USER PERCEPTIONS OF BENEFITS FROM WATER SUPPLIED BY CUMING COUNTY RURAL WATER DISTRICT #1

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USER PERCEPTIONS OF BENEFITS FROM WATER SUPPLIED BY CUMING COUNTY RURAL WATER DISTRICT #1*

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Introduction

We all rely on and need water for life, health, work, and play. In urban areas, good water supplies are a generally accepted part of the urban life style. In rural areas, water supplies may be more uncertain, though highly important to the well-being of plants, animals, and humans. Farmers need reliable supplies of good quality water for a number of agricultural uses in addition to the water needed for their households. Unfortunately, many rural residents are located in areas where water availability and/or water quality is such that private water systems do not supply the amounts and quality of water needed for good living conditions.

Rural water systems are complex and expensive mechanisms intended to provide reliable supplies of good quality water to residents of rural areas. A rural water system usually consists of a water source, pumps, pipelines, elevated or underground storage, and ancillary facilities and equipment. It is intended to deliver good quality water to farms or nonfarm homes or businesses scattered across the countryside.

Customers served by a water system have a wide range of water needs. Most need water for domestic and household use. Some may have livestock feeding operations that require large quantities of water for consumption by

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poultry, cattle, or swine, plus water for cooling, and for the cleaning of equipment, and facilities. Even if they do not have large numbers of livestock, farms may use substantial amounts of water for the application of herbicides and insecticides and the maintenance and cleaning of buildings, machinery and equipment. When rural water systems provide adequate supplies of good quality water to rural residents, both the quality of life and the economic base of the area are improved.

Purpose of the Study

This study was undertaken at the request of the manager of the Cuming County Rural Water District #1. It was a first attempt to identify, and, to the extent possible, to quantify the economic benefits accruing to water users due to their use of water supplied by the Cuming County Rural Water District. Limitations of time and funding made it necessary to focus the study on water users' estimates of the economic consequences for family living and livestock production of the system-supplied water. Specific objectives of the research were:

1. To identify the sources of water used by the respondents.
2. To identify the principal uses of these water supplies.
3. To identify and estimate the benefits respondents realize from the use of water supplied by the Rural Water System.

Livestock feeders served by the Cuming County Rural Water District and a sample of rural households were interviewed in late August and September of 1981. Responses from this survey are a principal part of the data base of this report.

The Context of the Study

The Cuming County Rural Water District #1 is located in Cuming County, Nebraska, with small portions of its water lines and service area extending into Thurston and Wayne Counties. At the time of this research, the system had operated for approximately four years and served about 470 water users. About 50 of the water users are large livestock production units that consume relatively large quantities of water. These large users are a very important source of revenue and have helped to make the system operations economically viable.

The Cuming County Rural Water System serves a portion of Northeast Nebraska where groundwater supplies often are of poor quality and total water supplies may be limited. The area was glaciated, and earth materials underlying the farmlands and towns contain aquifers that vary widely in water capacity and yield. Groundwater quality varies from good to poor. Quality reducing agents include iron, manganese, sulfates, nitrate nitrogen, and dissolved solids. These substances are present in varying concentrations.

The Cuming County Rural Water District secures high quality water from wells developed in the Dakota Sandstone formation. These wells are located about five miles east-northeast of Beemer. The extent of groundwater quality and supply problems in the area is demonstrated by the total of 17 wells that were drilled before finding a water source having an adequate yield of high quality water.

Description of Data Base

Data for this report were obtained from three main sources: (1) the manager of the Cuming County Rural Water System, (2) responses from personal interviews with selected rural water system customers, (3) and analyses

of samples from non-water system sources used by some of the livestock producers interviewed in this study. (All were Rural Water System customers.)

With assistance from the water system manager, the overall layout of the water system and the locations of all water users (system customers) were identified. Three areas with above average concentrations of water users were: (1) the "North Area" (customers in an area near Wisner and extending northeasterly into Wayne and Thurston counties), (2) the "East Area" (customers located east and northeast of West Point), and (3) the "West Area" (customers located west of West Point and south of the Elkhorn River). Data for these areas were tabulated separately making possible the identification of any locational differences in perceptions of respondents.

Interviews with Livestock Producers

Forty-three large-scale livestock production units were identified as having used large volumes of water during June, 1981. Two operators had two production units each, resulting in a target group of 41 operators who were to be interviewed. Two of these operators (one had two production units) were unavailable and could not be interviewed, so the remaining 39 operators, with a total of 40 production units, were interviewed. The operator with two production units responded to questions on two interview schedules, and each schedule was treated as a separate interview. Throughout the report this group of respondents was considered to be a sample of all large-scale livestock units and are referred to as "livestock producers." Information from their interview schedules is identified as being from "livestock production units."

