A GUIDEBOOK FOR ECONOMIC PLANNING OF RURAL WATER SYSTEMS

Bulletin B-773 March 1984
Agricultural Experiment Station
Division of Agriculture
Oklahoma State University

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Research reported herein was conducted under Oklahoma Station Project No. 1765 in a joint effort with EDD, ERS and USDA. Funding for the research involved was facilitated through the Local Decisions Project.

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A GUIDEBOOK FOR ECONOMIC PLANNING OF RURAL WATER SYSTEMS

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INTRODUCTION

A major determinant of the quality of life in rural areas is an abundant supply of high quality water for domestic use. Agricultural and industrial water requirements must also be met if rural areas are to flourish. Rural residents have for years relied on groundwater or have hauled water for their needs. Some rural areas do not have adequate supplies of quality water. Indications are that the water supply problem will continue or perhaps become worse in the future due to population growth.

Community leaders are particularly concerned with the water issue. Several problems confront these leaders as they attempt to plan and develop water supply and distribution systems to adequately meet their present and future needs. A more accurate method of estimating future water needs of a system is needed in order to plan for future system size. In addition, system size may be partially determined on the basis of existence of economies of size. Determination of system costs is also vital. It may be useful for leaders to consider alternative organizational structures such as consolidation or merger which might lend additional operational or financial efficiency to the current system.

The primary objective of this study is to develop methods which will allow decisionmakers in rural water districts to better utilize available information in evaluating alternatives for water system planning. Specifically, the objective is to develop:

1. a method to estimate water system capacity and future water use based on historical water use trends, socio-demographic data and population projections;
2. a method to identify the existence or non-existence of economies of size in rural water districts; and
3. a method to evaluate possible advantages and disadvantages of system consolidation.

Estimating Water System Capacity

In estimating system capacity, there are four primary areas of concern: raw water supply; treatment capacity; storage capacity; and distribution. To estimate the supply of raw water reliable yields for

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reservoirs or other supply sources should be obtained either from engineering reports or contractual agreements with water suppliers. Treatment capacity information can generally be obtained from engineering reports. FmHA recommends that each water system have a storage capacity equal to twice its daily use to help insure both adequate water volume and pressure. Distribution involves both pumping and distribution lines. FmHA and/or any reputable engineering firm can calculate pumping requirements and the maximum number of families which can be served by any particular size of line.

Estimating Water Use

Methods employed in analyzing historical water use and estimating future use are presented below. Water use is estimated on a per customer basis and then extended to apply on a system-wide basis.

In past research efforts, three methods have been employed to estimate future water use. These include: 1) the cross-sectional approach; 2) the regression approach; and 3) a combination of cross-sectional and time-series approach. Separate studies by Sloggett and Badger, 1974 [9], Goodwin, et al., 1979 [3], and Kuehn, 1980 [5] have focused on water use in Oklahoma and Missouri. Results of these research efforts show monthly per customer water use to be 4,588 gallons, 6,900 gallons and 5,504 gallons respectively for the study years 1974, 1979, and 1980.

Per Customer Water Use

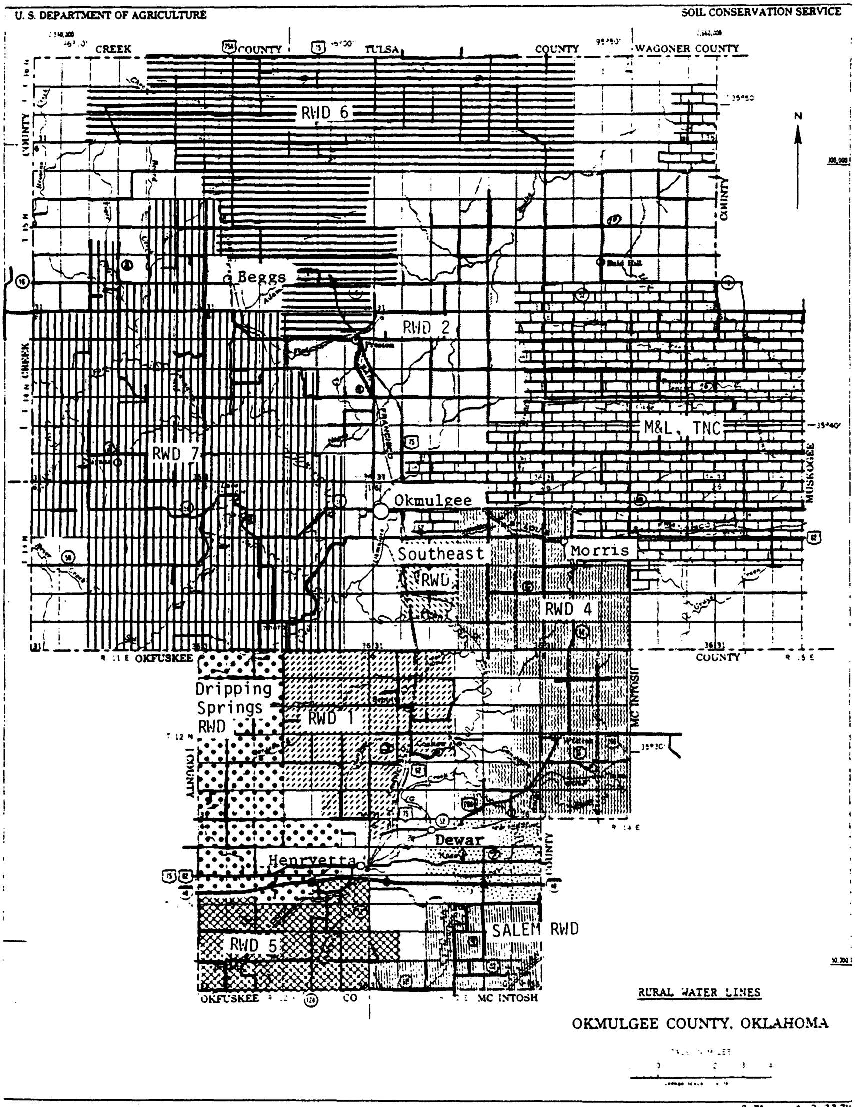
Four methods are employed in this study to estimate water use. For ease of discussion, they are referred to as: 1) constant; 2) percentage increase; 3) trended increase; and 4) regression estimation.

The study area consists of Okmulgee County and portions of seven adjacent counties: Tulsa, Wagoner, Muskogee, Creek, Okfuskee, Hughes and McIntosh. For ease in discussion, the study area will be referred to as Okmulgee County. Okmulgee County currently has 11 rural water districts (RWD'S) and 5 municipal systems. Current service areas of the 11 RWD's excluding areas in adjacent counties are shown in Figure 1. The data used to estimate water use for the first three methods were obtained through interviews with system managers and clerks, health department officials and board members. In the case of regression analysis, data were obtained by mail questionnaires.

<u>The Constant Method</u>. Daily per customer water use in 1980, based upon historical data for rural Okmulgee County, was 240 gallons. It is assumed in the constant method that the per customer water use remains constant to the year 2000. This method uses the average daily water use derived from dividing total water use by the number of rural customers.

<u>The Percentage Increase Method</u>. This method utilizes percentage increases in daily per customer water consumption provided by the Corps of Engineers in the Phase One Oklahoma Comprehensive Water Plan [8] to derive water use estimates. The Corps estimates

FIGURE 1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SOIL CONSERVATION SERVICE
CREEK
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TULSA
COUNTY
WAGONER COUNTY
RWD 6
Beggs
RWD 2
M&L, TNC
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Springs
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RWD 1
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Dewar
Henryetta
SALEM RWD
RWD 5
OKFUSKEE
CO
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that during the four 5-year periods from 1980 to 2000, daily per customer water use will increase 5 percent, 4 percent, 3.5 percent, and 3 percent, respectively. These estimated increases, when applied to the base water use figure of 240 gallons, give daily per customer water use of 252 gallons, 262 gallons, 271 gallons and 279 gallons for the years 1985, 1990, 1995 and 2000, respectively.

