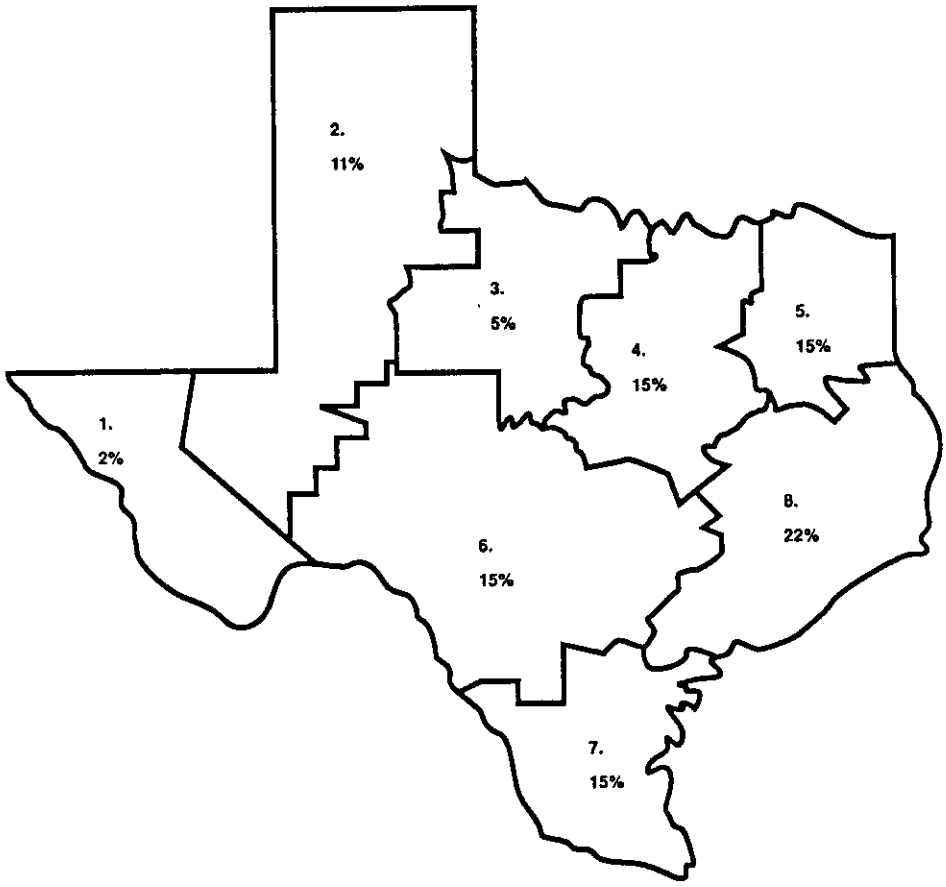


a. White
b. Black
c. Hispanic

Source: U.S. Bureau of Census

Figure 11

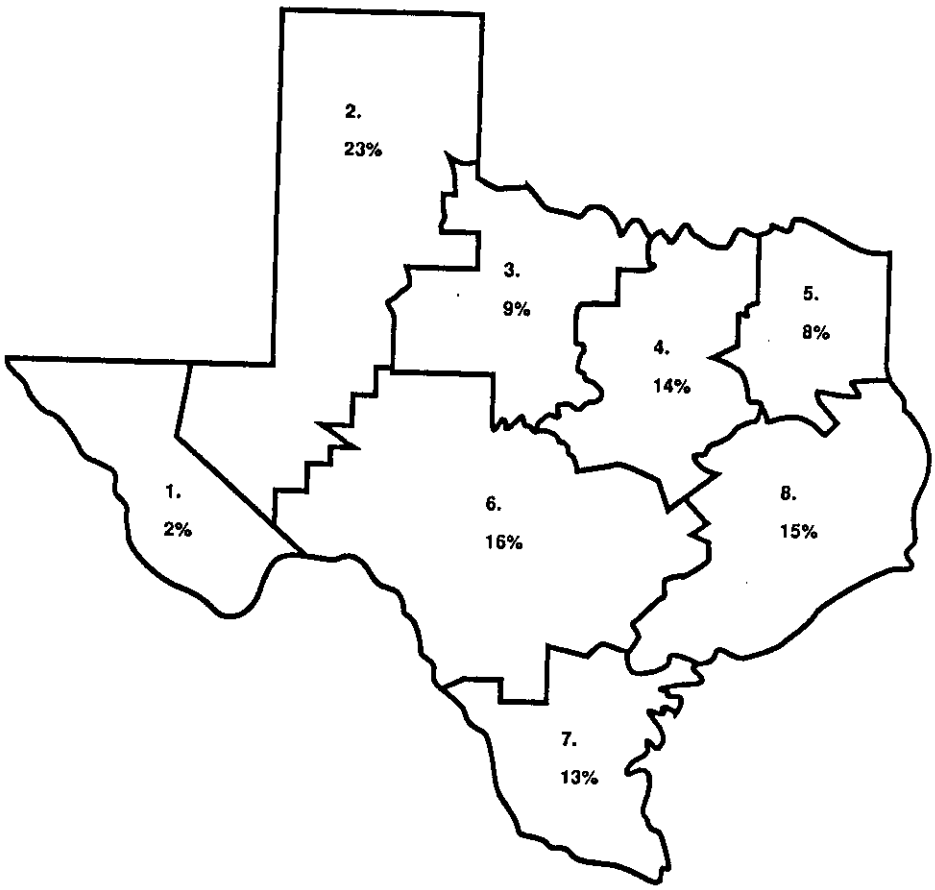
Percentage of Families Below Poverty Level in Texas by Geographical Regions, 1980



Source: U.S. Bureau of Census

Figure 12

Percentage of Population Engaged in Agriculture in Texas by Geographical Regions, 1980



