EVALUATION OF GROUND-WATER RESOURCES EASTERN SOUTH DAKOTA AND UPPER BIG SIOUX RIVER, SOUTH DAKOTA AND IOWA

TASK 9: WATER SUPPLY NEEDS

FINAL REPORT

December, 1985

Prepared for:

Planning Division
U.S. Army Corps of Engineers
215 North 17th Street
Omaha, Nebraska 68102
CONTRACT DACW45-80-C-0185

Department of Water and Natural Resources
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Pierre, South Dakota 57501

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SECTION A

FORT RANDALL CONSERVANCY SUB-DISTRICT

Fort Randall Conservancy Sub-District

SERVING BON HOMME, BRULE, BUFFALO, CHARLES MIX AND DOUGLAS COUNTIES
CORSICA, SOUTH DAKOTA 57328

Corsica, South Dakota
February 22, 1983

Dept. of Water & Natural Resources
Pierre, South Dakota

Dear Sirs:

Enclosed find information (which you requested) to be included in the Buffalo County water survey contracted by the Dept. of Water & Natural Resources, the U.S. Corps of Engineers, and Ft.Randall Conservancy Sub-District.

An estimate of present and 2020 rural domestic and livestock water needs by county is as follows:

Present rural domestic water needs_---- 25,000 gallons daily average

Present livestock water needs---------- 214,225 gallons daily average

2020 rural domestic water needs-------- 50,000 gallons daily average
2020 livestock water needs-------------264,000 gallons daily average

Due to the fluctuation of livestock prices, the number of livestock will vary considerably from year to year. Climatic conditions in the area will also drastically affect the number of livestock on farms and ranches.

An accurate estimate of water needs in the county is very difficult due to the fact that many of the livestock water needs are served by reservoirs and artesian flowing wells which have no gauges on them.

Yours truly,

Lyle Gardeman, Mgr.
Ft.Randall Conservancy Sub-District

SECTION B

LOWER JAMES CONSERVANCY SUB-DISTRICT

SECTION B-1

Mitchell

INTERVIEWS

WITH LOCAL ADVISORS

AND

WATER USE PROJECTIONS

Local advisors interviewed regarding Mitchell's water system include:

1.	Don Barber	RR 3	996-8696 (H)	996-3100 (O)
2.	Muriel Barns	204 West 12th	996-3313 (H)	996-6526 (O)
3.	James Hunt	717 East 2nd	996-6456 (H)	996-1031 (O)
4.	Herman Lerdal	1220 West Ash	996-5787 (H)	996-6611 (O)
5.	Vilas Mayer	709 East 14th	996-6017 (H)	996-5567 (O)
6.	Leonard Nelson	1419 Firesteel Drive	996-9258 (H)	996-7536 (O)
7.	George Shanard	1515 Northridge Road	996-8337 (H)	996-6677 (O)
8.	Al Sherman	805 East 4th	996-4400 (H)	
9.	Lonny Speas	1016 South Rowley	996-9299 (H)	996-6452 (O)
10.	Paul Tobin	1310 East 2nd	996-2940 (H)	996-6452 (O)
11.	Don Uptagrafft	1520 West Ash	996-5470 (H)	996-5567 (O)
12.	Bernie Schmucker	24 North Harmon Drive	996-4041 (H)	996-7761 (O)
13.	Carl Sheesley	620 South Isadore	996-5376 (H)	996-7583 (O)
14.	Gay Tollefson	605 West 10th	996-5492 (H)	996-6301 (O)
15.	Carl Schroeder	701 East 1st	996-4146 (H)	

GENERAL PERCEPTIONS

There was unanimity among the local advisors regarding the inadequacy of Mitchell's water system. Everyone interviewed believed that the current system is not adequate. The most frequently cited deficiencies being in the areas of treatment and supply.

Each person interviewed indicated a strong concern relative to the treatment plant describing it as "antiquated", "the weakest link in the system", "outdated" or "the number one problem facing the city's water system", and likened the continued use of the plant to "walking on the edge of disaster". The treatment plant, currently in use in Mitchell, was built in 1929. Parts for repairs are no longer available which means that replacement parts must be handmade, a procedure which is costly in terms of both time and money.

When questioned as to adequacy of the volume of water treated, the majority of people interviewed stated that they felt the treatment plant was capable of treating enough water to maintain Mitchell at its current level of activity. However, industrial growth is limited by water treatment plant capabilities. The water superintendent stated that the maximum output for the treatment plant was approximately 5.4 million gallons per day and that though average use did not require an excess of that amount, there have been times when the plant has had to operate at full capacity in order to keep up with demand.