<u>The Trended Increase Method</u>. The third estimation method utilizes data provided by water systems in Okmulgee County in developing models for three areas: 1) all rural areas; 2) Beggs, Morris and Dewar; and 3) Okmulgee and Henryetta. The model extends the past trends for daily water use for each of the entity groupings. Daily per customer water use for rural areas, for example, has increased from 156 gallons in 1970 to 240 gallons in 1980. If this trended increase continues through the year 2000, daily per customer water use for rural areas will then be 409 gallons.[1/]

<u>The Regression Method</u>. The fourth estimation method employs multiple regression analysis to arrive at estimates for water use. For purposes of this study, average monthly water use per customer was estimated as follows:

Monthly Water Use = f(number of persons in household, year house was built, educational attainment of household head, non-domestic water uses, annual family income).

Hypotheses concerning each variable's relationship to monthly use are:

1. Number of persons in household (NOPERS) - It is hypothesized that an increase in number of persons per residence would increase the amount of water used.

2. Year house was built (BUILT) - Inclusion of modern conveniences such as dishwashers, washing machines, garbage disposals and showers in homes built in the last several years is more common than for older homes. The year in which the residence was built proxies for the presence of any modern conveniences. Theoretically, one would expect water use to be higher the newer the residence.

3. Education (TOTED) - In general, people with a higher level of education tend to demand better services and more conveniences. Thus, it is hypothesized that total years of education and water use are positively correlated.

4. Non-domestic use - This factor accounts for the number of stock watered and the irrigation of home gardens.

    a. Water for stock (STOCK1, STOCK2) - STOCK1 and STOCK2 are the variables designated to account for the number of cattle and horses, respectively, watered from rural water services.

[1/] Results of one model are presented in Appendix I, Tables 3 and 4.

b. Gardens (G1, G2) - G1 is structured as a dummy variable, receiving a value of 1 if the home garden was irrigated and zero otherwise. The contribution of G2 is included in the intercept terms. It is anticipated that a positive relationship exists between the presence of an irrigated garden and water use.

5. Annual family income (XL, XU) - In the analysis, XU received a value of 1 if the income exceeded $40,000 and zero otherwise. The contribution of XL is included in the intercept form. Income and water use are hypothesized to be positively related.

Regression analysis of several models was completed. The following equation, based on 660 observations, was considered best on the basis of statistical reliability and economic consistency.[2/]

MOGALS = -1,505.73 + 954.86 NOPERS + 33.85 BUILT + 102.76 TOTED + 55.49 STOCK1 + 183.60 STOCK2 + 953.86 G1 + 2,221.92 XU

It can be seen that for each additional person in a rural household, monthly water use will increase by 954.86 gallons, ceteris paribus. The coefficient which relates age of the residence to water use indicates that water consumption increases by 33.85 gallons per month the newer the house. Other things remaining the same, each additional year of formal education for the household head is projected to increase monthly water consumption by 102.76 gallons. Each cow and horse watered from a rural water system will require 55.49 and 183.60 gallons per month, respectively. The presence of an irrigated garden will add 953.86 gallons per month, ceteris paribus. A family whose income is equal to or above $40,000 will use an additional 2,221.92 gallons of water per month.

If the mean value of each independent variable is applied to the equation, an average monthly water usage of 5,887 gallons is estimated. This is well within the bounds of recent studies [3], [5]. Based on this equation, a typical rural family of four with a household head who has a college education and an annual income of $30,000 maintains a family garden, has a cow and horse and lives in a home built in 1975 with a monthly water bill of $25.00 will use 7,737 gallons.

Total System Water Use

The above methods involve estimating water usage on a per tap basis. A demographic model developed by Oklahoma State University Extension Service [6] is used to project population for an area. Dividing each population estimate by the number of persons per tap yields the total number of taps. Total system water needs can be estimated by multiplying the number of taps by the per customer water use.

2/ All coefficients were statistically significant at a level greater than .01 except TOTED, which was significant at the .05 level. R^2 value was .387.

Economies of Size in Rural Water Systems

Rural water systems are currently being affected by increasing economic pressures. Demand for water is increasing due to increasing customer numbers and increasing per capita water consumption. As a result, many rural systems are confronted with choosing to serve additional customers through expansion or limiting their systems to serve only current customers. Expansion is often the selected alternative. This generally requires enlarged facilities to treat, store, or distribute adequate volumes of water to the customers.

Several questions repeatedly surface in the decisionmaking process involved with water system planning. Should the policy-making body adopt an expansion strategy or elect to maintain the system at its current size? Can the number of customers be increased within the bounds of existing system capacity? Can economic advantages be gained with expansion? Is it possible that higher quality water service can be provided with a larger system? Is consolidation a viable vehicle for attaining managerial, operational, or financial improvements in the system? What can be expected in the political, physical, legal, and financial senses if the option of consolidation is selected?

Service District Consolidation

Economies of size is a long-run concept. It measures the costs of providing services to an area of given size excluding any short-run size adjustments. In many ways, it is appropriate to view consolidation of water districts in light of economies of size. It may be that a district with high average costs would consolidate with a district with lower average costs and a constant cost structure. This might lower costs for the first district without appreciably affecting the costs of the second.

Operation, construction, and maintenance costs which change as a result of consolidation may be evaluated. The effect of increased customer number and change in customer density might also be analyzed. However, expenditures for service provision respond to such changes in a lagged fashion and as a result may either understate or overstate initial changes in expenditures [2]. Size-economies research addresses only the cost side of service provision. Population changes due to consolidation might change the income of the area, thereby changing demand for water services and resultant revenues. These revenues must be considered in evaluating net results of changes in average costs related to consolidation.

It is evident that not all potential benefits and costs of consolidation are revealed through the strict economic analysis of economies of size research. Consolidation may result in changes in service quality, a factor which must be considered when evaluating consolidation. Also to be considered are factors such as political feasibility, technical and financial constraints to consolidation, and legal questions which may arise as a result of consolidation.

Review of Selected Rural Water Studies

Much of the research on economies of size has involved the estimation of average cost (AC) curves, where AC is dependent upon a series of factors representing price and quantity of inputs, service conditions such as population and weather, state of technology and scale of output. Ordinary least squares regression has been the most widespread technique employed in economies of size research. Representative of this type of research are studies by Daugherty and Jansma [1], Goodwin, et al. [3], and Kuehn, et al. [5].

Research by Daugherty and Jansma [1] involved 246 Pennsylvania water authorities ranging in size from 55 to over 42,000 customers. Very slight economies existed when customers served and water sold increased at the same rate; substantial size economies resulted if water use per customer increased. Sloggett and Badger [9] investigated the economies of size question by employing a per customer cost approach to 57 Oklahoma rural water districts (only 8 of these systems had 500 or more customers). They found that the number of customers appeared to have no significant effect on costs. Goodwin, et al. [3] attempted to detect possible economies of size in Oklahoma rural systems. There was not conclusive evidence to indicate economies of size existed over the range of observations (89 to 1,285 customers) involved in this study. Another research effort by Kuehn, et al. [5] investigated rural water systems in Missouri for possible economies of size. No definite conclusions could be drawn concerning economies of size because the sample of 72 contained very few large districts.

Data and Analysis

Data for economies of size analysis were gathered from 111 systems throughout Oklahoma and Missouri. Information for each system was obtained through interviews with system clerks and managers, district audits, and State Health Department and FmHA records. Annual costs were categorized as either capital or operating. Capital expenditures were those going toward equipment purchase and system debt service. All other expenditures were considered to be operating costs. Cost data were for FY 1978, 1979 and 1980 but were adjusted to 1980 dollars by use of the Consumer Price Index. The RWD's in the study area were classified by one of three water sources: groundwater; water treatment; or treated water purchase. Size of the systems in terms of customers served ranged from 98 to 1,585. In all, 28 systems utilized a groundwater source, 18 utilized water treatment, 57 purchased treated water, and 7 systems used a combination of groundwater and purchased treated water.

Data for the study area were analyzed to detect any economies of size which might exist in annual total, capital or operating costs. A regression analysis was carried out for all systems in the aggregate and for each of the system classifications. Models run for each classification were:

Annual total cost per customer = f (Number of customers),
Annual capital cost per customer = f(Number of customers), and
Annual operating cost per customer = f (Number of customers).