Source: U.S. Bureau of Census

Table 9

Water Sources for Rural Housing Units by Eight Geographic Regions in Texas, 1980

Region Number	Number of Public Systems or Private Co.	Number of Individual Wells	Other Source
1	7732	6111	521
2	57670	52044	890
3	44518	20997	5489
4	159589	52123	3712
5	115370	54936	4360
6	99706	63438	4953
7	53146	21755	4431
8	170651	153963	4588
Totals	708382	425367	28944

Source: Data Summarized from Gillham (1990)

Table 10

Percentage of White, Black, and Hispanic in Texas by Geographical Regions, 1980

Region Number	White %	Black %	Hispanic %
1	54	3	43
2	76	5	19
3	84	6	10
4	81	12	7
5	83	16	1
6	65	6	29
7	52	1	47
8	74	16	10

Source: U.S. Bureau of Census

Table 11

Percentage and Number of Families Below Poverty Level by Geographical Regions in Texas, 1980

Region Number	Number	Percent
1	1930	2
2	10194	11
3	4971	5
4	14529	15
5	14391	15
6	14345	15
7	14052	15
8	22351	22
Totals	96763	100

Source: U.S. Bureau of Census

Table 12

Percentage and Number of Population Engaged in Agriculture in Texas by Geographical Regions, 1980

Region Number	Total Number	Percent
1	2199	2
2	27262	23
3	11085	9
4	17142	14
5	9078	8
6	19505	16
7	14931	13
8	17948	15
Totals	119150	100

Source: U.S. Bureau of Census

Table 13

Relationship Between the Levels of Effectiveness of Rural Water Systems and Selected Variables

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Whether Received Any Health Dept. Citations				
Yes (N=33)	3 (10%)	15 (45%)	15 (45%)	X^2= 10.38*
No (N=75)	22 (29%)	39 (52%)	14 (19%)	r= -0.31 G= -0.54
Position of Respondent				
Managerial (N=66)	13 (20%)	32 (48%)	21 (32%)	X^2= 2.51
Other (N=42)	12 (29%)	22 (52%)	8 (19%)	r= -0.16* G= -0.54
No. of Years Position Held				
10 or more (N=36)	10 (28%)	17 (47%)	9 (25%)	X^2= 6.27
4-9 (N=28)	3 (11%)	19 (68%)	6 (21%)	r= 0.04 G= 0.06
1-3 (N=43)	12 (28%)	17 (39%)	14 (33%)	

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
No. of Residential Connections				
1000 or more (N=22)	2 (9%)	12 (55%)	8 (36%)	X^2= 5.17
301-999 (N=50)	11 (22%)	25 (50%)	14 (28%)	r= -0.21*
300 or fewer (N=36)	12 (33%)	17 (47%)	7 (20%)	G= -0.30
No. of Commercial Connections				
10 or more (N=41)	10 (24%)	21 (52%)	10 (24%)	X^2= 1.29
1-9 (N=39)	8 (21%)	19 (49%)	12 (30%)	r= -0.03
None (N=22)	7 (32%)	10 (46%)	5 (22%)	G= -0.03
Whether New Connections Available				
Yes (N=96)	21 (22%)	48 (50%)	27 (28%)	X^2= 1.13
No (N=12)	4 (33%)	6 (50%)	2 (17%)	r= -0.10
				G= -0.27

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Whether Anyone Denied Water Connection				
Some (N=14)	2 (14%)	6 (43%)	6 (43%)	X^2= 2.91
				r= -0.16*
None (N=90)	23 (26%)	47 (52%)	20 (22%)	G= -0.37
Miles of Pipe in System				
100 or more (N=29)	4 (14%)	13 (45%)	12 (41%)	X^2= 3.81
				r= -0.19*
40-99 (N=19)	2 (11%)	12 (63%)	5 (26%)	G= 0.29
39 or less (N=44)	11 (25%)	23 (52%)	10 (23%)	
Whether Customers Pay for Pipe				
Yes (N=83)	19 (23%)	44 (53%)	20 (24%)	X^2= 3.81
				r= 0.03
No (N=23)	5 (22%)	10 (43%)	8 (35%)	G= 0.07

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
No. of Full Time Staff				
5 or more (N=23)	4 (17%)	14 (61%)	5 (22%)	X^2= 1.83
				r= -0.03
3-4 (N=20)	4 (20%)	10 (50%)	6 (30%)	G= -0.06
2 or less (N=63)	17 (27%)	29 (46%)	17 (27%)	
No. of Certified Staff Members				
2 or more (N=40)	10 (25%)	21 (52%)	9 (23%)	X^2= 0.80
				r= 0.06
1 or none (N=59)	14 (23%)	27 (45%)	18 (32%)	G= 0.11
Whether System Single or Multi County				
Multi Co. (N=32)	5 (16%)	15 (47%)	12 (37%)	X^2= 3.89
				r= -0.19*
Single Co. (N=73)	20 (27%)	38 (52%)	15 (21%)	G= -0.34

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Whether System Predominantly Farm or Non-Farm				
Farm (N=53)	11 (21%)	26 (49%)	16 (30%)	X^2= 3.39
Non-Farm (N=44)	10 (22%)	24 (54%)	10 (23%)	r= -0.16*
Both (N=9)	4 (44%)	4 (44%)	1 (12%)	G= -0.21
Number of Wells				
3 or more (N=41)	5 (12%)	23 (56%)	13 (32%)	X^2= 6.04
1-2 (N=37)	12 (32%)	15 (41%)	10 (27%)	r= -0.16*
None (N=28)	7 (25%)	16 (57%)	5 (18%)	G= -0.22
Water Use Trends				
Increasing (N=75)	17 (23%)	39 (52%)	19 (25%)	X^2= 2.98
Decreasing (N=1)	0	0	1 (100%)	r= 0.01
Stable (N=32)	8 (25%)	15 (46%)	9 (28%)	G= 0.03