The second most frequently cited inadequacy in Mitchell's water system was problems related to supply. The general concensus among all but three of the people interviewed was that supply of water is short, unpredictable, and unreliable. It was also commonly believed that these supply deficiencies were a detriment in attracting new industries to the area. This group of people all appeared very hopeful that the CENDAK or Garrison Diversion projects would alleviate this area of concern by providing a higher quality, more predictable source of water than that which currently exists.

The three people who did not view the water supply as a critical issue to be addressed stated that they were comfortable with the quantity of water available to Mitchell since the installation of the pumping system which brings water from the James River to Lake Mitchell. These three individuals acknowledged the desirability of stabilizing the flow of water from the James River through the CENDAX or Garrison Diversion projects, but believed the treatment facility posed a more immediate problem.

Of a lesser, but still notable concern, were the problems related to city water distribution. Many of the water mains and distribution lines are old and, though records are not readily available, it is estimated that losses are high due to undetected leaks. It was stated that three-inch holes have been discovered in the eight-inch lines. Distribution problems affect the older residential areas more than the newer suburbs or industrial areas simply because these more recently developed areas have newer water distribution systems.

Storage facilities in the four elevated and one ground unit are apparently adequate at this point in time. A refurbishing project involving two of the elevated units is currently underway which, when completed, should alleviate any storage problems the city would likely incur in the next few years.

The local advisors noted only negative impacts that the water quality and quantity have had on the community. The most frequent comments were that industrial growth was limited by the questionable supply and antiquated treatment facility and that there are frequent complaints from residents regarding the taste and smell of the water. The residential complaints regarding water quality increase as the supply in Lake Mitchell is decreased. This is apparently due to the fact that when the lake is low, there is less natural aeration and an increase in algae and bacteria which require that more chemicals be added to the water during the treatment process in order to meet standards. A recent study conducted by the South Dakota School of Mines and Technology in Rapid City indicated that due to anticipated treatment methods, the level of Tri Halo Methanes, a potential human carcinogen, increases as water travels further from the treatment plant, thus lowering the quality of water available to those individuals who live furthermost from the plant.

PERCEPTIONS OF RELATIVE IMPORTANCE

When questioned about the public's awareness of supply and treatment problems, it was repeatedly noted that the residents of Mitchell recently voted down a bond issue for a new treatment plant. A combination of very tight financial times, an uneducated public, and a population which basically runs affairs on a "crisis orientation" approach did not allow for improvements of the treatment facilities. In the past any water problems affecting the city have been related to supply deficiencies and now that the pretreatment storage supply in Lake Mitchell is adequate, the public seems to feel quite secure. An understanding of the severity of the treatment plant inadequacies is lacking.

While the water rates for Mitchell residents are low, when compared to other cities of comparable size, the average citizen would probably express the belief that the rates were too high. It was frequently stated that the residents of Mitchell do not know how much would be an "adequate" fee to pay for water because it is very unlikely that the average person has had occasion to study the costs of treatment and system maintenance. Mitchell has a large elderly population living on fixed incomes. To this segment of the population, any rate is too high and any increase becomes an additional hardship.

The majority of the local advisors did not think that the public would be willing to pay more for either increased supply or better quality water. Two of the advisors did think that if the residents of Mitchell could have a "test period" wherein they could have at their disposal a higher quality of water and then go back to what they are currently using, that they would be willing to pay a slight increase for the higher quality.

Once again, the skepticism and lack of education and/or knowledge of anything except that which currently is available seems to be preventing community support for active steps which would improve the treatment portion of the water system.

Four of the people interviewed commented that perhaps the actual water billing process is contributing to the public's confusion over the adequacy of their water rate. The city bills for water, sewer, and garbage collection on one statement which is tabulated quarterly. Billing for these three services are commonly referred to as the water bill and as such this has the tendency to distort the actual price being paid for water distribution.

ALTERNATIVE SOLUTIONS

In discussing alternatives which would best meet Mitchell's current and future water needs, the issue of improved treatment facilities was constantly listed as a top priority followed closely by an interest in increasing the supply.

There was also agreement relative to the idea that recycling water would not be an appropriate venture for Mitchell. Though the economic feasibility for recycling exists, it was commonly thought to be too psychologically distasteful to the residents.