Interviews with the 39 livestock producers were intended to identify:

a. The sources from which the respondents secured water, estimates of the proportion of the water supplies that came from each source, and principal uses of water.

b. Respondents' estimates of the changes in production processes which would occur ". . . if the rural water system ceased to exist . . ." More specifically:

   i. Estimates of the extent of changes in livestock production costs that would result from changes in: feed conversion, daily rate of gain, death losses, veterinary costs, size of production unit, and quantity of water used.

   ii. Estimates of the extent of changes in qualitative aspects of water use: convenience, quality of water supplies, and level of risk.

   iii. Estimates of the extent of effects on management approaches used in livestock production, and the economic returns to that production.

Respondent livestock producers were contacted in advance of interviews to determine their willingness to be part of the study. All of those contacted agreed to participate in the interviews. As previously noted, two producers who could not be contacted were dropped from the study.

Interviews with Rural Households

A sample of rural households other than the large-scale livestock producers was interviewed to obtain information about household aspects of water use. It included 37 rural households who secured part or all of their

household water from the Rural Water System. These households were selected in this way: (1) An 8 to 10 mile section of road that paralleled the Rural Water System pipeline was identified within each of the three subareas of the study (the North Area, the East Area, the West Area), (2) Households making up a 10 percent random sample of those located within one-half mile on either side of the road were interviewed. The interview schedule was intended to identify:

1. Each respondent household's water sources, estimates of the proportion of water supplies derived from each source, and principal uses of water.
2. Each respondent household's estimates of the changes in household activities and the costs and/or benefits that would result " . . . if the system ceased to exist . . ."

Households of the sample group were not contacted prior to the actual interview. If there was no response to an initial contact, the household was dropped from the sample, and travel along the main road was continued in the same direction until the next household adjacent to the road was reached. It was interviewed as the substitute for the household that had been dropped from the sample.

Water quality information

The third major component of the data base for this research was water quality information generated by analyses of samples from alternative water sources (sources other than the Rural Water System) of the livestock production units in the first sample. Water samples were taken at the time of farm visits for the personal interviews. Not all respondent livestock producers could supply samples, since many had disconnected their alternate water sources and were using only Rural Water System water. In some instances where the

producers had retained their private wells in operating condition, these wells were not being pumped and it was not possible to obtain water samples. In total, 21 water samples were collected from 20 livestock producers. Water samples were chilled and transported to the Soil Testing Laboratory at the University of Nebraska-Lincoln where each was analyzed.

Responses of Livestock Producers

Livestock uses of water

Many operators of livestock production units interviewed in this research reported that they secured water from wells or streams in addition to using water from the Rural Water System. Private wells were identified as alternative water sources by 26 of the 40 respondent livestock production units. Estimates of the proportion of water that was supplied by the Rural Water System varied from five to 100 percent. Sixty-five percent of all production units (26 units) reported 60 percent or more of their water came from the system (Table 1). Reliance on Rural Water System water appeared to be greatest in the North area.

Table 1. Livestock production units, by percentage of water from the Rural Water System and by location.

		Proportion of water from Rural Water System		
Location	Units in sample	100 percent	60-99 percent	Less than 60 percent
		number of respondents		
North Area	14	7	5	2
East Area	18	6	4	8
West Area	8	1	3	4
All Areas	40	14	12	14

A major use of water in all areas was for feedlot cattle operations, with 31 of 40 respondent production units reporting water use by feedlot cattle

(Table 2). In the North area, 71 percent of the respondents produced feedlot cattle, as did 89 percent of those in the East area, and 63 percent of those in the West area.

Table 2. Livestock production units, by type of livestock enterprise and by location.[a]

Location	Units in sample	Type of livestock enterprise							
		Feedlot cattle	Dairy	Cow & calf	Sows & boars	Feeder pigs	Finishing pigs	Poultry	Other
		number of livestock production units							
North Area	14	10	1	4	2	2	6	1	2
East Area	18	16	4	5	4	4	10	5	1
West Area	8	5	2	3	5	6	5	2	1
All Areas	40	31	7	12	11	12	21	8	4

[a] Double counting resulted from reports by multiple enterprise production units.

A tabulation of the cattle feeding operations indicating the number of cattle fed, the location, and the proportion of water coming from the Rural Water System showed no consistent pattern. Sixteen livestock production units indicated more than 40 percent of water supplies were secured from the Rural Water System. All were units that reported feeding 5,000 or fewer head per year. The three respondent units that reported feeding more than 5,000 head per year estimated that less than 40 percent of their water supplies were secured from sources other than the Rural Water System (Table 3).

A similar tabulation was prepared for respondent livestock units that reported swine production enterprises (Table 4). The pattern of responses was opposite to that reported by the cattle feeders. Fourteen of 21 units reported that 81 to 100 percent of their water was supplied by the Rural Water System (12 of these reported 100 percent reliance on the rural water system).

All but one producer who reported finishing more than 500 head per year reported placing almost total reliance on water from the rural water system.

Table 3. Livestock production units with feedlot cattle enterprises reporting use of Rural Water System water, by percent of water used, size of operation, and location.