Results for regression analysis for all systems and for systems by water source are shown in Table 1. These results indicate that none of the models tested had high R^2--values or statistically

TABLE 1

RESULTS OF ECONOMIES OF SIZE ANALYSIS, BY COST CATEGORY AND WATER SYSTEM CLASSIFICATION

SYSTEM TYPE	N	VARIABLES SIZE	VARIABLES INTERCEPT	R^2
All systems				
Total costs	111	-.026	65.275[c]	.015
Capital costs	111	-.012	22.122[c]	.016
Operating costs	111	-.016	27.470[c]	.024
Groundwater				
Total costs	13	-.142	227.183[b]	.030
Capital costs	13	-.120	140.386	.035
Operating costs	28	-.032	46.491[b]	.043
Water treatment				
Total costs	6	.042	55.201[a]	.435
Capital costs	6	.012	-3.162	.172
Operating costs	18	.008	2.102	.050
Purchased water				
Total costs	22	-.008	123.094[c]	.002
Capital costs	22	-.024	62.928[c]	.024
Operating costs	57	-.016	23.966[c]	.028
Combination system				
Total costs	7	-.119	87.298	.159
Capital costs	7	-.039	29.253	.110
Operating costs	7	-.080	58.045	.185

a/ Statistically significant at the .1 level.
b/ Statistically significant at the .05 level.
c/ Statistically significant at the .01 level.

significant coefficients. Therefore, it was concluded that for the range of observation in this study, no economies of size existed in total, capital or operating costs.

From this analysis, one conclusion seems plausible. The districts are probably operating in that portion of the cost structure for all systems which appears to be relatively constant. The study may be criticized for not having enough observations in the large categories. If larger rural systems were available for inclusion in the analysis, perhaps economies of size would have evidenced themselves.

Consolidation of Rural Water Districts

As rural water systems continue to face economic pressures, some decisionmakers will consider consolidation of systems as an alternative. FmHA, in 1973, altered its regulations to allow and encourage mergers. According to FmHA Instruction 451.5, State Directors are authorized to approve mergers or consolidations (hereafter referred to as mergers) when the resulting association will be eligible for an FmHA loan and assumes all the liabilities and acquires all the assets of the merged borrowers. Mergers are allowed when: (1) they are in the best interests of the Government and borrower; (2) the borrower can meet operating and maintenance expenses, debt repayment and maintain required reserves; (3) all property can be transferred to the borrowers; and (4) the membership of each organization involved and a majority of their members approve the merger [4].

To provide decisionmakers with information on consolidation, the study involved interviewing operators of seven consolidated districts in Oklahoma and Missouri. These districts ranged in size from 264 to 3,813 hookups (taps) and were the only consolidated rural districts in the time period from March 1975 to April 1980.

Data were obtained through interviews with individual water system boards and employees and from FmHA records. The data for each district include: 1) reasons for consolidation; 2) the consolidation process; 3) changes in physical operation; and 4) financial status. These data were analyzed to discern changes within the districts which might have resulted from consolidation.

Reasons for Consolidation

Interviews with board members and personnel of the seven consolidated districts indicated that the idea of consolidation was posed to them by FmHA in three of the seven districts; FmHA encouraged all seven consolidations. The four districts which considered consolidation on their own accord cited several reasons for this approach to organization. Many of the original districts (16 before consolidation, seven after) realized that increased size would enable them to hire full-time employees for management and maintenance, thereby improving the service quality and financial stability of the system. There was an expressed desire to be in the position to extend services to new areas or increase them in current service areas of increasing settlement. Two of the districts in the study consolidated to secure adequate water supplies by drilling wells and cancelling unappealing water purchase agreements. Others wished to stabilize water pressure by interconnecting distribution lines. Two districts cited consolidation as an instrument by which they could become more competitive for state and federal assistance through grants and loans. In one district, FmHA strongly suggested consolidation due to the apparent inability of the districts to provide appropriate service or financial management.

The Consolidation Process

Not all districts approached concerning the possibility of consolidation agreed to it. In Nowata County, for example, four other districts were afforded the opportunity to merge with the two that did. In Vernon County, one of the districts approached concerning consolidation refused. Their reason was fear of loss of local control or autonomy of their water district. FmHA officials indicate that this is the primary stumbling block to the consolidation process. In many rural areas, the only governmental form present is a rural water district.

The districts which chose to consolidate expressed the same concerns, but thought the potential advantages in consolidation outweighed their fears of loss of control. Only one of the seven districts experienced any problems in obtaining cooperation and harmony between the formerly independent RWDs. This happened to be the district which FmHA reprimanded for poor operation and management, but all problems of this nature have been overcome and now no apparent jealousy or dissension exists.

Changes in the Physical Operation

The primary changes occurring in the consolidation of districts were: (1) hiring full-time management and maintenance personnel; (2) installation of interconnecting lines between districts; and (3) adding to or changing their water source. Before consolidation, only five of the sixteen districts had full-time personnel. Upon consolidation, all of the districts were served by full-time employees or several part-time employees engaged in billing, management, and maintenance. These employees can now be expected to detect and repair malfunctions in the system with a higher degree of efficiency than the volunteers who were previously relied upon. All but one of the consolidated systems own their own equipment (backhoes, trenching equipment, trucks) which may be utilized to repair system breakdowns or extend facilities. This, coupled with the existence of personnel availability, greatly improves the rapidity and quality of repair and maintenance. The presence of full-time management assists in coordination of operational functions, purchasing, billing, handling of complaints, and obtaining information on sources of aid.

Interconnection of lines helped to stabilize water pressure and quantity of water available in the systems for their customers. Looping lines so that a continuous circuit of water existed was a major improvement in many of the districts. By interconnecting lines, it was possible to achieve increased service capability in terms of water quantities throughout the consolidated districts. In three of the seven districts, distances as short as one mile separated existing distribution lines of independent districts.

The third major area of improvement was in the addition or changing of water sources. This was a particularly important aspect for the Vernon County district, which was able to obtain its own water source by drilling wells. The establishment of these wells enabled them to no longer be reliant on other communities through purchased water contracts. For the four other districts using groundwater as their water source, it was possible to drill additional wells to meet increased demand in the areas where the best and most reliable water existed. This was not possible before consolidation. The systems utilizing purchased water are also in a better bargaining position now than before because they are larger single purchasers and can be relied upon to provide revenues to their water suppliers through increased purchases.

Financial Status

Six of the seven districts reported positive net revenues for the year ending December 31, 1980. Before consolidation, there were five districts reporting negative net revenues. Rate structures were greatly simplified in most instances through consolidation, as were the debt structure of the systems. It was possible for all outstanding loans to be refinanced by FmHA.

More interesting than net revenues and rate or debt structures is the cost per customer information that was generated through data obtained from the district. This information is supplemental to the economies of size analysis reported earlier in the chapter and may be combined with it to draw implications concerning the value of consolidation with respect to cost savings. The cost per customer information for the consolidated districts appears in Table 2. Cost figures were obtained from system records. The costs for systems before consolidation were obtained from the audit of the last year's operation and were adjusted to 1980 dollars using the Consumer Price Index. Cost figures for consolidated districts were from audits for the year ending December 31, 1980 and are also in 1980 dollars.

If no consolidation had taken place and both customer numbers and cost structures remained constant, annual costs per customer for Mutual would have been $285.31 instead of the current $220.87 after consolidation. For all consolidated districts except Vernon County, annual costs per customer are less after consolidation than they would have been without consolidation. It is also interesting to note the wide differences in capital and operating costs between districts, especially between the first four districts (Oklahoma) and the last three districts (Missouri). This is due largely to accounting differences. Therefore, the figures representing annual total costs per customer are probably most valuable in drawing implications, although the change in capital and operating costs within a system are important.

Lower per customer costs in consolidated water systems are most likely the result of improved management and elimination of duplicate services. With full-time management and maintenance personnel available, costs incurred due to water losses, less than optimal utilization of equipment, expensive contract labor and small- quantity purchasing of material can be reduced. It is also possible to eliminate costs which accrue as a result of duplicate office facilities, part-time labor and inefficient billing and record-keeping practices. Considerable cost per customer decreases, up to 85 percent in the comparison case of Watova and Consolidated Nowata County RWD #4, are shown in the case studies.