When discussing conservation techniques, the majority of local advisors believed that voluntary restrictions would be the most acceptable to the residents of Mitchell and that both mandatory restrictions and increasing the cost of water would be the least acceptable. It was also noted that the most acceptable method of conservation would probably do the least to conserve water while the two methods considered the least acceptable would be the most productive relative to conservation.

FLOOD ISSUES

Flooding is not currently a problem in Mitchell. In the past, spring thaws would create isolated problems; however, there has not been cause for concern in recent years.

WATER USE PROJECTIONS

In making water use projections, water treatment statistics for the past five years as well as population and industrial projections will be utilized.

The average daily intake at the treatment plant over the past five years was as follows:

1977----------------	2,000,000/day
1978----------------	2,300,000/day
1979----------------	1,900,000/day
1980----------------	2,000,000/day
1981----------------	1,900,000/day

One can readily see that usage has remained fairly constant over the past five years.

The population of Mitchell is currently 13,916 (1980 Census), up 492 from the 1970 Census. In a report prepared by Planning and Development District III for the Farmers Home Administration, projections place Mitchell's population at about 14,430 by 1990. The trend has been for the municipal population to increase as rural population declines. This population increase reflects a large proportion of elderly or retired people who usually are not particularly large water consumers.

These projections indicate that though Mitchell is experiencing a slight population growth, water usage has not increased. Mitchell may be unique in this respect as initial data on other cities, included in this study, indicates that it is not unusual to see an increase in water consumption with stable or even declining populations. The fact that water use in Mitchell has remained constant may be due in part to the fact that residents of this city have, in the past, been faced with a water supply shortage and have developed an awareness of the necessity to conserve water. It is obvious, however, that conservation techniques can offset growth for only limited periods of time and if the city continues to grow, water usage will increase.

City planners are not currently anticipating that any major industies will locate or leave the Mitchell area and are expecting that relative to industrial use, consumption will remain relatively constant.

WATER USE DATA

The City of Mitchell meters and maintains records on raw water intake at the treatment plant. These figures and the computed daily average are included in this report.

The City of Mitchell does not maintain records of the total amount of water which is billed each quarter. To attain the total amount of water which is billed and the breakdown relative to residential, commercial, industrial uses, and unaccounted for losses, it would be necessary to go through the city water bills adding up the accounts. As per Rick Miner's instructions, I did not attempt this time-consuming process.

MITCHELL

Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)	Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)
1977			1978		
January	46,560	1.5	January	51,590	1.7
February	40,973	1.5	February	51,620	1.8
March	49,890	1.6	March	63,110	2.0
April	49,609	1.6	April	58,170	1.9
May	66,210	2.1	May	69,490	2.2
June	71,977	2.4	June	86,050	2.9
July	102,040	3.3	July	89,350	2.9
August	70,410	2.3	August	86,210	2.8
September	55,600	1.8	September	68,610	2.3
October	54,630	1.8	October	59,240	1.9
November	50,010	1.7	November	50,162	1.7
December	52,930	1.7	December	53,834	1.7
TOTAL	720,839	2.0	TOTAL	787,436	2.2

MITCHELL

Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)	Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)
1979			1980		
January	53,486	1.7	January	43,070	1.4
February	50,180	1.8	February	41,070	1.4
March	54,081	1.7	March	45,445	1.5
April	47,310	1.6	April	57,077	1.9
May	58,510	1.9	May	76,931	2.5
June	66,080	2.2	June	77,666	2.6
July	83,780	2.7	July	113,226	3.6
August	68,660	2.2	August	71,258	2.3
September	68,934	2.3	September	66,493	2.2
October	59,208	1.9	October	55,841.	1.8
November	44,260	1.5	November	39,649	1.3
December	43,941	1.4	December	38,732	1.2
TOTAL	698,350	1.9	TOTAL	726,458	2.0

MITCHELL

Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)	Year & Month	Raw Water Intake/Mo. (M.G.)	Avg. Daily Intake (M.G.)
1981			1982		
January	42,429	1.4	January	48,576	1.6
February	39,254	1.4	February	45,115	1.6
March	46,269	1.5	March	50,227	1.6
April	48,865	1.6	April	52,127	1.7
May	67,931	2.2	May	58,622	1.9
June	79,249	2.6	June	65,164	2.2
July	91,673	3.0	July	81,267	2.6
August	69,256	2.2	TOTAL	401,098	1.9
September	62,248	2.1			
October	53,081	1.7			
November	50,224	1.7			
December	47,604	1.9			
TOTAL	698,083	1.9			

ADDENDUM

1. Water Rates:

Mitchell bills for water on a quarterly basis. There is a $9 minimum service charge each quarter with an additional charge of 65¢ per unit of water. (A unit of water is defined as 750 gallons).