Feedlot cattle (number fed/yr.)	Location	Percent of water from Rural Water System				
		0-20[a]	21-40	41-60	61-80	81-100
		-----number of livestock production units------				
	North	2	1		2	4
< 1000	East	3				3
	West	1				2
	North					
1,001 - 5,000	East	2	1	1		3
	West			1		
	North					
5,001 - 10,000	East	1				
	West					
	North					
Over 10,000	East		1			
	West	1				
Total		10	3	2	2	12

[a] Includes those livestock production units currently using no water from the Rural Water System.

A similar pattern of water use from the Rural Water System was evident in the reports of livestock producers who had sow herds and raised feeder pigs (some units were farrow-to-finish operations, and only their finishing enterprises are reported in Table 4).

Other water uses

The large livestock producers in the sample were also asked about their uses of water other than for livestock. Thirty-nine of the 40 sample units used water for household purposes. Thirty-two of these secured all household water from the Rural Water System, and 37 reported the watering of lawns and

Table 4. Livestock production units with pig finishing enterprises using Rural Water System water, by percent of water used, number of livestock, and area.

Pigs finished (number fed/yr)	Area	Percent of water from Rural Water System				
		0-20[a]	21-40	41-60	61-80	81-100
		------number of livestock production units------				
	North	1	1			
< 500	East	3	1			
	West					1
	North	1				2
501-1500	East					5
	West					2
	North					1
Over 1500	East					1
	West					2
Total		5	2			14

[a] Includes livestock production units that reported using no water from the Rural Water System.

gardens. Of this latter group, 26 reported that the Rural Water System supplied 95 percent or more of their water for lawn and garden use. A few units also reported water was used in farm shops and in feed preparation. Water supplied for these purposes was reported by equal numbers of respondents as being entirely from private wells or entirely from the Rural Water System.

Expected effects " . . . if the rural water system ceased to exist . . ."

During the period of operation of the Cuming County Rural Water System, the availability of water delivered by the system undoubtedly has resulted in modification of livestock production practices of the respondent units. Modifications of operations that occur over time typically are difficult to identify after the fact. In an attempt to isolate these effects, respondents were asked to estimate effects on their operations ". . . if the Rural Water System ceased to exist . . ." Six of the 40 livestock production units

indicated they would decrease the number of animals raised in one or more livestock enterprises. None of the respondents indicated that loss of the Rural Water System would lead to ceasation of the production of one or more types of livestock. Thirty production units reported their water consumption would not change. These responses did not indicate that major changes in water use or livestock production would occur if the Rural Water System ceased to exist. However, they were not fully consistent with responses to questions about effects on productivity that would result from the loss of water supplied by the Rural Water System.

Questions about changes in livestock productivity factors (feed per pound of gain, veterinary expenses, medication costs, survival of young animals) which would be expected if the Rural Water System ceased to exist gave respondents opportunity to identify the general effects (would the factor be expected to increase, decrease, or remain constant), and dollar value estimates of those effects. Approximately two-thirds of the sample livestock producers reported that livestock productivity factors would remain constant if the Rural Water System ceased to exist.

The remaining one-third of the respondent production units reported that they would expect effects that would be costly. Costs of feed per pound of gain, veterinary services and medication were expected to increase. No consistent relationship was evident between type of livestock enterprise and reports of expected increases in these factors. If rural water system water were not available, lower survival rates for young animals were expected; but none of the respondents offered specific evidence in support of this expectation.

Only a few of the livestock producers were willing to provide estimates of dollar values of the expected effects on their livestock operations

". . . if the Rural Water System ceased to exist . . ." For those who did, estimated increases in feed cost per head ranged from $.25 to $1.08 for feedlot cattle, and from $.40 to $2.40 per head for finishing pigs. Estimates of the dollar value of increases in veterinary and medication costs were combined. These estimates of cost increases were $.70 to $1.00 per head for feedlot cattle and $.50 to $2.00 per head for finishing pigs. No one provided estimates of costs that would result from decreased survival of young animals.

Water quality, convenience, and risk

Three additional aspects of water supply effects on livestock operations were examined: (1) the quality of water used, (2) perceptions of convenience, and (3) perceptions of risk. Results of water quality tests performed on the 21 water samples obtained from private water sources of the livestock producers who were interviewed indicated water hardness was generally in the medium range, and most salinity concentrations were medium to low (Table 5). Sulfate levels were below 250 ppm for all but one of these livestock units, though two were only slightly below that level. Three

Table 5. Livestock production units, by alternate water supply characteristics, by area, and by location.

Location	Livestock production units in sample	Alternative water supply characteristics									
		Hardness			Sulfate		Nitrate		Salinity[a]		
		Up to 200 ppm	200 to 400 ppm	Over 400 ppm	Up to 250 ppm	Over 250 ppm	Up to 10 ppm	Over 10 ppm	Low	Medium	High
		number of livestock production units									
North	7	0	5	1	6	1	4	3	0	5	2
East	9	0	9	0	9	0	9	0	7	2	0
West	5	2	3	0	5	0	5	0	2	1	2
Totals	21	2	17	1	20	1	18	3	9	8	4

[a] Salinity ranges of low, medium, and high were classified by Soil Testing Laboratory which analyzed water samples.

water quality samples had indicated levels of nitrate-nitrogen above the standards recommended for human consumption (10 ppm). Calcium levels ranged from 85-436 ppm. The water quality characteristics identified in tests of the 21 water samples were much the same in each of the three areas (North, East and West).