TABLE 2. SUMMARY OF ANNUAL COSTS PER CUSTOMER FOR CONSOLIDATED DISTRICTS, BEFORE AND AFTER CONSOLIDATION

CONSOLIDATED DISTRICTS	YEAR OF OPERATION	NUMBER OF CUSTOMERS	COSTS PER CUSTOMER		
			TOTAL	CAPITAL	OPERATING
			---------dollars[a]-----------		
Alfalfa County #1	1980	546	210.84	131.92	78.92
Alfalfa County #1	1975	190	390.59	244.08	146.51
Dewey County #3	1980	306	220.87	128.10	92.77
N.W. Dewey	1975	145	252.33	135.90	126.43
Mutual	1975	120	285.31	126.42	158.89
Jefferson County #1	1980	931	317.45	175.44	142.01
Addington	1975	56	362.80	182.45	180.35
Hastings	1975	110	387.95	159.08	228.87
Nowata County #4	1980	264	160.72	65.68	95.06
Nowata County #6	1976	115	284.01	156.19	127.82
Watova	1976	65	298.12	189.95	108.17
Boone County #1[b]	1980	3,813	151.55	54.31	97.24
Boone County #5	1975	485	124.16	90.12	34.04
Boone County #6	1975	934	267.81	36.38	231.43
Boone County #8	1975	691	193.67	34.85	158.82
Pemiscot County #1[b]	1980	2,026	111.98	32.81	79.17
Pemiscot County #1	1976	355	325.50	44.94	280.56
Pemiscot County #2	1976	419	159.47	22.49	136.98
Pemiscot County #3	1976	618	142.25	25.58	116.67
Vernon County #1[b]	1980	1,354	195.98	49.70	146.28
Vernon County #3	1980	447	183.40	70.24	113.16
Vernon County #4	1980	907	178.63	35.83	142.80

[a]All costs are in terms of 1980 dollars.

[b]Capital costs do not include depreciation or transfers to reserve funds for these districts.

Application of Developed Methods

This study has developed methods to estimate water system capacity and water use, detect economies of size, and evaluate advantages and disadvantages of consolidation. Local decisionmakers involved with planning rural water systems may find some or all of these tools useful. The application of these tools is illustrated by examining a case study involving three RWD's in Okmulgee County. Forms have been structured to allow decisionmakers to identify the current system capacity and financial status of their districts, estimate future water use, and evaluate their future financial status. This should indicate to local decisionmakers how the tools can be used to aid in planning a water system. (See Appendix II.)

The case study includes Rural Water Districts #6 and #7 and M&L Water Incorporated in Okmulgee County. To aid the decisionmaker in this evaluation, tools developed in this study are employed to formulate:

1) an inventory of existing systems;
2) an estimate of water system capacity;
3) an estimate of water use;
4) an estimate of the financial condition of the proposed consolidated district (Consolidated Okmulgee County RWD#1); and
5) an evaluation of per customer costs with and without consolidation.

Inventory of the Existing System

RWD #6 is in northern Okmulgee and southern Tulsa Counties. As of July 1982, there were 1,553 customers in RWD #6. In 1981, 149 million gallons of treated water were purchased from the City of Okmulgee, 40.741 million gallons of which were resold to M&L Water, Inc. A grant of $600,000 and a five percent loan for $775,000 has been approved by FmHA for construction of treatment plant facilities on Brown Creek Reservoir in RWD #6. Plant capacity is 400,000 gallons per day; reservoir capacity is 250,000 gallons per day. Therefore, the additional water supply for the district as a result of reservoir capacity limitations will be 250,000 gallons per day or 91 million gallons per year. The project includes construction of 30,000 feet of ten-inch transmission lines and 90,000 gallons of storage.

The service area of RWD #7 is comprised of northwestern Okmulgee County. There were 520 customers being served as of July, 1982. Treated water was purchased from Okmulgee in the amount of 31,999,500 gallons in 1981. Currently, RWD #7 has a loan applicaton pending with FmHA for $255,000 for improvements to incoming supply lines and distribution lines. An additional incoming four-inch supply line is proposed for the western side of the district, as well as a nine-mile section of four-inch line to create a loop for increased water flow. RWD #7 can accept no new customers at the present time. Fifty-five applications for new service are pending which can be filled only upon completion of the improvement project. Engineering estimates show that an additional 250 customers can be added upon completion of the new supply and distribution line project.

M&L Water, Inc., serves 544 customers in northeastern and east central Okmulgee, northwestern Muskogee and southwestern Wagoner Counties. Treated water is purchased from RWD #6 and the City of Okmulgee. In 1981, M&L purchased 40,741,000 gallons from RWD #6 and 7,462,200 gallons from Okmulgee. Planned improvements for M&L consist of eight- and six- inch incoming supply lines from Okmulgee, some minor line loops, new 150 gallons per minute booster pumps in the present pump station and construction of a 70,000 gallon storage tank. The purpose of this project is twofold: (1) to increase water quantity and pressure available to customers and (2) to lower costs by becoming independent of RWD #6 for water through direct purchase from Okmulgee. In 1981, water from Okmulgee cost $.80 per 1000 gallons and water from RWD #6 cost $1.25 per 1000 gallons. Engineers for the district project that the improvements will enable the district to serve 900 total customers.

The financial situation for each of the three districts for 1981 is presented in Form 1. Income, capital, and operating expenditures, and net income are shown. All three districts had positive net incomes for 1981. Water sales comprise the majority of income, but annual membership charges of $25, $20 and $20 for RWD #6, #7, and M&L, respectively, do contribute to total income. Major expenditure items include wages and salaries, repair and maintenance, and water purchases. The debt payment expenditures shown are to FmHA for loan obligations. Depreciation varies by district according to the amount of equipment owned for repair and maintenance and the original value of the system facilities. Overall, procedural differences in accounting may make comparison of individual cost categories inappropriate, but the broad categories of capital and operating expenditures should be reliable for such comparison.

Estimating System Capacity

System capacity for the Consolidated Okmulgee County RWD #1 may be calculated following the procedure outlined on page 2. The limiting factors in determining water system capacity are raw water supply, treatment facilities, storage and pumping capacity, and distribution lines.

Water supply for Consolidated RWD #1 will be from two sources: (1) raw water from Brown's Creek Reservoir and (2) treated water from the City of Okmulgee. Brown's Creek is a Soil Conservation Service structure with storage capacity of 280 acre feet (91 million gallons). This storage represents the useful capacity for water supply. On a daily basis, this reservoir will supply 250,000 gallons. The remainder of the supply will come from the City of Okmulgee, which has long-term contracts with each of the three districts at present to supply them with unlimited quantities of treated water on demand.

Treatment capacity of the Brown's Creek plant is 400,000 gallons per day, well above the actual yield of the reservoir. Okmulgee has adequate capacity to provide the remainder of water demanded through the year 2000. The pumping facilities, which are now adequate for distribution will be improved in the M&L project and should be more than adequate.

FORM 1. FINANCIAL STATUS OF 6, 7 and M & L, DATE 6/30/81

FINANCIAL COMPONENT	RWD #6	RWD #7	RWD M&L
	Dollars		
I. INCOME			
A. Water Sales	239,367.24	129,861.25	128,243.99
B. Membership	36,400.00	9,600.00	10,800.00
C. Interest	27,806.08	-0-	-0-
D. Other	13,900.00	2,642.00	3,049.15
E. TOTAL (Add A, B, C and D)	377,473.92	142,103.25	142,093.14
II. EXPENDITURES			
A. Operating			
1. Wages & Salaries	50,059.91	15,571.02	16,500.00
2. Office & Administrative[a]	21,882.38	3,512.47	14,441.33
3. Utilities	18,728.35	8,952.32	439.12
4. Repair & Maintenance	24,579.32	8,461.17	14,328.27
5. Water Purchases	102,405.74	24,712.75	56,134.29
6. Other	3,167.17	-0-	-0-
7. TOTAL OPERATING (Add A.1, A.2, A.3, A.4, A.5 and A.6)	220,822.47	61,209.73	101,843.01
B. Capital			
1. Debt Payment	51,453.32	29,092.99	20,628.60
2. Depreciation	85,342.34	-0-	16,899.82
3. TOTAL CAPITAL (Add B.1 and B.2)	136,795.66	29,092.99	37,528.42
C. TOTAL EXPENDUTURES (Add A.7 and B.3)	357,618.13	90,302.72	139,371.44
NET INCOME (I.E minus II.C)	26,619.23	51,800.53	2,721.71

[a]Includes office supplies, telephone, legal and accounting fees, taxes, employee benefits and insurance.