2. Bond Issue:

Prior to the vote on the bond issue for a new treatment facility, the City of Mitchell developed an active publicity campaign in an effort to inform the public on the necessity of a new treatment plant and to answer questions that the residents might pose. A town meeting was held; a two-page ad in the local newspaper (Daily Republic) was published and a special brochure was printed and distributed to all households in the city. In addition, the ratio stations aired three open forums on the issue and made public announcements as to the time, date, and places to vote.

3. Peaking Factor:

All peak days occurred during the months of either July or August and were as follows:

1982 = 4,390,000
1981 = 4,285,000
1980 = 4,585,000
1979 = 4,915,000
1978 = 5,260,000
1977 = 4,880,000

Al Sherman, Mitchell's Water Superintendent, stated that the record peak occurred in 1974 with 5,590,000 gallons being treated. At that time, the treatment plant was operating at full capacity. He further commented, however, that due to the deterioration of the facility over the years, it was his belief that the 1978 figure of 5,260,000 is the maximum amount that the treatment plant could process at this time.

INSTRUCTIONS: Down the left side of the paper, several ways of conserving water are described. Please tell us your reactions to each of them by answering the 5 questions asked across the top of the page. For example, read the description of Conservation Measure A, and then answer all 5 questions about it by checking that one of the 4 spaces under each question that best expresses your opinion. When finished, please fill out the background information and then return the questionnaire to us in the enclosed postage-paid envelope. We are most grateful for your cooperation.

	Question 1: How much do you know about this particular water conservation measure?				Question 2: How well do you think it would work?				Question [3]: How economical [do you] think it would	
CONSERVATION MEASURES	know nothing	know just a little	know a fair amount	know quite a bit	wouldn't save any water	would save only a very little water	would save a fair amount of water	would save a lot of water	it would cost more than it would be worth	prob[ably] come even[;] would cost much it w[ould] save
A. Individuals install new water-conserving plumbing fixtures such as low-flow toilets and shower heads in their homes.	4	20	25	13		14	26	10	8	13
B. City and state governments engage in active campaigns to educate the public on how to conserve water.	6	17	26	11	1	13	27	15	9	12
C. Sewage is processed and the treated water reused for manufacturing and irrigation of crops.	8	15	20	18	1	5	30	21	4	15
D. Building codes require the installation in new buildings of water-conserving plumbing fixtures such as low-flow shower heads and toilets.	14	16	19	11		7	36	15	3	8
E. As the amount of water used increases, the price per gallon is raised.	13	11	25	10	4	18	23	11	6	13
F. The city controls the rate of urban growth and thus the demand for water by issuing only a limited number of building permits each year.	14	16	18	7	11	26	9	9	21	16
G. The use of water for lawns and gardens is reduced by half.	1	8	33	14	2	9	30	18	3	7
H. During a severe drought, the government imposes restrictions on water use that if violated result in stiff fines.	9	18	25	5	1	2	29	25	6	6

To be effective, some of the measures described above would have to be made into law and enforced by government. Generally, how would you feel about this? (Please check one)

I would be strongly opposed	I would be somewhat opposed	I would be somewhat in favor	I would be strongly in favor
8	10	33	7