Additional factors having effects on water quality, such as iron and manganese content, were not identified in these tests. And, it was not possible to identify the characteristics of alternative water supplies which may have been available to the additional 20 livestock production units from which no samples were obtained. Their Non-Rural Water System water sources may have abandoned for any of several reasons, including water quality. Comments that were incidental to several of the interviews indicated persons with especially poor quality water from wells or streams abandoned those sources when water from the Rural Water System became available. Thus, it appears that the 21 samples that were tested in this study probably were not representative of the alternative water sources of all respondent units.

This perspective is reinforced by the responses to questions about water quality, convenience, and risk. Thirty of the 40 respondents indicated the quality of water used would decrease if the Rural Water System ceased to exist (Table 6). Thirty-one respondents indicated convenience would decrease, and 32 indicated risk associated with their livestock operations would increase.

Cost-related aspects

In rural areas, the cost of securing adequate supplies of potable water can be relatively high. Rural water systems charge a monthly amount based on a water rate schedule that usually is intended to cover all costs of operation and debt service incurred by the system. Private water systems generally are relatively expensive. Substantial investment may be required; and

Table 6. Livestock production units, by expected effect from loss of rural water system water, aspect of operation, and location.

Aspects of operation	Area	Expected effect: Increase	Remain the same	Decrease
Water quality	North	0	3	11
	East	0	3	15
	West	0	4	4
Convenience	North	0	3	11
	East	0	4	14
	West	0	3	5
Risk	North	12	2	0
	East	13	3	2
	West	7	1	0

depreciation, operating, and maintenance costs can be substantial. Respondents to this survey provided estimates of their monthly Rural Water System bills and of the increased costs which they would expect to incur if the Rural Water System ceased to exist.

The cost to livestock production units for water delivered by the Cuming County Rural Water System averaged about $115/month for the 39 production units that provided estimates (Table 7). Almost half reported monthly water bills of less than $100. Twelve reported monthly amounts of $100 to $199, and eight indicated amounts of $200 or more. The largest estimated amount was $650 per month.

Table 7. Livestock production units reporting monthly water bill, by amount of monthly bill, and by location.

Location	Total units reporting	Amount of monthly water bill: <$100	$100 to $199	$200 or more	Range
		number of livestock production units			
North	14	5	6	3	$25-250
East	18	10	4	4	$25-650
West	7	4	2	1	$40-200
Total	39	19	12	8	$25-650

Changes in livestock producers' water costs would occur if the Rural Water System ceased to exist. There would be no monthly bill for Rural Water System service, a cost reduction that would be offset by the costs of securing water from one or more alternative sources (usually from a private water system). If the producer had no private system, or had an existing private system of low capacity, additional investment would be required. Depreciation, maintenance, and operational costs would be expected to increase, if a previously inactive or lightly used well were upgraded to be suitable as the unit's only water source. Estimates of expected changes in costs as identified by respondents are tabulated in Table 8. Thirty-five of the 40 production units reported that they would expect increased depreciation costs, 26 would expect increased maintenance costs, and 36 would expect increased operating costs, if the Rural Water System ceased to exist. Responses to a parallel question addressed to all respondents without regard to their present water hauling activities indicated only four units would expect water hauling costs to increase.

The dollar amounts of expected cost increases were estimated by most respondents. Estimates ranged from what appeared to be unrealistically low to unrealistically high. Increased depreciation costs were estimated as $25 to $3,000 per year, increased maintenance costs as $30 to $2,500 per year, and increased operational costs as $25 to $600 per year. Within these cost ranges the estimates were scattered from the lower to higher amounts, with no readily evident pattern. In addition to those reporting estimates of increased depreciation costs, five units reported depreciation would be unchanged as present water systems would not be altered. Of the 24 units expecting higher maintenance costs, 19 estimated annual cost increases of $200 or less. Respondents in areas with poor water quality gave the highest cost increase

Table 8. Livestock production units providing estimates of expected changes in costs, by type of cost item, location and type of effect.

Cost item	Location	Type of effect--cost would: Increase	Remain the same	Decrease
		------number of production units-------		
Depreciation cost (wells, pumps, pipelines and related equipment)	North	12	2	0
	East	16	2	0
	West	7	1	0
Maintenance cost (wells, pumps, and pipelines)	North	12	2	0
	East	11	7	0
	West	3	5	0
Operational cost (well and/or pump)	North	13	1	0
	East	16	2	0
	West	7	1	0
Water hauling cost	North	1	13	0
	East	2	15	0
	West	1	7	0

estimates due to the frequent replacement of wells and the higher maintenance costs expected in poor water quality areas. Operational cost increases were projected by all but four production units, and ranged from $25 per year to $600 per year.