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Rate Charged for Water				
Uniform rate (N=46)	10 (22%)	23 (50%)	13 (28%)	X^2= 4.17
				r= -0.05
Step rate (N=52)	12 (23%)	26 (50%)	14 (27%)	G= -0.07
Decreasing rate (N=5)	1 (20%)	4 (80%)	0	
Fixed price (N=5)	2 (40%)	1 (20%)	2 (40%)	
Cost of System's Operation				
Less than income (N=23)	3 (12%)	10 (44%)	10 (44%)	X^2= 5.57
				r= -0.21*
More than income (N=43)	9 (21%)	23 (54%)	11 (25%)	G= -0.29
Same as income (N=36)	12 (33%)	16 (45%)	8 (22%)	
Whether Ration Water				
Yes (N=15)	4 (27%)	6 (40%)	5 (33%)	X^2= 0.67
				r= -0.08
No (N=77)	19 (24%)	39 (52%)	19 (24%)	G= -0.08

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Maintenance Done By				
Self (N=49)	12 (25%)	29 (59%)	8 (16%)	X^2= 5.92
				r= 0.15
Contract out (N=36)	9 (25%)	17 (47%)	10 (28%)	G= 0.24
Both (N=18)	3 (16%)	7 (39%)	8 (45%)	
Whether a Service Schedule is Followed				
Yes (N=78)	18 (23%)	41 (53%)	19 (24%)	X^2= 1.62
				r= 0.11
No (N=27)	5 (18%)	12 (45%)	10 (37%)	G= 0.21
Whether Admit EPA Violations				
Yes (N=20)	3 (15%)	9 (45%)	8 (40%)	X^2= 2.41
				r= -0.16*
No (N=88)	22 (25%)	45 (51%)	21 (24%)	G= -0.31

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Funding Source for Operation				
Customer only (N=97)	23 (24%)	51 (53%)	23 (23%)	X^2= 7.84 r= 0.05
FmHA (N=2)	0	0	2 100%)	G= 0.28
Combination and Others (N=5)	2 (40%)	1 (20%)	2 (40%)	
Condition of Records				
Complete (N=100)	25 (25%)	50 (50%)	25 (25%)	X^2= 2.84 r= 0.16*
Incomplete (N=6)	0	3 (50%)	3 (50%)	G= 0.60
Whether Water Systems Too Regulated				
Yes (N=45)	16 (36%)	20 (44%)	9 (20%)	X^2= 6.78 r= 0.22*
No (N=58)	8 (13%)	33 (58%)	17 (29%)	G= 0.37

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Whether State or Federal Regulations too Stiff				
Yes (N=36)	14 (39%)	17 (47%)	5 (14%)	X^2= 10.86*
				r= 0.33*
No (N=58)	7 (12%)	31 (53%)	20 (35%)	G= 0.55
Whether Member of TRWA				
Yes (N=98)	23 (23%)	48 (49%)	27 (28%)	X^2= 0.68
				r= 0.03
No (N=8)	1 (13%)	5 (62%)	2 (25%)	G= 0.10
Whether Loan Sold Out by FmHA				
Yes (N=40)	7 (18%)	21 (52%)	12 (30%)	X^2= 1.51
				r= -0.09
No (N=57)	16 (28%)	25 (44%)	16 (28%)	G= -0.14
Whether Wish to Merge with MUD				
Yes (N=9)	3 (34%)	4 (44%)	2 (22%)	X^2= 0.56
				r= 0.06
No (N=94)	21 (22%)	48 (51%)	25 (27%)	G= 0.18

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
Whether Explored Other Funding Sources				
Yes (N=38)	10 (26%)	22 (58%)	6 (16%)	X^2= 4.17
No (N=67)	14 (20%)	30 (45%)	23 (35%)	r= 0.16* G= 0.29
Whether Made Future Projections				
Yes (N=72)	17 (24%)	39 (54%)	16 (22%)	X^2= 3.97
No (N=32)	7 (22%)	12 (38%)	13 (40%)	r= 0.13 G= 0.24
% of Whites in Systems				
95 - 100% (N=33)	9 (27%)	16 (49%)	8 (24%)	X^2= 6.07
80 - 94% (N=29)	10 (35%)	13 (45%)	6 (20%)	r= 0.18* G= 0.24
79% or less (N=29)	4 (14%)	12 (41%)	13 (45%)	

Table 13 (Continued)

Selected Factors	Level of Effectiveness: Highly Effective	Somewhat Effective	Less Effective	Statistical Tests
% of Blacks in Systems				
10% or more (N=31)	5 (16%)	11 (36%)	15 (48%)	X^2= 11.49*
				r= 0.32*
1 - 9% (N=37)	8 (21%)	20 (55%)	9 (24%)	G= 0.43
0% (N=25)	10 (40%)	12 (48%)	3 (12%)	
% of Hispanics in Systems				
1 - 9% (N=36)	9 (20%)	26 (56%)	11 (24%)	X^2= 1.39
				r= -0.01
0% (N=62)	16 (26%)	28 (45%)	18 (29%)	G= -0.01

*Probability value significant at .05 or less.