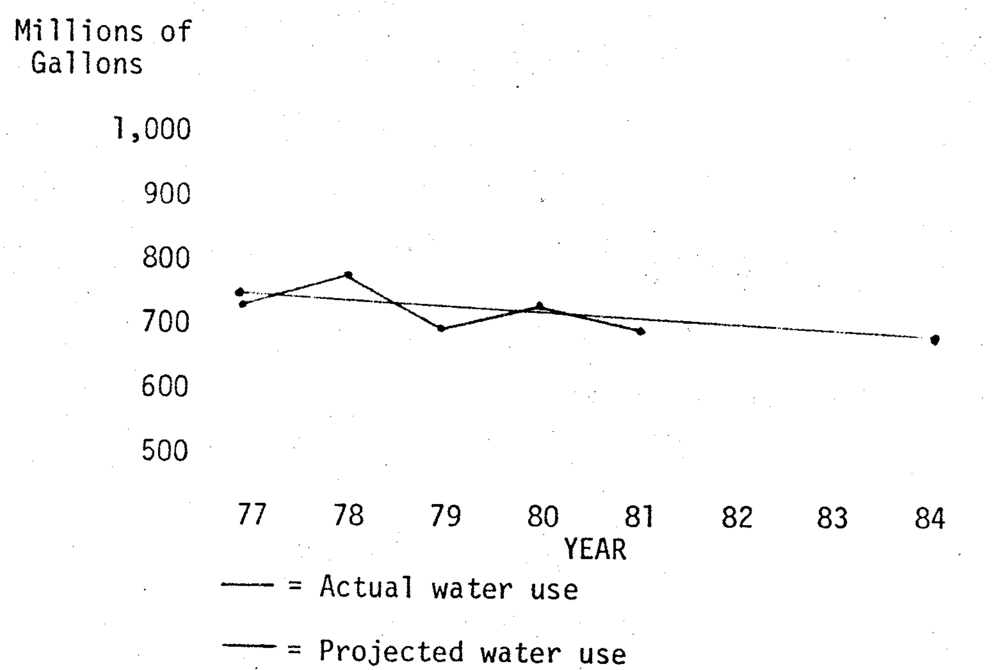
The Eastern South Dakota and Upper Big Sioux River, South Dakota and Iowa study was authorized in 1976. The Corps of Engineers is using this survey to obtain information to aid in formulat[ing an] economic, environmental, and socially acceptable plan in accordance with the Water Resources C[ouncil] Principles and Standards. Individual responses will be collected and tabulated by type of res[ponse and] will not be filed or published by names of individuals surveyed. Individual responses will be [kept in] our files as back-up data, and after ten years retired to the Records Center. Only the tabula[tions] of the types of responses will be published in a report which will be circulated to other Fede[ral] Water and Land Management Agencies for planning purposes. Answers to these questions are volu[ntary].

4. Projections:

Quantitative analysis based on water use in the years 1977 through 1981 indicate that water consumption in Mitchell will steadily decrease as indicated in Exhibit 1, Linear Regression Analysis and Exhibit 2, Simple Moving Average.

EXHIBIT 1

Linear Regression Analysis



Method of Computation

Straight Line = Y = a + bx
Value for a = a = $\bar{y} - b\bar{x}$
Value for b = b = $\frac{Exy - n\bar{x}\bar{y}}{Ex^2 - n\bar{x}^2}$

Where:
a = the y intercept
b = the stops of the line
$\bar{y}$ = the average of all y's
$\bar{x}$ = the average of all x's
x = the x value at each data point
y = the y value at each data point
n = the number of data points
Y = the value of the dependent variable computed with the regression equation

Water Pumped (MG)	Year		
y	x	xy	x^2
721	77	55,517	5,929
787	78	61,386	6,084
698	79	55,142	6,241
726	80	58,080	6,400
698	81	56,538	6,561
3,630	395	286,663	31,215

$$\bar{x} = \frac{Ex}{n} = \frac{395}{5} = 79$$

$$\bar{y} = \frac{Ey}{n} = \frac{3,630}{5} = 726$$

$$b = \frac{E\ xy - n\bar{x}\bar{y}}{E\ x^2 - n\bar{x}^2} = \frac{286,663 - 5\ (79)\ (726)}{31,215 - 5\ (79)^2} = 10.7$$

$$a = \bar{y} - b\bar{x} = 726 - (-10.7)\ (79) = 1571.3$$

$$Y = a + bx = 1,571.3 + (-10.7)\ (77) = 747.4$$

$$Y = a + bx = 1,571.3 + (-10.7)\ (84) = 672.5$$

EXHIBIT 2

Simple Moving Average

Year	Million Gallons	Two Years	Three Years
77	721		
78	787		
79	698	754	
80	726	742.5	735.33
81	698	712	737
82		712	707
83		705	710.44
84			705.26

Mr. Sherman, Mitchell's Water Superintendent, does not believe that either of these statisical analysis express an accurate assessment of Mitchell's future water consumption. He believes that: 1) the total average daily consumption will steadily increase and 2) there exists a danger that the current treatment plant will not be able to meet the future demands for peak day usage. The discrepancy between the statistical analysis and Mr. Sherman's evaluation is due to qualifying factors affecting water usage in the City of Mitchell.

In the past, the total city water consumption steadily rose as the city grew. In addition, life styles have changed. In the past the average water use per resident increased. This increase was due to a number of factors, including labor saving devices such as dishwashers, automatic laundry appliances; recreational activities such as swimming pools, hot tubs, etc. and esthetic considerations such as lawn sprinkling, car washing, etc.