The estimated yearly costs reported by livestock production units for Rural Water System service and the estimated cost increases for private systems that would result if the Rural Water System ceased to exist were compared for the 29 production units that provided data making possible these comparisons (i.e. the units that estimated both private water system cost increases and annual Rural Water System bills). These comparisons indicated 20 of the 29 units expected that yearly cost increases for additional private water system use would be less than present yearly charges for Rural Water System service. These units estimated they would pay, on the average, 52

percent less for water if the Rural Water System ceased to exist and they had to place total reliance on private water systems. A tabulation providing comparisons of estimated increases in the yearly costs of private water system operations and estimated yearly charges for water from the Rural Water System is presented in Table 9.

Table 9. Comparison of estimated total yearly cost increases for water if the Rural Water System ceased to exist and estimated present yearly cost of water from the Rural Water System.[a]

Total estimated yearly cost increase due to use of private water system[a]	Estimated present yearly charges for water from Rural Water System					
	$300 or less	$301-600	$601-900	$901-1200	$1201-1500	more than $1500
	number of livestock production units					
< $300		1		5[b]	1	1
$301-600	2	2	1			1
$601-900		1		1		2
$901-1200					1	3
$1201-1500			1			1
> $1500	1			2		2

[a] Cost increases are estimates of costs that would be incurred if a private water system were used to replace water being supplied by the Rural Water System. These cost increases would be partly or totally offset by the ceasation of charges for water presently purchased from the Rural Water System.

[b] Includes three units reporting no cost increase for private water system use.

In considering the meanings to be drawn from these data, it must be remembered that this is a comparison between estimates of expected costs and present monthly billings for water received from the Rural Water System. As is always the case when a hypothetical situation is used as the basis for estimates of future costs, the level of error may be high. When combined with

the previous responses, these data apparently indicate the respondents believe that the Rural Water System water is worth its additional cost due to the quality of the water, the convenience of the supply, and the reduction of risk resulting from use of Rural Water System water.

Additional cost considerations

Additional perspectives on the costs that would be incurred by water users if the Rural Water System ceased to exist can be gained from estimates of the cost of water supplies from private wells. It is not feasible to estimate costs of well construction, maintenance, and operation in each of the locations to which the Rural Water System delivers water. Private wells differ widely in capacity, age, quality of construction, quality of water produced, etc., and costs vary accordingly from location to location. In the approach used here, estimated costs of construction and maintenance of two "typical" wells are used as the bases for cost estimates. Those who wish to draw inferences about their personal situations need to recognize that these data are included as examples, and that only by securing a bid from a qualified well driller can costs for their exact situations be estimated.

The wells selected as typical are described by data listings presented in Table 10. These data indicate that a farm or rural household that presently secures all its water from the Rural Water System and does not have an operational well would incur substantial water supply costs if the Rural Water System ceased to exist. A 15 gallon per minute well constructed in 1982 would require an investment of about $4000. Annual costs associated with its operation would include depreciation, maintenance, and operating expense. As indicated in Table 10, annual depreciation cost would be about $226. Annual interest cost on average investment would be about $253 (12 percent interest rate assumed). Annual maintenance costs could vary widely depending upon the

Table 10. Characteristic's and estimated costs for typical private water wells assuming construction during calendar year 1982.

Item	Approximate well capacity 15 g.p.m.	50 g.p.m.
Depth of well	200 feet	200 feet
Casing	4½ inch P.V.C.	4½ inch P.V.C.
Screen	Plastic	Plastic
Submersible pump	1 horsepower	5 horsepower
Total dynamic head[a]	235 feet	235 feet
Pressure tank	Not included	Included
Construction cost, complete	$4,050	$5,700[b]
Well life	20 years	20 years
Pump & motor replacement, complete[c]	$700	$1,550
Annual depreciation costs:		
Well, less pump & motor at replacement cost (20 year life)	$167.50	$ 207.50
Pump and motor at replacement cost (12 year life)	$ 58.33	$ 129.16
Annual interest on average investment at 12 percent/year	$253.05	$ 354.45
Annual energy cost, 24 hour/day operation @ 4.8¢/kwh[d]	$528.23	$1,760.76
Annual energy cost, 12 hour/day operation @ 4.8¢/kwh[d]	$264.11	$ 880.38
Annual energy cost, 6 hour/day operation @ 4.8¢/kwh[d]	$132.06	$ 440.19

[a] Assumes 40 p.s.i. discharge pressure

[b] If 6 inch casing is used, add $1,000.

[c] Expected to be required one time during 20-year life of well unless more frequent replacement is caused by lightning damage or mechanical failure of bearings or other components.

[d] Calculated from the Nebraska performance criteria for pumping plants assuming 80 percent of criteria performance by DeLynn Hay, Department of Agricultural Engineering, UN-L.