Table 14

Relationship Between Health Department Citations Received by Water Systems and Selected Variables

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Position of Respondent			
Mgr-Sec. (N=70)	23 (33%)	47 (67%)	X^2= 0.18
			r= 0.06*
Other (N=44)	12 (27%)	32 (73%)	G= 0.13
Length of Operation			
10 or more yrs. (N=38)	11 (29%)	27 (71%)	X^2= 0.89
			r= 0.01
4-9 yrs. (N=29)	11 (38%)	18 (62%)	G= 0.02
1-3 yrs. (N=46)	13 (28%)	33 (72%)	
No. of Residential Connections			
1000 or more (N=25)	15 (60%)	10 (40%)	X^2= 15.62*
			r= 0.36*
301-999 (N=51)	15 (29%)	36 (71%)	G= 0.60
300 or fewer (N=38)	5 (13%)	33 (87%)	

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
No. of Commercial Connections			
10 or more (N=44)	16 (36%)	28 (64%)	X^2= 1.03
1-9 (N=42)	11 (26%)	31 (74%)	r= 0.05
None (N=22)	7 (32%)	15 (68%)	G= 0.11
Whether New Connections Available at Present			
Yes (N=101)	32 (32%)	69 (68%)	X^2= 0.10
No (N=13)	3 (23%)	10 (77%)	r= 0.06
			G= 0.21
Whether Anyone Denied Water Connections			
Some (N=14)	8 (57%)	6 (43%)	X^2= 4.24*
None (N=96)	25 (26%)	71 (74%)	r= 0.23*
			G= 0.58

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Miles of Pipe in System			
100 or more (N=29)	16 (55%)	13 (45%)	X^2= 9.77*
			r= 0.32*
40-99 (N=21)	7 (33%)	14 (67%)	G= 0.52
Less than 39 (N=45)	9 (20%)	36 (80%)	
Whether Customers Pay for Pipe			
Yes (N=88)	28 (31%)	60 (69%)	X^2= 2.33
			r= 0.06
No (N=25)	7 (28%)	18 (72%)	G= 0.15
No. of Full Time Staff Members			
5 or more (N=23)	11 (48%)	12 (52%)	X^2= 6.35*
			r= 0.22*
3-4 (N=23)	8 (35%)	15 (65%)	G= 0.39
2 or less (N=66)	15 (23%)	51 (77%)	

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
No. of Certified Workers			
2 or more (N=44)	17 (39%)	27 (61%)	X^2= 1.30
			r= 0.13
1 or none (N=61)	16 (26%)	45 (74%)	G= 0.28
Whether System Single or Multi County			
Multi Co. (N=35)	15 (43%)	20 (57%)	X^2= 1.30
			r= 0.18*
Single Co. (N=76)	19 (25%)	57 (75%)	G= 0.38
Source of Water			
Own wells (N=70)	18 (26%)	52 (74%)	X^2= 1.56
			r= -0.14
Other (N=44)	17 (39%)	27 (61%)	G= -0.29
Number of Wells			
3 or more (N=43)	15 (35%)	28 (65%)	X^2= 2.36
			r= 0.01
1-2 (N=38)	8 (21%)	30 (79%)	G= 0.03
None	11	20	

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Use of Water System			
Increasing (N=79)	24 (30%)	55 (70%)	X^2= 2.29
Stable (N=34)	15 (35%)	28 (65%)	r= 0.00
Decreasing (N=1)	1 (100%)	0	G= 0.03
Rate Charged for Water			
Uniform/ Fix (N=54)	15 (28%)	39 (72%)	X^2= 0.59
Step rate (N= 54)	18 (33%)	36 (67%)	r= -0.07
Decreasing rate (N=5)	2 (40%)	3 (60%)	G= -0.14
Meters Read			
Once a month (N=89)	28 (32%)	61 (68%)	X^2= 0.63
Less Regularly (N=5)	2 (40%)	3 (60%)	r= 0.02
Never (N=1)	0	1 (100%)	G= -0.03

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Whether Cost of System's Operation			
Less than income (N=25)	7 (28%)	18 (72%)	X^2= 0.25
More than income (N=45)	15 (33%)	30 (67%)	r= -0.01
Same as income (N=37)	11 (30%)	26 (70%)	G= -0.01
Water Supply			
Adequate (N=101)	31 (31%)	70 (39%)	X^2= 0.60
Inadequate (N=12)	4 (33%)	8 (67%)	r= 0.00
			G= -0.05
Frequency of Chlorination			
Once a month (N=6)	1 (17%)	5 (83%)	X^2= 2.57
Daily (N=48)	19 (40%)	29 (60%)	r= 0.01
As needed (N=52)	15 (28%)	37 (72%)	G= 0.09

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Condition of Records			
Good (N=106)	31 (29%)	75 (71%)	X^2= 0.38
			r= -0.10
Incomplete (N=6)	3 (50%)	3 (50%)	G= -0.42
Water Systems Too Much Regulated			
Yes (N=46)	14 (30%)	32 (70%)	X^2= 0.02
			r= 0.03
No (N=62)	17 (27%)	45 (73%)	G= 0.07
State & Federal Regulations Too Stiff			
Yes (N=37)	8 (22%)	29 (78%)	X^2= 1.63
			r= -0.15
No (N=61)	22 (36%)	39 (64%)	G= -0.34
Whether TRWA Member			
Yes (N=103)	32 (31%)	71 (69%)	X^2= 0.03
			r= 0.05
No (N=9)	2 (22%)	7 (78%)	G= 0.22

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Whether Loan Sold Out by FmHA			
Yes (N=43)	8 (19%)	35 (81%)	X^2= 4.65*
			r= -0.23*
No (N=59)	24 (41%)	35 (59%)	G= -0.50
Whether Ration Water			
Yes (N=15)	5 (33%)	10 (67%)	X^2= 0.01
			r= 0.04
No (N=81)	23 (28%)	58 (72%)	G= 0.12
Maintenance Done By			
Self (N=51)	16 (31%)	35 (69%)	X^2= 0.97
			r= 0.06
Contract out (N=39)	13 (33%)	26 (67%)	G= 0.10
Both self and by contract (N=19)	4 (21%)	15 (79%)	
Whether a Service Schedule is Followed			
Yes (N=82)	25 (31%)	57 (69%)	X^2= 0.03
			r= -0.04
No (N=29)	10 (34%)	19 (65%)	G= -0.09