Storage facilities in consolidated RWD #1 will be increased from the current 364,000 gallons to 524,000 gallons by the addition of 160,000 gallons storage in the RWD #6 and M&L projects. Interconnecting and looping of distribution lines will establish adequate water pressures throughout the new district. Incoming supply lines will also be of adequate size to provide water from the treatment facilities and the City of Okmulgee throughout the district. Form 2 summarizes water system characteristics, including maximum capacities of water source, treatment, storage, and distribution for the districts.

Estimating Water Use

To estimate water use for Consolidated RWD #1, it is necessary to determine water use per customer as well as the number of customers in the service area. The procedure for estimating water use per customer is presented in Form 3. To arrive at monthly water use per customer, mean values of the sample for each source variable are multiplied by the coefficient for that variable and then summed. For instance, for the total education variable, the mean of 12.490 years is multiplied by 102.76 to obtain a total education source contribution of 1,283.49 gallons per month. A similar procedure is followed for each variable. The dummy variables pertain to garden irrigation and annual family incomes. Thirty percent of respondents indicated they maintained an irrigated garden, so the total possible contribution in water use due to garden irrigation was multiplied by .30 to allow for this. The same procedure was followed for the income dummy variable. A summation of all source variables indicates that monthly water demand per customer is 5,684.75 gallons.

An alternative approach could be used in deriving this monthly water use. This approach involves utilizing county mean values for rural residents for all source variables from the U.S. Census of the Population and the U.S. Census of Housing [10]. The procedure was followed (but results are not shown) and employed 1980 Census data. A monthly per customer water use figure of 5,089.32 was obtained. In practical application of this research, this alternative approach will most likely be easier to conduct due to data availability. Census data for rural residents by county are available and will enable extension workers to predict monthly water consumption.

Monthly water consumption estimates per customer for Consolidated Okmulgee County RWD #1 are presented in Form 4. Six alternative estimates are employed, each of which can be utilized to address comparable problems in other rural areas. The estimates can be made system specific by using any specified percentage increase in water use for the percentage and trended increase methods. In addition, local historical data can be used to derive current water use figures.

Form 5 may be completed to obtain the total annual water use for proposed Consolidated RWD #1. The number of customers in the service area in 1982 is 2,627. Upon completion of the RWD #7 project, 55 additional customers will be served, bringing the total to 2,682. If the historical growth trends and demographic model identified earlier

FORM 2. SUMMARY OF WATER SYSTEM CAPACITY FOR INDIVIDUAL DISTRICTS AND CONSOLIDATED DISTRICT[a]

System Component	District #6	District #7	District M & L	Consolidated District
I. Water Supply[b]	as needed	as needed	as needed	as needed + 400,000 GAL/DAY
Water Treatment	-0-	-0-	-0-	250,000 GAL/DAY
Water Storage	156,000 GAL.	43,000 GAL.	165,000 GAL.	524,000 GAL.
II. Pressure Pumps[c]	500 gpm 250 gpm	80 gpm 80 gpm	100 gpm 100 gpm	1 @ 500 gpm 1 @ 250 gpm 2 @ 150 gpm 2 @ 80 gpm
	(size in inches)			
III. Incoming Supply				
Lines	two 10-inch	one 4- inch one 2- inch	one 6- inch	one 12- inch two 10- inch two 4- inch

[a]Capacities are before consolidation and improvement projects for separate districts and after consolidation and improvement for the consolidated district.

[b]Assumes the current agreement with the supplier to supply treated water to the RWDs on demand will continue.

[c]Gallons per minute.

FORM 3. DERIVATION OF MONTHLY WATER USE PER CUSTOMER FOR CONSOLIDATED DISTRICT

SOURCE	MEAN VALUE[a]		COEFFICIENT VALUE[b]		TOTAL CONTRIBUTION Gal. per mo.
Persons per Household	3.048	X	954.86	=	2,902.77
Year Residence Built[c]	63.963	X	33.85	=	2,165.15
Total Education	12.490	X	102.76	=	1,283.49
Number of Cattle	1.234	X	55.49	=	68.45
Number of Horses	.514	X	183.60	=	94.30
Garden Irrigation[d]	.300	X	953.86	=	286.16
Annual Family Income[e]	.176	X	2,221.92	=	391.16
Correction for Mean				=	1505.73
Total Monthly Water Demand (per customer)					5,685.75

[a]Mean value of study sample for each source contributor.

[b]Coefficient value as determined by regression analysis. (See Page 5.)

[c]Thirty percent of the sample maintained gardens, therefore .300 was used for the mean value of the dummy variable G1. The percentage of households irrigating gardens should be used as the mean value.

[d]Seventeen and six-tenths percent of the sample had annual family income over $40,000; therefore, .176 was used for the mean value of the income variable XU. The percentage of households having annual family income above $40,000 should be used as the mean value.

FORM 4. MONTHLY PER CUSTOMER WATER USE ESTIMATES FOR CONSOLIDATED DISTRICT, 1981-2000, SELECTED YEARS

	Historically Based[a]			Regression Based[b]		
Year	Constant[c]	Percentage Increase[d]	Trended Increase[e]	Constant[c]	Percentage Increase[d]	Trended Increase[e]
	Gallons Per Month					
1981	7,187	7,187	7,187	5,686	5,686	5,686
		X 1.05	X 1.1585		X 1.05	X 1.1585
1985	7,187	7,560	8,326	5,686	5,800	6,587
		X 1.04	X 1.1577		X 1.04	X 1.1577
1990	7,187	7,860	9,639	5,686	6,032	7,626
		X 1.035	X 1.1363		X 1.035	X 1.1363
1995	7,187	8,130	10,953	5,686	6,243	8,645
		X 1.03	X 1.1199		X 1.03	X 1.1199
2000	7,187	8,370	12,266	5,686	6,430	9,684

[a] 1981 figure based upon historical county data.

[b] 1981 figure based upon regression results of county data.

[c] Assumes no change in water consumption per customer.

[d] Assumes increase of 5, 4, 3.5 and 3 percent in water consumption per customer in each 5-year period 1980-2000, respectively.

[3] Assumes increase in water consumption per customer will follow the county trend, determined by historical county water consumption data.

FORM 5. TOTAL ANNUAL WATER USE FOR CONSOLIDATED DISTRICT
DATE December 31, 1983

Current number of customers	2,627
Additional customers with line extensions	+ 55
Additional Growth, 1982 to 1984 [a]	+ 375
Total number of customers, July, 1984	3,057
Water use per customer per month (gallons) (From Form 4)	x 5,685.75
	17,381,337.73
Conversion to annual basis	x 12
Annual water use (gallons)	208,576,052.76

[a] Derived from using historical growth rate and demographic model for the designated period.

are applied for the period 1982 to 1984, there will be a total of 3,057 customers by 1984, which is the projected date of completion of the improvement projects for RWD #6, #7, and M&L. This figure is then multiplied by the monthly water demand for the regression-based constant estimate selected from Form 3. Conversion to an annual basis yields a total annual consumption of 208,576,053 gallons for the proposed consolidated district.

A comparison of water system capacity and total water use for 1984 may be made by comparing information obtained in Forms 2 and 5. If total annual water use (Form 5) is converted to a daily basis, a figure of 571,441 gallons results. It can be readily seen that this exceeds the storage capacity of 524,000 gallons. FmHA recommends 1,142,882 gallons of storage capacity. Of the total daily water use, 44 percent (250,000 gallons) can be provided by the systems' own treatment facilities. Engineering estimates derived from FmHA guidelines show that pumping and distribution capabilities are adequate to meet daily water use.

Estimating Financial Status

Having determined the water use for Consolidated RWD #1 and knowing the current revenues and costs of the individual systems, it is possible to estimate the financial status of the district for its first year of operation in 1984. This financial status is summarized in Form 6.