SOURCE: Estimates were supplied by Jensen Drilling Company, Incorporated, Blair, Nebraska and T. A. Austin, Iowa State University.

quality of the water supply and the quality of well construction. In the best possible circumstances motor and pump replacement costs that are included in annual depreciation would be the only maintenance required. Under less fortunate circumstances, well maintenance could be required more frequently and would result in additional annual costs. Operating costs for energy at the present per kilowatt hour electricity cost of 4.8 cents and the estimated dynamic head of 235 feet would be about $.067 per 1,000 gallons of water pumped or a maximum of $1.45 per day for 24 hour operation pumping at 15 g.p.m. ($528 per year).

As indicated in Table 10, annual depreciation costs for an approximately 50 gallon per minute well would be about $337. Annual interest cost on average investment would be about $354. Maintenance costs above the one time replacement of pump and motor that are reflected in these annual depreciation costs, would depend on circumstances that vary from location to location. Operating costs for energy would be the same as previously noted ($.067 per 1,000 gallons of water pumped), implying a maximum daily cost of $4.82 for 24 hour operation pumping at 50 g.p.m. ($1,760.76 per year).

Water system customers who have maintained operating wells would have different cost situations if the Rural Water System ceased to exist. Depending on the age of their wells, the quality of well construction, and water quality, depreciation and maintenance costs might be more or less than the examples presented in Table 10. In many cases, depreciation costs would be less and maintenance costs more than for a well newly constructed in 1982. Operating costs for electricity would be about the same assuming the pumps are operating at normal efficiency levels.

Taken as a whole, these estimates based on data for typical wells, indicate the actual cost of water supplies from private wells may be considerably greater than is generally perceived. Assuming an electricity cost of 4.8 cents per kilowatt hour and 12 hours per day pumping at the well capacity, operation of a 15 g.p.m. well would result in an estimated annual cost to the owner of about $743 (plus any maintenance costs in addition to the once-in-20-years motor and pump replacement). Under the same assumptions, operation of a 50 g.p.m. well would result in an estimated annual cost to the owner of about $1,217. These data indicate loss of the Rural Water System would result in substantially increased costs for most water users who do not presently also have an operating well.

Overall Reactions to the Rural Water System

Respondent were asked to give an overall reactions to the Rural Water System as a water supply source. Each was also asked for additional comments of any kind he/she saw fit to make. Some producers provided two to four comments. Each was tabulated separately, resulting in a total number of comments that exceeds the number of respondent livestock production units (Table 11). Three views expressed most often were: (1) the Rural Water System is a good project, (2) water from the system is of good quality, and (3) the Rural Water System acts as an insurance policy for livestock producers by decreasing risk. Additional comments mentioned were: the Rural Water System has produced very positive economic effects; many aspects of life are better due to better quality water; livestock do better; and the system water supply saves time.

A few producers identified design or construction problems. In some parts of the system respondents indicated pressure was not adequate to deliver

the quantity of water needed at times of peak demand. A few others mentioned low pressure. Problems with pipeline freeze-up were also identified.

Table 11. Comments indicating user reactions to the Cuming County Rural Water System.

Location	Total livestock production units in sample	Condensed version of comments							
		Good project	Good water quality	Convenient (less maintenance)	Pressure		Less risk	Expense	
					Good	Poor		High	Low
		Number of responses							
North	14	5	4	1	2	0	4	2	1
East	18	7	7	4	5	4	5	1	0
West	8	2	1	0	2	0	5	0	0
Totals	40	14	12	5	9	4	13	3	1

Rural Household Responses

Water uses

The second phase of the study addressed the situations, responses, and benefits accruing to rural farm and nonfarm households other than large-scale livestock producers due to the Rural Water System. These farm and nonfarm households were contacted using the procedures outlined previously. A total of 37 interviews were completed in the three service areas (North, East, and West). Responses indicated many of these households secured water from sources in addition to the rural water system. Twenty-three reported a portion of their water came from private wells. One pumped water directly from a stream, and one household received additional water from a municipality. The proportion of water from these alternative water sources varied from household to household (Table 12). Fifty-seven percent of the sample households obtained more than 60 percent of their water from the Rural Water System.

thirty-two percent (12) of the 37 households used water from only the Rural Water System.

Table 12. Rural households, by proportion of water from the rural water system and by location.

Location	Households in sample	Proportion of water from rural water system		
		100 percent	60-99 percent	Less than 60 percent
		number of rural households		
North	10	3	3	4
East	14	7	1	6
West	13	2	5	6
All Areas	37	12	9	16

Water uses of a rural farm or nonfarm household can differ considerably from uses typical of households located in a city. In addition to the use of water for human consumption, water may be used for livestock, field spraying, cleaning of machinery and buildings, the watering of large lawns and gardens, and other miscellaneous uses. This diversity is illustrated by the responses reported in Table 13. Thirty-four households reported the watering of livestock with 12 using only Rural Water System supplied water for that purpose. Thirty-two of the 36 households reporting household use relied exclusively on the Rural Water System for their household supply, as did 17 of 28 reporting lawn and garden use, and 14 of 24 who reported water use for machinery, equipment and autos.