This increase continued into the 1970's at which time Mitchell was faced with a water supply shortage when the volume of water in the pretreatment storage lake dropped to an alarmingly low level and the city residents were forced to examine the availability of water and the usage patterns which they had established. A general awareness of the need to conserve this natural resource developed and a variety of conservation measures have been employed. Mitchell has city ordinances which contain provisions for the regulation of water use. The necessity for implementation of this policy is determined by either the Water Superintendent or the city council and is based on factors related to supply, treatment, storage and distribution capabilities.

On a more personal level, many residents have installed low flow plumbing fixtures, have ceased watering their lawns, and generally evaluate such daily activity as whether the dishwasher is full enough to warrant operation, if there are enough clothes for a full load of wash, or does the car really need to be washed.

While one's water usage is not an overwhelming issue among Mitchell residents, conservation of this natural resource has become a way of life for most people. These activities have had the effect of lowering the "per resident" consumption and the total city consumption below that which had existed prior to the supply shortage of the late 1970's. This causes both linear regression analysis and the simple moving average to indicate that the trend will be for consumption to continue to decrease.

Simple logic tells us, however, that this trend cannot continue forever, especially in view of the fact that Mitchell's population is steadily increasing. The point will be reached when conservation can no longer offset population growth at which point total daily usage will again begin to increase.

Mr. Sherman could not specify a date when total city consumption will increase, but he does believe that if the city is allowed to grow relative to population and/or industrial growth, that there will be an increase in the amount of water used. He also recognizes the increasing potential for problems occurring on peak use days as the population continues to grow and the capabilities of the current treatment facility continue to decrease.

SECTION B-2

Domestic

Domestic Water Use

To estimate present and 2020 average and peak day domestic water use for the areas to be included in this study, estimates of the population during that time span were necessary. 1980 population figures were taken from the decennial census data. 1990 and 2000 estimates were established through simple linear regression analysis utilizing the 1930 through 1980 decennial census data. The estimates for 2010 and 2020 were developed utilizing known economic and social conditions of the area and by examining population changes during the years 1960, 1970, and 1980 as these recent years more adequately reflect current area trends than do the earlier statistics.

Consumption rates for average and peak day water use allow us to determine the probable demands that will be placed on a water system. A consumption rate of 40 gallons per person per day was used to calculate domestic water use in rural areas and cities which have no industry. A consumption rate of 60 gallons per person per day was used to calculate the peaking factor for domestic water use in rural areas and cities which have no industry. These figures have been established by the Engineering, Architectural and Planning Firm of Hoskins-Western-Sonderegger Inc. of Lincoln, Nebraska.

Estimated domestic water use for the cities of Alpena, Ethan, Letcher, Mt. Vernon, Stickney, and Carthage and Jerauld County, Davison County, Aurora County and the west half of Miner County through the years 1980, 1990, 2000, 2010 and 2020 is displayed in tables I through IX.

TABLE I - DOMESTIC WATER USE

Alpena

Year	Estimated Population	Estimated H_2O Use	Estimated Peak Use
1980	288 (actual)	11,520 gal/day	17,280 gal/day
1990	246	9,840 gal/day	14,760 gal/day
2000	243	9,720 gal/day	14,580 gal/day
2010	243	9,720 gal/day	14,580 gal/day
2020	225	9,000 gal/day	13,500 gal/day

TABLE II - DOMESTIC WATER USE

Ethan

Year	Estimated Population	Estimated H_2O Use	Estimated Peak Use
1980	351 (actual)	14,040 gal/day	21,060 gal/day
1990	313	12,520 gal/day	18,780 gal/day
2000	309	12,360 gal/day	18,540 gal/day
2010	321	12,840 gal/day	19,260 gal/day
2020	338	13,520 gal/day	20,280 gal/day

TABLE III - DOMESTIC WATER USE

Letcher

Year	Estimated Population	Estimated H_2O Use	Estimated Peak Use
1980	221 (actual)	8,840 gal/day	13,260 gal/day
1990	195	7,800 gal/day	11,700 gal/day
2000	170	6,800 gal/day	10,200 gal/day
2010	167	6,680 gal/day	10,020 gal/day
2020	159	6,360 gal/day	9,540 gal/day