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Whether Admit EPA Violations			
Yes (N=21)	7 (33%)	14 (67%)	X^2= 0.00
			r= 0.03
No (N=93)	28 (30%)	65 (70%)	G= 0.07
Source of Funding for Operation			
Customers only (N=103)	28 (27%)	75 (73%)	X^2= 10.78*
			r= -0.29*
FmHA (N=2)	2 (100%)	0	G= -0.88
Customers & others (N=5)	4 (80%)	1 (20%)	
Whether Water Systems Too Regulated			
Yes (N=46)	14 (30%)	32 (70%)	X^2= 0.12
			r= 0.03
No (N=62)	17 (27%)	45 (73%)	G= 0.07
Whether State or Federal Regulations Too Stiff			
Yes (N=37)	8 (22%)	29 (78%)	X^2= 2.62
			r= -0.15
No (N=61)	22 (36%)	39 (64%)	G= -0.34

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
Whether Merge with MUD			
Yes (N=11)	3 (27%)	8 (73%)	X^2= 0.00
			r= -0.02
No (N=98)	29 (30%)	69 (70%)	G= -0.06
Whether Merge with Other Systems			
Yes (N=24)	9 (38%)	15 (62%)	X^2= 0.04
			r= 0.05
No (N=68)	22 (33%)	46 (67%)	G= 0.11
Whether Explored Other Funding Sources			
Yes (N=41)	15 (37%)	26 (63%)	X^2= 0.69
			r= 0.10
No (N=70)	19 (27%)	51 (73%)	G= 0.22
Whether Making Future Projections			
Yes (N=76)	25 (33%)	51 (67%)	X^2= 0.59
			r= 0.09
No (N=34)	8 (24%)	26 (76%)	G= 0.23

Table 14 (Continued)

Selected Factors	Whether Health Dept. Citations Received: Yes	No	Statistical Tests
% of Whites in System			
95-100% (N=33)	5 (15%)	28 (85%)	X^2= 21.37*
			r= 0.39*
80-94% (N=30)	3 (10%)	27 (90%)	G= -0.63
79% or less (N=29)	17 (59%)	12 (41%)	
% of Blacks in System			
10% or more (N=32)	14 (44%)	18 (56%)	X^2= 6.51*
			r= 0.25*
1-9% (N=37)	8 (22%)	29 (78%)	G= 0.47
0% (N=25)	4 (16%)	21 (84%)	
% of Hispanic in System			
1-9% (N=51)	22 (43%)	13 (21%)	X^2= 5.69*
			r= 0.24*
0% (N=63)	29 (57%)	50 (79%)	G= 0.49

*Probability value significant at .05 or less.

Table 15

Characteristics of Consumers in Texas Rural Water Systems

Items	Number (N=97)	Percent
Location of Respondents in Four Regions		
Northeast	25	25.8
South	20	20.6
Southwest	29	29.9
Northwest	23	23.7
Degree of Knowledge of Water System		
High Knowledge	28	28.9
Moderate Knowledge	33	34.0
Low-No Knowledge	36	37.1
Length of Water Usage		
Less than 5 yrs.	16	16.5
6-10	36	37.1
11-15	22	22.7
16 or more yrs.	22	22.7
Not sure	1	1.0
Whether Anyone Was Denied Water Connection		
Yes	31	32.0
No	58	59.8
Not sure	8	8.2

Table 15 (continued)

Items	Number (N=97)	Percent
Whether Plan to Continue With System		
Yes	83	85.6
No/not sure	14	14.4
Whether Favor Consolidation Into MUD		
Yes	11	11.3
No	56	57.7
Not sure	30	31.0
Whether Favor Consolidation Into Other Water System		
Yes	8	8.2
No	57	58.8
Not sure/No response	32	33.0
Whether Favor Consolidation Into SUD		
Yes	21	21.6
No	42	43.3
Not sure/No response	34	35.1
Whether Possess Own Well		
Yes	14	14.4
No	82	84.5
No response	1	1.1

Table 15 (continued)

Items	Number (N=97)	Percent
Water Used For		
Household use only	33	34.0
Household and yard	42	43.3
Agr./Commercial	22	22.7
Average Water Bill		
Not sure	2	2.1
$30 or less	23	23.7
$31-50	28	28.8
$51-100	21	21.7
$101 or more	23	23.7
Water Charges		
Too high	40	41.3
Moderate-fair	56	57.7
Not sure	1	1.0
Customer's Distance from Municipality		
20 miles or less	64	66.0
20-40	17	17.5
41-50	10	10.3
51 or more	3	3.1
Not sure/No response	3	3.1

Table 15 (continued)

Items	Number (N=97)	Percent
Whether Attend Annual Meetings of the Water System		
Yes	37	38.1
No	60	61.9
Whether Water System Helps Community Other Than Water Needs		
Yes	44	45.4
No	34	35.0
Not sure	19	19.6
Any Problems Experienced By Customers		
Pollutants only	4	4.1
Muddy or colored water	1	1.0
Disruptions	7	7.2
Other problems	10	10.3
2 or more problems	41	42.3
None	13	13.4
Not sure/No response	21	21.7
Growth Pattern of Water System		
Grown extensively	53	54.6
Stayed same	21	21.6
Gone down	8	8.3
Not sure	15	15.5

Table 15 (continued)

Items	Number (N=97)	Percent
Whether Water System Provides Sense of Community		
Yes	41	42.3
No	14	14.4
Not sure	42	43.3
Whether Participated or Held Position in Water System		
Yes	21	21.6
No	76	78.4
Whether Customer Uses Own Filter System		
Yes	12	12.4
No	84	86.6
No response	1	1.0
Overall Effectiveness of the Water System		
Low	4	4.1
Mediocre	47	48.5
High	41	42.3
Not sure/No response	5	5.1
Can Water System be Improved?		
Yes	43	44.3
No	1	1.0
Not sure	37	38.2
No response	16	16.5