Revenues. Revenues for the district are estimated to be $749,644.15 for the year. This figure is obtained by identifying revenues from water sales, memberships, and other sources. Water sales revenues are based upon an average monthly water bill of $17 per customer for 3,057 customers. An average bill under the rate structure proposed for RWD #6 after improvements is applied to the monthly per customer water demand to arrive at the $17 estimate. The proposed monthly rate structure is:

0-1000 gallons	$7.50 minimum
1001-5000 gallons	$2.00/1000 gallons
over 5000 gallons	$1.50/1000 gallons

This monthly water bill represents a slight increase in payment by RWD #6 and RWD #7 and a considerable decrease in the payment by M&L customers.

An annual membership fee of $25 will add $76,425 to revenues. Currently, there are membership fees of $25, $20, and $20 for RWD #6, #7, and M&L. Revenues from interest on investments and other sources such as late fees and penalties are assumed constant from 1981 to 1984.

Operating Expenditures. Operating costs are also shown in Form 6. Wages and salaries are increased by 10 percent annually from the 1981 total for 1982 and 1983. It is assumed that the consolidated district will employ one system manager, two sub-region operators, one repairman, one administrative secretary and two billing clerks. Office and administrative costs for one office and repair and

FORM 6. ESTIMATED ANNUAL FINANCIAL STATUS FOR CONSOLIDATED DISTRICT, DATE December 31, 1983

INCOME		
Water Sales	3,057 customers[a] x $ 17 monthly bill[b] x 12 months	$ 623,628.00
Membership	3,057 customers x $ 25 membership fee	76,425.00
Interest		30,000.00
Other		+ 19,591.15
TOTAL INCOME	(A)	749,644.15
EXPENDITURES		
Operating		
Wages & Salaries	$___ current + $___ change[c] x ___ increase[d]	$ 99,377.94
Office & Administration	$___ current + $___ change x ___ increase	43,951.69
Utilities	$___ current + $___ change x ___ increase	24,768.24
Repair & Maintenance	$___ current + $___ change x ___ increase	57,316.20
Water Purchase	$___ /1000 gallons x ___ 1000 gallons used annually	118,576.00
Other		+ 3,832.28
TOTAL OPERATING	(B)	347,822.35
Capital		
Debt Payment	$___ current + $___ additional[e]	$ 180,110.91
Depreciation	$___ current + $___ additional	+ 162,232.16
TOTAL CAPITAL	(C)	342,343.07
TOTAL EXPENDITURES	$___ (B) + $___ (C)	(D) $ 690,165.42
NET INCOME (LOSS)	$___ (A) - $___ (D)	(E) $ 59,478.73

a/ Total number of customers served on the date indicated at the top of the form.

b/ Average monthly water bill per customer (estimated from water rate structure and average water use per customer per month).

c/ Estimated increase or decrease in total personnel salaries due to consolidation.

d/ Estimated annual inflation rate compounded for number of years between current date and date of consolidation shown at the top of the form. All operating expenditure items are inflated by 10 percent annually except for utility expenditures, which are inflated by 15 percent annually (e.g. a 10 percent inflation rate for 2 years would yield the following increase: 1.10 X 1.10 = 1.21).

e/ Additional annual debt payment and depreciation for new facilities, lines and equipment due to consolidation.

maintenance costs are also increased by 10 percent annually from the 1981 figure for 1982 and 1983 to account for inflation. Utility expenditures in Form 6 are for maintenance of one office rather than the present two offices and have been inflated 15 percent annually to adjust for rising utility costs. Water purchases total $118,576 based on a charge of $1.00 per 1000 gallons for 118,576,000 gallons. This amount was obtained by subtracting the 90 million gallons annual water treatment capacity of the system from the 208,576,000 gallons annual water demand of the system. Currently the City of Okmulgee charges $.90 per 1000 gallons but is expected to increase their charge by 1984. Total operating expenditures for the year ending December 31,1983 are $347,822.35. Water purchases made up 32 percent of this cost and wages and salaries 27 percent.

Capital Expenditures. Annual capital expenditures total $324,343.07 (Form 6). Debt payment (obligation to FmHA for loans) for the new district is calculated by summing the current debt of RWD #6, #7 and M&L and the new debt of the three districts after their respective improvement projects are completed. Current annual debt payment is $101,174.91. New annual debt payment with five percent FmHA loan funds will be $78,936 for a total of $180,110.91. Depreciation comprises $162,236.16 of the annual capital expenditures. This figure includes current depreciation in the three districts of $102,242.16 plus depreciation over a 40-year life of all improvements.

Consolidation and Economies of Size

The discussion has highlighted the physical and operational advantages which can be attained through consolidation of RWD #6, #7, and M&L. Increased leverage for obtaining FmHA loans is possibly one of their major advantages. FmHA has related that consolidation of the districts would improve their chances of receiving financing. In addition, however, it is necessary to investigate the districts on an annual cost per customer basis both before and after consolidation.

Annual costs per customer for each of the districts are presented in Form 7. For each district, the number of customers is given along with annual per customer operating, capital, and total costs. Costs for all districts are based on 1983 dollars. This was done by using estimated costs for Consolidated RWD #1 and applying an assumed annual inflation rate of 10 percent to the 1981 operating cost figures for RWD #6, #7 and M&L. Capital costs were not inflated. FmHA payments are the same each year and depreciation of facilities and equipment was assumed to be based on the straight-line method.

A comparison of annual per customer capital costs indicates that each of the three original districts will have higher costs after consolidation than before. Major expansion or revision of distribution lines and addition of treatment, storage and pumping facilities are capital intensive in nature and should be expected to increase annual per customer capital costs even though customer numbers increased.

Annual per customer operating costs, on the other hand, decreased significantly for all three districts after consolidation. For example, per customer operating costs for M&L, Inc., declined 50

FORM 7. COMPARISON OF ANNUAL PER CUSTOMER COSTS FOR #6, #7, M&L AND CONSOLIDATED DISTRICT

	#6	#7	M&L	Consolidated District
Total Operating Costs	$220,822.47	$61,209.73	$101,843.01	$347,822.35
Inflation Adjustment[a]	x 1.21	x 1.21	x 1.21	
Total Operating Costs	267,195.19	74,063.17	123,230.04	347,822.35
Number of Customers[b]	÷ 1,553	÷ 520	÷ 544	÷ 3,057
Per Customer Operating Costs (B)	$ 172.05	$ 142.43	$ 226.53	$ 113.78
Total Capital Costs[c]	$136,795.66	$ 29,092.99	$37,528.42	$342,343.07
Number Customers	÷ 1,553	÷ 520	÷ 544	÷ 3,057
Per Customer Capital Costs (A)	$ 88.08	$ 55.95	$ 68.99	$ 111.99
Total Per Customer Costs (A+B)	$ 260.13	$ 198.38	$ 295.52	$ 225.77

[a] Operating costs for RWD #6, #7 and M&L were inflated annually by 10 percent from 1981 through 1983 (e.g. 1.10 x 1.10 = 1.21).

[b] Number of customers is for RWD #6, #7 and M&L are for 1981. Only cost figures are put on a 1983 basis.

[c] Capital costs for RWD #6, #7 and M&A are assumed constant from 1981 to 1983. Debt paymetns to FmHA are the same each year and the assumed depreciation method is straight-line.

percent from $226.53 before consolidation to $113.78 after consolidation. The majority of this decrease results from elimination of the office facility M&L now maintains and lower prices paid for their purchased water. Currently, M&L purchases 80 percent of their water from RWD #6 at $1.35 per 1000 gallons. This would be replaced by a purchase of water from Okmulgee at $1.00 per 1000 gallons through the new consolidated district. Additional savings for the districts probably resulted from more efficient utilization of existing repair and maintenance equipment. The excess capacity of some equipment may be used in cases where expensive contract labor hire was once needed, as in the case of backhoes or ditching equipment.

It would appear that the lower costs per customer which are reflected in this study after the districts consolidated may be due to the same economies of size components as were evidenced in the case studies presented earlier. Economies are hypothesized to be a result of more efficient management, repair, and maintenance of the physical and financial operation of the district after consolidation. Elimination of duplicate functions such as office and billing procedures could lower per customer costs. Data are not currently available to substantiate further or more explicit suppositions regarding the existence of economies of size in consolidated rural water districts.