TABLE VII - DOMESTIC WATER USE

Jerauld County

Year	Estimated Population	Estimated Water Use	Estimated Peak Use
1980	2,929 (actual)	117,160 gal/day	175,740 gal/day
1990	2,287	91,480 gal/day	137,220 gal/day
2000	1,732	69,280 gal/day	103,920 gal/day
2010	1,598	63,920 gal/day	95,880 gal/day
2020	1,475	59,000 gal/day	88,500 gal/day

TABLE VIII - DOMESTIC WATER USE

Davison County - Mitchell

Year	Estimated Population	Estimated Water Use	Estimated Peak Use
1980	13,916 (actual)	2,435,000 gal/day	3,827,000 gal/day
1990	14,663	2,566,000 gal/day	4,032,000 gal/day
2000	15,351	2,686,000 gal/day	4,222,000 gal/day
2010	16,150	2,826,000 gal/day	4,441,000 gal/day
2020	16,800	2,940,000 gal/day	4,620,000 gal/day

Remainder of Davison County

Year	Estimated Population	Estimated Water Use	Estimated Peak Use
1980	3,904 (actual)	156,000 gal/day	234,000 gal/day
1990	3,225	129,000 gal/day	193,000 gal/day
2000	2,864	115,000 gal/day	172,000 gal/day
2010	2,863	115,000 gal/day	172,000 gal/day
2020	2,685	107,000 gal/day	161,000 gal/day

SECTION B-3

Livestock

Livestock Water Use

The annual average number of head of livestock was developed from the Census of Agriculture Statistics, U.S. Department of Commerce, Bureau of the Census, 1969, 1974, 1978. The number of livestock maintained varies each year due to economic factors, weather conditions and technological advances. Despite these variables, there seems to be a 10 year cyclical pattern where in the number of large livestock, i.e. cattle and calves, increases, peaks and then drops off.

The mean average of the number of large livestock during the years 1969, 1974 and 1978 includes these fluctuations, but eliminates the extremes, giving us an estimate of the average number of livestock over a 9-10 year period. There are no anticipated events which would appreciably alter this cyclical pattern or dramatically raise or lower the mean average in the next few years. Small livestock, i.e. hogs, pigs sheep and lambs statistics have remained fairly constant for the past 10 years and no major changes are expected.

Large livestock require approximately 5.9 gallons of water per day and small livestock require approximately 2 gallons of water per day. Confined livestock must have their total water requirement provided for them, while livestock which is pastured usually has an additional source of water. Quantities of water required for maintenance of livestock in a confined environment would be similar to peak use statistics. In South Dakota livestock is raised in both confined feed lots and in open pastures.

In areas currently serviced by a rural water system , 15-20 percent of the livestock water requirement is obtained from the Rural Water system. Ten years ago only about 10-15 percent of the livestock water was obtained from Rural Water systems. The percentage of water may be elevated in times of drought and lowered slightly during extremely wet years. However, this percentage appears to be steadily increasing as the rural water concept becomes more familar. Consumption quantities and the degree of reliance upon rural water systems for livestock watering was established by the Engineering, Architectural and Planning Firm of Hoskins-Western-Sonderegger Inc. of Lincoln, Nebraska.

Estimated livestock water use for Jerauld County, Davison County Aurora County and the west ½ of Miner County is displayed in the tables X through XIV.

Table XI - Livestock Water Use

Jerauld County

	No. of Head	Avg. Daily Water Use (confined)	Avg. Daily Water Use (confined & pasture)
Large Livestock	47,222	278,610 gal/day	55,722 gal/day
Small Livestock	28,236	55,698 gal/day	11,140 gal/day

Table XII - Livestock Water Use

Davison County

	No. of Head	Avg. Daily Water Use (confined)	Avg. Daily Water Use (confined & pasture)
Large Livestock	45,444	268,120 gal/day	53,624 gal/day
Small Livestock	42,613	85,226 gal/day	17,045 gal/day

Table XIII - Livestock Water Use

West ½ Miner County

	No. of Head*	Avg. Daily Water Use (confined)	Avg. Daily Water Use (confined & pasture)
Large Livestock	23,957	141,346 gal/day	28,269 gal/day
Small Livestock	17,387	34,775 gal/day	6,955 gal/day

*These figures indicate ½ the total livestock population of Miner County.