Detailed data about types of livestock was obtained from the 20 rural households who used the Rural Water System as the sole or partial source of water for one or more of their livestock operations (Table 14). About two-thirds (13 of 20) produced beef cattle with herds averaging about 120 head. Cow/calf herds averaged about 50 head each for nine households. Seventy

percent of the 20 households interviewed reported finishing pigs, though other aspects of swine production were frequently reported. Sow and boar herds were from 50 to 90 head, the number of feeder pigs raised annually ranged from 100 to 1200 head, as did the number of finishing pigs fed yearly. The distribution in number and type of livestock did not appear to differ by location in the three major service areas (North, East, and West). Twelve of the 14 rural households with finishing pig operations indicated that the Rural Water System supplied more than 75 percent of the water used, with 10 of these reporting 100 percent reliance on the Rural Water System.

Table 13. Rural households use of Rural Water System water, by proportion of water from the Rural Water System, and by type of use.

Type of water use	Households reporting use	Proportion of water from Rural Water System			
		None	1-50 percent	51-99 percent	100 percent
		number of rural households			
Livestock	34	14	4	4	12
Household	36	3	1	0	32
Lawn and garden	28	8	2	2	17
Machinery	24	9	0	0	14
Other[a]	2	0	0	0	2

[a] Includes crop spraying and cleaning of milk barns.

Expected effects if the Rural Water System ceased to exist

Livestock effects

Respondents were asked the same questions as were directed to livestock producers to identify the effects on their livestock enterprises if the Rural Water System ceased to exist. Only two of 20 gave responses indicating they would make changes in their livestock operations, both reporting they would

Table 14. Rural households reporting types of livestock, by type of livestock enterprise, and by location.

Location	Households reporting	Type of Livestock Enterprise: Beef cattle	Cow/ calf	Dairy	Horses and ponies	Sheep and goats	Sows and boars	Feeder pigs	Finishing pigs	Poultry
		number of rural households								
North	7	3	5	0	4	0	2	6	6	1
East	8	6	2	0	3	3	3	3	6	0
West	5	4	2	2	0	0	2	2	2	3
All areas	20	13	9	2	7	3	7	11	14	4
Those with more than 75 percent of water supplied by RWS		7	5	1	5	2	6	9	12	1

decrease livestock numbers by about 50 percent. Even though Rural Water System water appears to be preferred for all types of swine production, most respondents indicated they would not make major changes in their livestock enterprises if the system water were no longer available.

Effects on households

Responses indicated the loss of the Rural Water System would not greatly change household water use for the 33 sample rural households currently using system water for household needs. Thirty of the 33 households reported doing their laundry at home, and all but two sample households in the West area indicated this practice would continue. Eleven households, all located in the East and West areas, indicated that their use of some types of appliances would change; e.g., automatic clothes washers and dishwashers would no longer be practical for some. Six of the 11 households reported they would purchase a water softener.

Twenty households reported using system water on lawn and/or gardens and 15 washed vehicles and equipment with it. Six of these households reported they would not continue watering lawns and/or gardens at present levels, and three stated they would reduce the use of water for washing vehicles and equipment if the Rural Water System ceased to exist. Respondent households in the West area gave responses indicating they would be affected the most by loss of water from the Rural Water System.

Effects on costs

The estimated effect on household water costs if the Rural Water System ceased to exist was reported to be minor for the majority of the respondent rural households. This was particularly true for households in the North area, where minimal changes were expected if system service were not available. Some households in the East and West areas reported they would have to incur relatively high initial investment and maintenance costs for water softeners. Without the system water, some types of appliances were projected not to be usable, thus implying households would not receive future benefits associated with their usage. A few households in the East and West areas reported they would lose the advantages of washing vehicles and equipment at home, and of watering lawns and/or gardens, if the Rural Water System did not exist.

These estimates appear to reflect underestimates of the economic cost of private water supplies. As reported in Table 10 and its associated discussion, investment and operating costs of a 15 g.p.m. household well in 1982 can be quite large. Responses reported here provide further evidence that few persons know the economic cost of their water supplies.

Reactions to Rural Water System

Respondent rural households were asked for their impressions and comments concerning the Rural Water System. As a whole, the sample households reported the Rural Water System to be a good project and rated the quality of water received as good (Table 15). Two somewhat critical comments were offered by one respondent each. One indicated displeasure with the chlorination evident in the water. Another commented on a temporary odor noticed in mid-July which was no longer evident at the time of the interviews.

Table 15. Comments indicating rural households' reactions to the Cuming County Rural Water System, by area.