Summary and Conclusions

Local decisionmakers are responsible for planning which will determine growth patterns in their communities. One of the major determinants of community growth is the quality of services which are provided to businesses and residents in the communities. Of particular concern to decisionmakers is the provision of quality water service in their communities both now and in the future.

Proper planning of water systems involves optimal placement of the capital-intensive, limited-capacity components of a water system. System planning processes must include determination of water system capacity and estimates of total system water use. The primary objective of this study was to develop a system of methods which would allow decisionmakers in rural water districts to better utilize available information in evaluating alternatives for water system planning.

Information utilized in estimating water use was obtained from rural water districts in Okmulgee County through system records and a mail questionnaire. Two procedures were used to estimate water use. The first estimated water use per customer in four ways: (1) the constant method; (2) the percentage increase method; (3) the trended increase method; and (4) the regression method. The constant method indicates that the current daily per tap water use of 239.56 gallons will remain constant through the year 2000. The percentage increase method adds 5, 4, 3.5 and 3 percent for each 5-year period between 1980 and 2000.

The trended increase utilizes historical water use information via regression analysis to arrive at plausible estimates. The regression method was developed using survey responses from selected RWD's in Okmulgee County. The mean water use for the sample was found to be 5,685 gallons per month per customer when values for each variable at the mean were substituted into the equation.

The second estimation procedure utilizes the daily per customer water use estimates of the constant, percentage increase, and trended increase methods and population estimates for the period 1980 to 2000 to obtain total system water use. The regression method may also be used if county average data are available for use in the regression equation. This procedure is useful for estimating water use for county-wide or regional water systems or suppliers of rural systems on the whole.

Economies of size analysis was carried out in two ways. First, general economies of size analysis was performed using regression analysis on information provided by 111 rural water systems in Oklahoma and Missouri. Second, results of case studies of seven consolidated rural water districts in Oklahoma and Missouri are presented.

Annual per customer costs were estimated as a function of customers in the district for total, capital, and operating costs for all systems. A similar analysis was also completed by system type: purchased water, water treatment; groundwater; or a combination of purchased water and groundwater. No economies of size were evidenced by research results using regression analysis. Equations analyzing total annual costs, total capital costs, or total operating costs proved to have very low R^2-values and highly insignificant coefficients. No economies were shown to exist for any water source. These equations also had extremely low R^2-values and very low "Student-t" values for the variable coefficients. Lack of evidence of economies of size may be due to the size range of the systems sampled, the largest being 1,585 customers.

Seven consolidated rural water districts were investigated for advantages and disadvantages resulting from consolidation. Major advantages include improvements in quality of water service, management, operation and financial stability. Managers of systems investigated commented that the quality of water service as measured by quality and quantity of water, service interruptions, and water pressure had improved since consolidation. Efficiency and repair and maintenance are precipitated by the better management made possible through consolidation. Leaders in the districts attributed these improvements to full-time employees who were hired after consolidation. Most districts were unable to afford sufficient full-time assistance before consolidation and were forced to pay high prices for contract labor.

The financial status of the consolidated RWD's before and after consolidation was compared using annual cost per customer based on 1983 dollars. In six of the seven districts, total annual costs per customer were lower after consolidation. No consistent trends were identified for annual capital and operating costs per customer. In general, these costs were lower after consolidation.

Limitations of the Study

One major limitation of this study was the necessity to use only cross-sectional data rather than including time series data in analyzing water demand and economies of size. Due to a lack of historical information of variables included in regression estimation of water demand and cost components of economies of size analysis, there seemed to be no viable alternative to employment of cross-sectional data.

Another limitation was the lack of consistently reported cost information. Differences in accounting procedures from district to district make it difficult to accurately estimate individual income and expenditures (items such as membership revenue, labor costs, repair and maintenance, and depreciation). Standardization of procedures would enable researchers to make more reliable estimates of individual financial items. Even so, total annual income and expenditures as well as capital and operating cost figures are considered to be sufficiently accurate for acceptance.

Reliance on survey response data for a sizeable portion of the research may have introduced bias and misinformation due to the respondents' perceptions of the questions and answers provided. A corollary to this is the fact that many of the responses required subjective judgements to be made, a drawback of many studies of this nature. By virtue of cost, manpower and time constraints, the sample had to be limited as it was. A broader geographic and larger numeric sample would infer that results could be applied on a more widespread basis.

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APPENDIX A

TABLE 3. PAST TRENDS AND FUTURE ESTIMATES IN DAILY PER CUSTOMER WATER USE FOR ALL RURAL AREAS, AND BEGGS, MORRIS AND DEWAR, SELECTED YEARS

Year	All Rural Areas[a]	Beggs, Morris and Dewar[b]
	----------------Gallons per day------------	
1970	146.08	[c]
1975	187.03	123.88
1976	197.10	145.75
1977	190.41	165.53
1978	231.37	164.20
1979	224.03	186.03
1980	239.56	191.70
1985	277.53	256.60
1990	321.31	318.54
1995	365.09	386.49
2000	408.87	442.43

[a] Estimates of annual changes in water use from the base year 1970 are made using a model developed from historical water use data for rural areas, 1970-1980.

Δ USE = -17,102.77 + 8.7588 YEAR

R^2 = .9562

σ = 30.3619

[b] Estimates of annual change in water use from the base year 1975 are made using a model developed from historical water use data for Beggs, Morris and Dewar, 1975-1980.

Δ USE = -24,335.28 + 12.3889 YEAR

R^2 = .9758

σ = 23.7523

[c] Denotes missing data.

TABLE 4. PAST TRENDS AND FUTURE ESTIMATES IN DAILY PER CUSTOMER WATER USE FOR OKMULGEE AND HENRYETTA, 1975-2000[a]

Year	Okmulgee	Henryetta
	---Gallons per Day---	
1975	b	267.00
1976	b	271.74
1977	b	324.47
1978	b	361.65
1979	416.71	372.94
1980	352.88	410.10
1985	503.78	560.99
1990	654.67	711.89
1995	805.56	862.78
2000	956.56	1,013.68

[a]Estimates of annual change in water use from the base year 1975 are made using a model developed from historical water use data for Henryetta, 1975-1979. Adequate data for an Okmulgee model were not available.

$$\Delta \text{ USE} = -49{,}344.32 + 30.170 \text{ YEAR}$$

$$R^2 = .9693$$

$$\sigma = 49.2301$$

[b]Denotes missing data.

APPENDIX B

FORM 1. FINANCIAL STATUS OF ____________________, DATE __________

FINANCIAL COMPONENT	RWD	RWD	RWD
	-----------	Dollars	-----------
I. INCOME			
A. Water Sales	______	______	______
B. Membership	______	______	______
C. Interest	______	______	______
D. Other	______	______	______
E. TOTAL (Add A, B, C and D)	______	______	______
II. EXPENDITURES			
A. Operating			
1. Wages & Salaries	______	______	______
2. Office & Administrative[a]	______	______	______
3. Utilities	______	______	______
4. Repair & Maintenance	______	______	______
5. Water Purchases	______	______	______
6. Other	______	______	______
7. TOTAL OPERATING (Add A.1, A.2, A.3, A.4, A.5 and A.6)	______	______	______
B. Capital			
1. Debt Payment	______	______	______
2. Depreciation	______	______	______
3. TOTAL CAPITAL (Add B.1 and B.2)	______	______	______
C. TOTAL EXPENDUTURES (Add A.7 and B.3)	______	______	______
NET INCOME (I.E minus II.C)	______	______	______

[a]Includes office supplies, telephone, legal and accounting fees, taxes, employee benefits and insurance.

FORM 2. SUMMARY OF WATER SYSTEM CAPACITY FOR INDIVIDUAL DISTRICTS AND CONSOLIDATED DISTRICT[a]

System Component	District			Consolidated District
	________	________	________	
I. Water Supply[b]	________	________	________	________
Water Treatment	________	________	________	________
Water Storage	________	________	________	________
II. Pressure Pumps[c]	________	________	________	________
	________	________	________	________
				________
				________
	(size in inches)			
III. Incoming Supply				
Lines	________	________	________	________

[a]Capacities are before consolidation and improvement projects for separate districts and after consolidation and improvement for the consolidated district.