Table 15 (continued)

Items	Number (N=97)	Percent
Sex of Respondent		
Male	70	72.2
Female	27	27.8
Age Distribution of Customers		
25 or less	4	4.1
26-35	23	23.7
36-45	19	19.6
46-55	20	20.6
56-65	21	21.6
66+	9	9.4
No response	1	1.0
Number in Household		
1-2	12	12.4
3-4	50	51.5
5-6	28	28.9
7-8	7	7.2
Race		
White	50	51.5
Black	12	12.4
Hispanic	35	36.1
Housing of Customer		
Rent	37	38.1
Own home	60	61.9

Table 15 (continued)

Items	Number (N=97)	Percent
Annual Family Income		
10K or below	18	18.6
11-20K	27	27.8
21-30K	33	34.0
31-50K	9	9.3
51K or more	10	10.3

Table 16

Relationship Between Customers' Assessment of the Level of Effectiveness of Rural Water Systems and Selected Factors

Factors	Level of Effectiveness: High	Level of Effectiveness: Low/Medium	Statistical Tests
Location of Systems in Texas Regions			
Northeast (N=24)	13 (54%)	11 (46%)	X2= 5.57
			G= 0.23
South (N=20)	8 (40%)	12 (60%)	r= 0.15
Southwest (N=25)	14 (56%)	11 (44%)	
Northwest (N=23)	6 (26%)	17 (74%)	
Degree of Knowledge of Project			
High (N=28)	22 (79%)	6 (21%)	X2= 29.53**
			G= 0.80
Moderate (N=32)	16 (50%)	16 (50%)	r= 0.56**
Low/None (N=32)	3 (9%)	29 (91%)	
Length of Water Usage			
16 or more yrs. (N=22)	11 (50%)	11 (50%)	X2= 4.52
			G= -0.22
11-15 yrs. (N=22)	11 (50%)	11 (50%)	r= -0.15
6-10 yrs. (N=35)	17 (49%)	18 (51%)	
Less than 5 yrs. (N=12)	2 (17%)	10 (83%)	

Table 16 (continued)

Factors	Level of Effectiveness: High	Level of Effectiveness: Low/Medium	Statistical Tests
Whether Denied Water Connection			
Yes (N=31)	10 (32%)	21 (68%)	X2= 8.56*
			G= -0.18
No (N=56)	31 (56%)	25 (44%)	r= -0.06
Not sure (N=5)	0	5 (100%)	
Plan to Continue with System			
Yes (N=82)	40 (49%)	42 (51%)	X2= 5.43*
			G= 0.79
No/Not sure (N=10)	1 (10%)	9 (90%)	r= 0.24**
Favor Consolidation into MUD			
Yes (N=11)	4 (36%)	7 (64%)	X2= 14.0**
			G= 0.46
No (N=56)	33 (59%)	23 (41%)	r= 0.25**
Not sure (N=24)	3 (12%)	21 (88%)	
Favor Consolidation into Other System			
Yes (N=8)	6 (75%)	2 (25%)	X2= 15.0**
			G= 0.74
No (N=57)	31 (54%)	26 (46%)	r= 0.41**
Not sure (N=25)	3 (12%)	22 (88%)	

Table 16 (continued)

Factors	Level of Effectiveness: High	Low/Medium	Statistical Tests
Favor Consolidation into SUD			
Yes (N=21)	16 (76%)	5 (24%)	X2= 21.71**
			G= 0.74
No (N=42)	22 (52%)	20 (48%)	r= 0.48**
Not sure (N=27)	3 (11%)	24 (89%)	
Own Well			
Yes (N=14)	10 (71%)	4 (29%)	X2= 4.82*
			G= 0.58
No (N=78)	31 (40%)	47 (60%)	r= 0.23*
Water Used For			
Household (N=28)	6 (21%)	22 (79%)	X2= 18.92**
			G= -0.67
For irrigation (N=42)	17 (40%)	25 (60%)	r= -0.36**
For commercial/ dairying (N=21)	17 (81%)	4 (19%)	
All purposes (N=1)	1	0 (100%)	

Table 16 (continued)

Factors	Level of Effectiveness: High	Low/Medium	Statistical Tests
Average Water Bill			
$101 or more (N=23)	18 (78%)	5 (22%)	X2= 14.12**
			G= 0.53
$31-$100 (N=47)	16 (34%)	31 (66%)	r= 0.33**
Below $30 (N=22)	7 (32%)	15 (68%)	
Water Charges			
Too high (N=36)	4 (11%)	32 (89%)	X2= 28.59**
			G= -0.83
Moderate/ fair (N=55)	37 (67%)	18 (33%)	r= -0.49**
Not sure (N=1)	0	1 (100%)	
Distance From Municipality			
41 or more miles (N=13)	2 (15%)	11 (85%)	X2= 7.31
			G= 0.16
21-40 miles (N=17)	11 (65%)	6 (35%)	r= 0.14
20 or fewer miles (N=60)	28 (47%)	32 (53%)	
Attend Annual Meetings			
Yes (N=37)	31 (84%)	6 (16%)	X2= 35.92**
			G= 0.92
No (N=55)	10 (18%)	45 (82%)	r= 0.65**

Table 16 (continued)

Factors	Level of Effectiveness: High	Low/Medium	Statistical Tests
System Helps Community Other Than Water			
Yes (N=44)	38 (86%)	6 (14%)	X2= 60.08**
No (N=33)	1 (3%)	32 (97%)	G= 0.91
Not sure (N=15)	2 (13%)	13 (87%)	r= 0.67**
Experienced Any Problems with System			
2 or more (N=39)	11 (28%)	28 (72%)	X2= 5.16
1 problem (N=22)	12 (54%)	10 (46%)	G= 0.34
No/not sure (N=26)	13 (50%)	13 (50%)	r= 0.20
Growth Pattern of Water System			
Grown (N=53)	38 (72%)	15 (28%)	X2= 37.50**
Stayed same (N=21)	2 (9%)	19 (91%)	G= 0.90
Gone down (N=8)	0	8 (100%)	r= 0.54**
Not sure (N=10)	1 (10%)	9 (90%)	