Location	Total rural households in sample	Condensed version of comments							
		Good project	Good water quality	Convenience	Pressure		Less risk	Expense	
					Good	Poor		High	Low
	number of households								
North	10	4	0	1	2	0	4	3	0
East	14	5	6	2	3	1	0	2	0
West	13	6	3	1	2	0	3	1	0
All areas	37	15	9	4	7	1	7	6	0

Summary and Conclusions

Personal interviews with 39 operators of 40 large-scale livestock production units and with persons in 37 rural households in Cuming County Nebraska generated the primary data base of this report. All persons interviewed were customers of the Rural Water System. This research provided insights into the perceptions of the Rural Water System customers regarding the usefulness and value of the Rural Water System. To a very limited extent, it provides

indications of the economic value of water delivered by the system. Summaries of findings related to each objective and related conclusions are:

Objective One: To identify the sources of water used by the respondents--Customers of the Rural Water System secure water from the system, from private wells, from streams, and, to a very limited extent, from a municipal supply system. Water from the system was the exclusive water supply of 14 of the 40 large-scale livestock production units that responded to the interviews. An additional 12 units relied on the Rural Water System for an estimated 60 to 99 percent of water supplies. Water from the Rural Water System is mixed with water from other sources by respondent units that use water from more than one source. Respondent households indicated use of water from the same sources as those reported by the livestock producers, though the extent of reliance on the Rural Water System was more complete for households than for livestock production units.

Conclusion: Despite its having been in operation for only four years, the Rural Water System is a water source of primary importance to its customers. A relatively large proportion of the customers have made it their primary source of supply, and place total (or near total) reliance on its water for their households and livestock operations.

Objective Two: To identify the principal uses of these water supplies--Respondent large-scale livestock production units were engaged in cattle feeding, dairy production, cow-calf production, swine production, poultry production, and several miscellaneous livestock production activities. Twenty-six feedlot cattle operations of fewer than 5,000 head annual capacity reported slight to total reliance on the Rural Water System for water supplies. Twelve reported 81 to 100 percent of water they used came from the Rural Water System. The three respondent units with greater than 5,000 head

annual capacity relied on private water systems for almost all of their water supplies.

Swine production units reported a more complete reliance on the Rural Water System. Fourteen of 21 units with swine production, including all but one of the units with annual production of more than 500 head, secured 81 to 100 percent of their water from the Rural Water System. Other livestock enterprises reported securing from zero to 100 percent of their water from the Rural Water System. Thirty-two of the 40 units relied completely on the system for household water.

Respondent households other than large-scale livestock producers indicated primary reliance was placed on the Rural Water System as a source of household water. Thirty-two of 36 that gave responses indicated all household water was secured from the Rural Water System. A similarly high proportion reported exclusive use of Rural Water System water for lawn and garden watering. Livestock and other uses were reported to be supplied from wells, a stream, and from the Rural Water System, with the exact circumstances depending on each respondent's situation.

When asked why these use patterns were followed, the most frequent responses given by livestock producers and households interviewed in this research were: (1) water supplied by the Rural Water System was of high quality, (2) water supplied by the Rural Water System water was convenient to use, and (3) the reliability of Rural Water System supplied water lessened the risks associated with livestock production and household living.

Conclusion: Water supplied by the Rural Water System was perceived to have higher quality, convenience, and reliability than water from alternate sources. Respondent water users reported use patterns that indicated swine production units rely more completely on the Rural Water System than is the

case with feedlot cattle operations. Rural Water System water was the preferred source of household water supplies. The reported use patterns indicate a high proportion of respondents use water from the Rural Water System for uses where quality, convenience, and reliability are important considerations.

Objective Three: To identify and estimate the benefits respondents realize from the use of water supplied by the Rural Water System--Responses to a hypothetical question about consequences for respondents if the Rural Water System ceased to exist were: (1) The expected changes in households and livestock production units would be relatively small. (2) The average expected increases in direct costs for livestock units due to depreciation, maintenance, and operating costs, would be less than the average yearly cost of water purchased from the Rural Water System. And, (3) Investment costs for private water systems and household appliances would be relatively high for respondents with poorer quality alternative supplies and/or no operating well.

Engineering estimates of the costs of well ownership and operation indicated these costs to be much greater than was perceived generally by those interviewed in this research. Estimates of depreciation costs, interest on investment, and energy costs, appear to equal or exceed the monthly payments for delivered by the Rural Water System for persons with wells having construction costs reflecting 1982 price levels.

Most responses to evaluation questions about the Rural Water System were favorable and supportive of its continued operation. Criticisms were few in number. A number of respondents indicated in their responses that they perceived the Rural Water System to be a "high cost" source of water supply.

Conclusion: The respondents indicated through their responses to questions and through their habits of use of water from the Rural Water System, that water supplied by the system is worth its cost to them. The average of water

user estimates of direct economic costs of water from alternate water supply sources was estimated to be less than or equal to the average cost of water delivered by the Rural Water System. (The engineering estimates of these economic costs were considerably higher than the user estimates.) Differences in the quality, convenience, and reliability of water received was perceived to make the Rural Water System a desireable water source. Responses indicated persons interviewed in this research were generally well satisfied with the Rural Water System as a partial or complete source of water.