[b]Assumes the current agreement with the supplier to supply treated water to the RWDs on demand will continue.

[c]Gallons per minute.

FORM 3. DERIVATION OF MONTHLY WATER USE PER CUSTOMER FOR CONSOLIDATED DISTRICT

SOURCE	MEAN VALUE[a]		COEFFICIENT VALUE[b]		TOTAL CONTRIBUTION Gal. per mo.
Persons per Household	________	X	________	=	________
Year Residence Built[c]	________	X	________	=	________
Total Education	________	X	________	=	________
Number of Cattle	________	X	________	=	________
Number of Horses	________	X	________	=	________
Garden Irrigation[d]	________	X	________	=	________
Annual Family Income[e]	________	X	________	=	________
Correction for Mean				=	________
Total Monthly Water Demand (per customer)					________

[a]Mean value of study sample for each source contributor.

[b]Coefficient value as determined by regression analysis. (See Page 5.)

[c]Thirty percent of the sample maintained gardens, therefore .300 was used for the mean value of the dummy variable G1. The percentage of households irrigating gardens should be used as the mean value.

[d]Seventeen and six-tenths percent of the sample had annual family income over $40,000; therefore, .176 was used for the mean value of the income variable XU. The percentage of households having annual family income above $40,000 should be used as the mean value.

FORM 4. MONTHLY PER CUSTOMER WATER USE ESTIMATES FOR CONSOLIDATED DISTRICT, 1981-2000, SELECTED YEARS

	Historically Based[a]			Regression Based[b]		
Year	Constant[c]	Percentage Increase[d]	Trended Increase[e]	Constant[c]	Percentage Increase[d]	Trended Increase[e]
	Gallons Per Month					
1981	______	______	______	______	______	______
		X 1.05	X ______		X 1.05	X ______
1985	______	______	______	______	______	______
		X 1.04	X ______		X 1.04	X ______
1990	______	______	______	______	______	______
		X 1.035	X ______		X 1.035	X ______
1995	______	______	______	______	______	______
		X 1.03	X ______		X 1.03	X ______
2000	______	______	______	______	______	______

[a]1981 figure based upon historical county data.

[b]1981 figure based upon regression results of county data.

[c]Assumes no change in water consumption per customer.

[d]Assumes increase of 5, 4, 3.5 and 3 percent in water consumption per customer in each 5-year period 1980-2000, respectively.

[3]Assumes increase in water consumption per customer will follow the county trend, determined by historical county water consumption data.

FORM 5. TOTAL ANNUAL WATER USE FOR CONSOLIDATED DISTRICT
DATE ______________________

Current number of customers	________
Additional customers with line extensions	+ ________
Additional Growth, 19__ to 19__ [a/]	+ ________
	________
Total number of customers, ________, 19___	________
Water use per customer per month (gallons) (From Form 4)	x ________
	________
Conversion to annual basis	x 12
	________
Annual water use (gallons)	________

[a/]Derived from using historical growth rate and demographic model for the designated period.

FORM 6. ESTIMATED ANNUAL FINANCIAL STATUS FOR CONSOLIDATED DISTRICT, DATE ____________

INCOME			
Water Sales	________ customers[a/] x $________ monthly bill[b/] x ______ months		$________
Membership	________ customers x $________ membership fee		________
Interest			________
Other			+ ________
TOTAL INCOME		(A)	________
EXPENDITURES			
Operating			
Wages & Salaries	$______ current ± $______ change[c/] x ________ increase[d/]		$________
Office & Administration	$______ current ± $______ change x ________ increase		________
Utilities	$______ current ± $______ change x ________ increase		________
Repair & Maintenance	$______ current ± $______ change x ________ increase		________
Water Purchase	$______ /1000 gallons x ________ 1000 gallons used annually		________
Other			+ ________
TOTAL OPERATING		(B)	________
Capital			
Debt Payment	$______ current + $______ additional[e/]		$________
Depreciation	$______ current + $______ additional		+ ________
TOTAL CAPITAL		(C)	________
TOTAL EXPENDUTURES	$________ (B) + $________ (C)	(D)	$________
NET INCOME (LOSS)	$________ (A) - $________ (D)	(E)	$________

[a/]Total number of customers served on the date indicated at the top of the form.

[b/]Average monthly water bill per customer (estimated from water rate structure and average water use per customer per month).

[c/]Estimated increase or decrease in total personnel salaries due to consolidation.

[d/]Estimated annual inflation rate compounded for number of years between current date and date of consolidation shown at the top of the form. All operating expenditure items are inflated by 10 percent annually except for utility expenditures, which are inflated by 15 percent annually (e.g. a 10 percent inflation rate for 2 years would yield the following increase: 1.10 X 1.10 = 1.21).

[e/]Additional annual debt payment and depreciation for new facilities, lines and equipment due to consolidation.

FORM 7. COMPARISON OF ANNUAL PER CUSTOMER COSTS FOR _____, _____, _____ AND CONSOLIDATED DISTRICT

	_____	_____	_____	Consolidated District
Total Operating Costs	$_____	$_____	$_____	$_____
Inflation Adjustment[a/]	x_____	x_____	x_____	
Total Operating Costs	_____	_____	_____	_____
Number of Customers[b/]	÷_____	÷_____	÷_____	÷_____
	_____	_____	_____	_____
Per Customer Operating Costs (B)	$_____	$_____	$_____	$_____
Total Capital Costs[c/]	$_____	$_____	$_____	$_____
Number Customers	÷_____	÷_____	÷_____	÷_____
Per Customer Capital Costs (A)	$_____	$_____	$_____	$_____
Total Per Customer Costs (A+B)	$_____	$_____	$_____	$_____

[a/] Operating costs for RWD #6, #7 and M&L were inflated annually by 10 percent from 1981 through 1983 (e.g. 1.10 x 1.10 = 1.21).

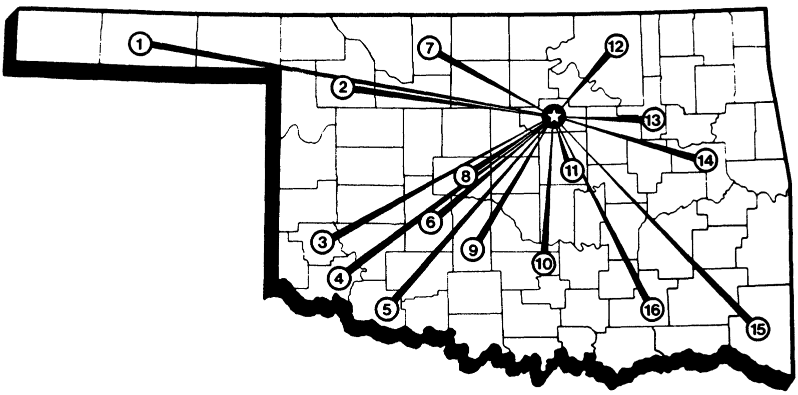
[b/] Number of customers is for RWD #6, #7 and M&L are for 1981. Only cost figures are put on a 1983 basis.

[c/] Capital costs for RWD #6, #7 and M&A are assumed constant from 1981 to 1983. Debt paymetns to FmHA are the same each year and the assumed depreciation method is straight-line.

OKLAHOMA

AGRICULTURAL EXPERIMENT STATION

System Covers the State



Main Station—***Stillwater, Perkins and Lake Carl Blackwell***

1. **Panhandle Research Station — *Goodwell***
2. **Southern Great Plains Field Station — *Woodward***
3. **Sandyland Research Station — *Mangum***
4. **Irrigation Research Station — *Altus***
5. **Southwest Agronomy Research Station — *Tipton***
6. **Caddo Research Station — *Ft. Cobb***
7. **North Central Research Station — *Lahoma***
8. **Southwestern Livestock and Forage Research Station — *El Reno***
9. **South Central Research Station — *Chickasha***
10. **Agronomy Research Station — *Stratford***
11. **Pecan Research Station — *Sparks***
12. **Veterinary Research Station — *Pawhuska***
13. **Vegetable Research Station — *Bixby***
14. **Eastern Research Station — *Haskell***
15. **Kiamichi Field Station — *Idabel***
16. **Southeastern Oklahoma Agricultural Research and Extension Center — *Atoka***