Table 16 (continued)

Factors	Level of Effectiveness: High	Low/Medium	Statistical Tests
System Provides Sense of Community			
Yes (N=41)	33 (80%)	8 (20%)	X2= 39.20**
			G= 0.81
No (N=14)	1 (7%)	13 (93)	r= 0.58**
Not sure (N=37)	7 (19%)	30 (81%)	
Whether Participated/ Held Position in the System			
Yes (N=21)	18 (86%)	3 (14%)	X2= 16.55**
			G= 0.85
No (N=71)	23 (32%)	48 (68%)	r= 0.45**
Whether Use Own Filter System			
Yes (N=12)	8 (67%)	4 (33%)	X2= 1.93
			G= 0.49
No (N=79)	32 (40%)	47 (60%)	r= 0.18*
Whether System Can Be Improved			
Yes (N=43)	21 (49%)	22 (51%)	X2= 1.26
			G= 0.31
No/not sure (N=33)	11 (33%)	22 (67%)	r= 0.16

Table 16 (continued)

Factors	Level of Effectiveness: High	Low/Medium	Statistical Tests
Sex of Respondent			
Male (N=69)	34 (49%)	35 (51%)	X2= 1.77
			G= 0.38
Female (N=23)	7 (30%)	16 (70%)	r= 0.16
Age of Respondent			
56 years or more (N=30)	18 (60%)	12 (40%)	X2= 10.19**
			G= -0.49
36-55 years (N=38)	19 (50%)	19 (50%)	r= -0.32**
Less than 35 years (N=23)	4 (17%)	19 (83%)	
Number in Household			
5 or more (N=31)	11 (35%)	20 (65%)	X2= 1.9
			G= -0.16
3-4 (N=49)	25 (51%)	24 (49%)	r= -0.08
1-2 (N=12)	5 (42%)	7 (58%)	
Race			
White (N=48)	24 (50%)	24 (50%)	X2= 10.06**
			G= 0.043
Black (N=11)	0	11 (100%)	r= 0.01
Hispanic (N=33)	17 (51%)	16 (49%)	

Table 16 (continued)

Factors	Level of Effectiveness: High	Level of Effectiveness: Low/Medium	Statistical Tests
Housing			
Own home (N=58)	37 (64%)	21 (36%)	X2= 21.43**
			G= -0.86
Rent (N=34)	4 (12%)	30 (88%)	r= -0.51**
Annual Family Income			
31K or more (N=19)	17 (89%)	2 (11%)	X2= 26.83**
			.G= 0.74
21-30K (M=32)	16 (50%)	16 (50%)	r= 0.52**
11-20K (N=25)	6 (24%)	19 (76%)	
Below 10K (N=16)	2 (12%)	14 (88%)	

*Probability value significant at .05 to .01.

**Significant at .001 or less.

APPENDIX B:

Questionnaires used

THE QUESTIONNAIRE FOR SURVEY OF FM.H.A. DISTRICTS IN TEXAS

Please provide the following information anonymously and in as much details as you possibly can.

1. How many total rural water supply systems do you have in your District? _____

2. What percentage of these systems are predominantly
   a) white____ b) black and/or Hispanic____

3. We want to know the overall status of Fm.H.A. loans given to rural water systems in your District during the past five years. Please indicate:
   a) The number of rural water systems which have been sold off to other agencies? ____
   b) The number of rural water systems you still hold loans for today? ____

4. Approximately, what percentage of rural water systems in your District during the past five years or so have:
   a) provided public sewerage facilities_____
   b) provided water for commercial purposes_____
   c) been delinquent in paying loans_____
   d) been in violation of water quality standards_____
   e) been in violation of organizational or operation standards such as not having trained operators_____
   f) been consolidated with other system(s)_____
   g) been given maintenance grants by you_____
   h) had a negative impact on the area_____

5. What are some of the most frequently identified important needs and/or problems or rural water systems in your District?_____
   _____
   _____
   _____

6. What are some of your suggestions to meet those needs or overcome those problems?_____
   _____
   _____
   _____

PLEASE USE OTHER SIDE OF THIS SHEET FOR ADDITIONAL DETAILS OR COMMENTS REGARDING RURAL WATER SYSTEMS IN YOUR DISTRICT.

THE QUESTIONNAIRE USED FOR TELEPHONE SURVEY OF OFFICIALS OF THE RURAL WATER SYSTEMS IN TEXAS

1. Your position: _____

2. How long held: _____

3. Approximately, what year did this system begin operation? _____

4. What are the goals of your water system?
_____

5. Approximate number of water connections/hookups served:
   a) Residential: _____
   b) Commercial: _____

6. If new or prospective customers call you today, do you have water connections available in your system at present?
   Yes _____; No _____
   Comments:_____

7. Approximately, how many residents located within your system have been denied water connections by you? _____ Or don't use water from you? _____

8. Approximately how many miles of pipe does your water system have? _____

9. Do customers in your system pay for pipes and their installations? Yes _____; No ____

10. Number of your staff members: (a) Full-time ____; (b)Part-time ____; (c) Certified ____

11. Is this system a: (a) single or multi county? _____
    (b) Predominantly rural farm? _____
    (c) Predominantly rural non-farm? _____

12. What are the sources of your water supply?
    (a) Wells, how many? _____
    (b) Surface water, what kind?_____
    (c) Others: _____

13. Approximately how many of your customers also possess their own private wells? _____

14. Overall, has the amount of water use in your water system during the recent past been: Increasing? _____ Decreasing?_____ Staying the same? _____

15. What rate do you charge for water?
    (a) Uniform meter rate _____; How often are meters read?_____
    (b) A step rate (increasing as water use goes up) _____
    (c) A decreasing rate as water use rises _____
    (d) A fixed or flat charge without meters _____

16. Are your system's operation and maintenance costs:
    (a) higher than your income? _____
    (b) lower than your income? _____
    (c) about equal? _____
    (d) increasing steadily? _____
    (e) decreasing? _____
    (f) staying stable? _____

17. Is the water supply from your system:
    (a) adequate to meet all water demands of present customers?_____
    (b) inadequate? _____

18. How often are the following done in your system?
    (a) Chlorination of water: _____
    (b) Ration water: _____
    (c) Test water samples: by who and in what way?

    _____
    and by other agencies and what tests?

    _____

19. What types of individuals and/or firms handle your operation and maintenance?_____

20. Do you presently have a set schedule under which the system equipment is monitored and/or serviced? Yes _____; No _____

21. Based on your experience with your system, what seems to be the most frequent problems regarding operation and maintenance of the physical system? (list the most frequent first)_____

22. What is the general nature of the major customer complaints regarding the water system? (most the frequent first)_____

23. Have you been in any violation of EPA's or Texas Health Department's water quality standards? Yes _____; No_____. If yes, explain the the nature and frequencies of these violations: _____
    _____

24. What are your major sources of funds for operation and

maintenance ofthe system? Customers _____
Others: _____

25. What percentage of water that you pump annually is lost? _____ What are the causes of that loss, if known? _____

26. Are your records of accounts and operations:
(a) In good shape? _____
(b) Rather incomplete? _____
(c) Don't exist? _____
Comments:_____

27. Do your believe that federal and state regulations of rural water systems are too many? Yes _____; No _____;
How? _____
and too stiff? Yes _____; No _____;
How? _____
And what should they do for you?_____

28. Is your water system a member of the Texas Rural Water Association? Yes _____; No_____. If no, why not?
_____
If yes, what are your benefits?
_____
What would you like TRWA to do for you?
_____

29. Is Fm.H.A. beneficial to your system or do you have problems with that organization?_____

30. Has your loan already been sold by Fm.H.A. to another organization? Yes _____; No _____. If yes, how do you feel about this?_____

31. Are you interested in merging or consolidating your system with a municipality? Yes _____; No _____. Why?
_____
Or with other rural water systems(s)? Yes _____;
No_____. Why or why not?_____

32. Have you explored alternative sources of maintenance or operation funds or grants from organizations other than Fm.H.A.? Yes _____; No _____. If yes, what sources?
_____

33. Have you made any projections or plans for your system for future years (e.g. year 2000 or beyond)? Yes _____;
No _____. If no, why not?_____
If yes, what plans?_____

34. Of your water users, approximately what percentage are:
White _____; Black _____; Hispanic _____; Other_____

35. Approximately, what is the average annual family income in your system?

Below $10,000 _____	30,001 to 40,000 _____
10,001 to 20,000 _____	40,001 to 50,000 _____
20,001 to 30,000 _____	over 50,001 _____

36. What changes would you like to see in this system?

_____

37. In your assessment, what are some of the important negative and/or positive impacts of your water system on your area?_____

THANK YOU. COMMENTS, IF ANY:

THE QUESTIONNAIRE USED FOR THE SURVEY OF CONSUMERS IN SELECTED RURAL WATER SYSTEMS

1-3. ID# _____ **4.** Location: _____

5. What is the name of your water system? _____

6. What year was it started? _____

7. Do you know any of its officials/board members?
Yes____No___

8. How long have you been using water from this system?
_____ years

9. Have you and/or people known to you ever been denied water connection by the system? Yes___ No___;
Why?_____

10. 888888888Do you plan to continue using water from this system? Yes___ No
Why?_____
_____

11. Would you be in favor of consolidating this system:
(1) into a MUD or municipal district? Yes___ No___
(2) into other contiguous system(s)? Yes___ No___
(3) into a SUD? Yes___ No___
Why? _____

12. Do you also own a private well? Yes___ No___

13. What do you use water from this system for?
household needs _____
lawn & gardening _____
farm and agriculture _____
dairying _____
other commercial needs_____

14. What is your average water bill? $_____

15. Are water charges: too high?____ moderate or fair? ____

16. How far do you live from a municipality? _____

17. Do you attend annual meetings of this water system?
Yes____ No____;
Why?_____

18. Does this water system help your community in ways other than supplying water? Yes___ No___
Why or how?_____

19. Have you experienced any of these problems related to water supply during the past three years?

(1) odor in water _____; describe: _____

(2) unusual pollutants _____; describe: _____

(3) muddy or colored water _____; describe: _____

(4) unusual disruptions of water___;describe: _____

(5) other problems _____; describe: _____

20. Since you joined this water system, has it:

grown extensively? ____

stayed the same? ____

gone down? ____

21. In what way or to what extent does this water system provide its members a sense of community? _____

22. Have you participated (or held a position) in any aspect of this water system? Yes___ No___

If yes, what? _____

23. Do you use your own filter for water from this system for household use? Yes___ No___

24. Overall, what is your evaluation or assessment of the effectiveness or productivity of this water system?

Highly effective ... Less effective

5 4 3 2 1 0

25. What can be done to improve the productivity or efficiency of this system? _____

26. Your gender: M___ F___

27. Age: _____ years

28. How many are in your household? _____

29. Your ethnicity: White_____ Black_____ Hispanic_____ Other _____

30. Do you rent? _____ or own your residence? ____

31. Your family's approximate annual income:

Below $10,000 _____; 11 to 20,000 ____;

21 to 30,000 _____: 31 to 50,000 ____;

51,000 or more ____