Table XIV - Livestock Water Use

Aurora County

	No. of Head	Avg. Daily Water Use (confined)	Avg. Daily Water Use (confined & pasture)
Large Livestock	30,014	177,083 gal/day	35,417 gal/day
Small Livestock	26,142	52,284 gal/day	10,457 gal/day

SECTION C

EAST DAKOTA CONSERVANCY SUB-DISTRICT

EASTERN SOUTH DAKOTA WATER SUPPLY STUDY

for

U.S. Corps of Engineers, Omaha District
and
South Dakota Department of Water and Natural Resources

by

EAST DAKOTA CONSERVANCY SUB-DISTRICT
Brookings, South Dakota

Jerry L. Siegel, Manager-Treasurer

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December 1982

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PROJECT SUMMARY

The study area was selected by the Omaha District-Corps of Engineers and East Dakota Conservancy Sub-District to represent (1) the rural area bounded on the west by the Sub-District boundary and on the east by the service boundary of the Kingbrook Rural Water System, roughly 50% of western Kingsbury County and 10% of central Miner County and (2) communities in the Sub-District that were identified as experiencing water quantity or quality problems. These were Arlington, Bruce, Canova, Clear Lake, Hayti, Howard, Iroquois, Lake Preston, Madison and Ramona.

The results of this analysis indicate that both the selected rural areas and municipalities are having similar water supply problems. There is an ample supply of water available for use; however, its quality is poor. Chemical analysis data confirmed that municipalities have water quality problems. Conversations with municipal officials show that "water hardness" is a major problem throughout the study unit.

Water quality problems are greatest for the Municipalities of Clear Lake, Hayti, Howard and Iroquois. Although there are problems, they essentially involve "Quality of Life" problems associated with violations of secondary drinking water standards instead of severe health problems associated with violations of primary drinking water standards. The communities do not view their problems lightly. Presently, they are attempting to develop a better water source. Unfortunately, most of the communities are not in a position to feasibly hook up to a rural water system. Therefore, their primary alternative is to search for a better quality groundwater source through the community/rural groundwater studies program of the S.D. Geological Survey. In some cases, alternative groundwater sources offer little improvement in water quality and/or the cost of transporting better quality water to the city is restrictive.

It was determined that rural and community population levels have fallen at a steady rate for the past 40 years. This population loss directly affects the amount of water consumed by the municipalities and the rural domestic users. Water demand is projected to remain fairly constant, unless an unexpected population increase occurs.

The rural areas livestock numbers are expected to continue fluctuating between the 1968 level and the 1978 herd sizes. Area farmers, if given the opportunity to hook up to a rural water system, could be initially expected to use approximately 295,000 gallons per day for their domestic and livestock uses. This usage figure would likely increase because some ranchers would build up their herd size because of better quality water and others would begin using

rural water for livestock use in addition to household use once their current wells quit functioning.

It is unlikely that the Kingbrook Rural Water System or any other rural water system will expand into the western portion of Kingsbury County or the central portion of Miner County in the near future. With .85 farmsteads per square mile, an expansion would not be cost effective. Two efforts were attempted to extend Kingbrook Rural Water service westward and both were dropped for economic reasons.

EASTERN SOUTH DAKOTA WATER SUPPLY STUDY

Introduction

This report contains information generated by the East Dakota Conservancy Sub-District staff as a part of the Omaha District-Corps of Engineers Eastern South Dakota Water Supply Study under a contract with the S.D. Department of Water & Natural Resources. The overall purpose of the Corps' study is to fully examine the water supply problems and needs of eastern South Dakota. The Corps of Engineers is scheduled to develop a coordinated, comprehensive plan for meeting identified water needs east and north of the Missouri River

Role and Scope

The role of the Sub-District in this study is to identify, analyze, and propose recommendations to resolve community, rural domestic and livestock water problems and needs.

The scope of our community investigation includes the municipalities of Arlington, Bruce, Canova, Clear Lake, Hayti, Howard, Iroquois, Lake Preston, Madison and Ramona. The scope of our rural area investigation includes the area bounded on the west by the Sub-District boundary and on the east by the service area of the Kingbrook Rural Water System. Figure 1 shows the general location of the communities and rural areas included in the study unit.

Objectives

The Sub-District's main objectives, as outlined in the contract with the Department of Water & Natural Resources, are to: (1) estimate present and 2020 average and peak day water use for designated communities; (2) estimate present and 2020 rural domestic and livestock water needs; (3) provide an estimate of potential increase in water use if an adequate supply of good quality water were available; and (4) identify the boundaries of all existing and proposed rural water systems within the study unit.

Other objectives of this investigation are to develop potential solutions to resolve identified problems and water needs.

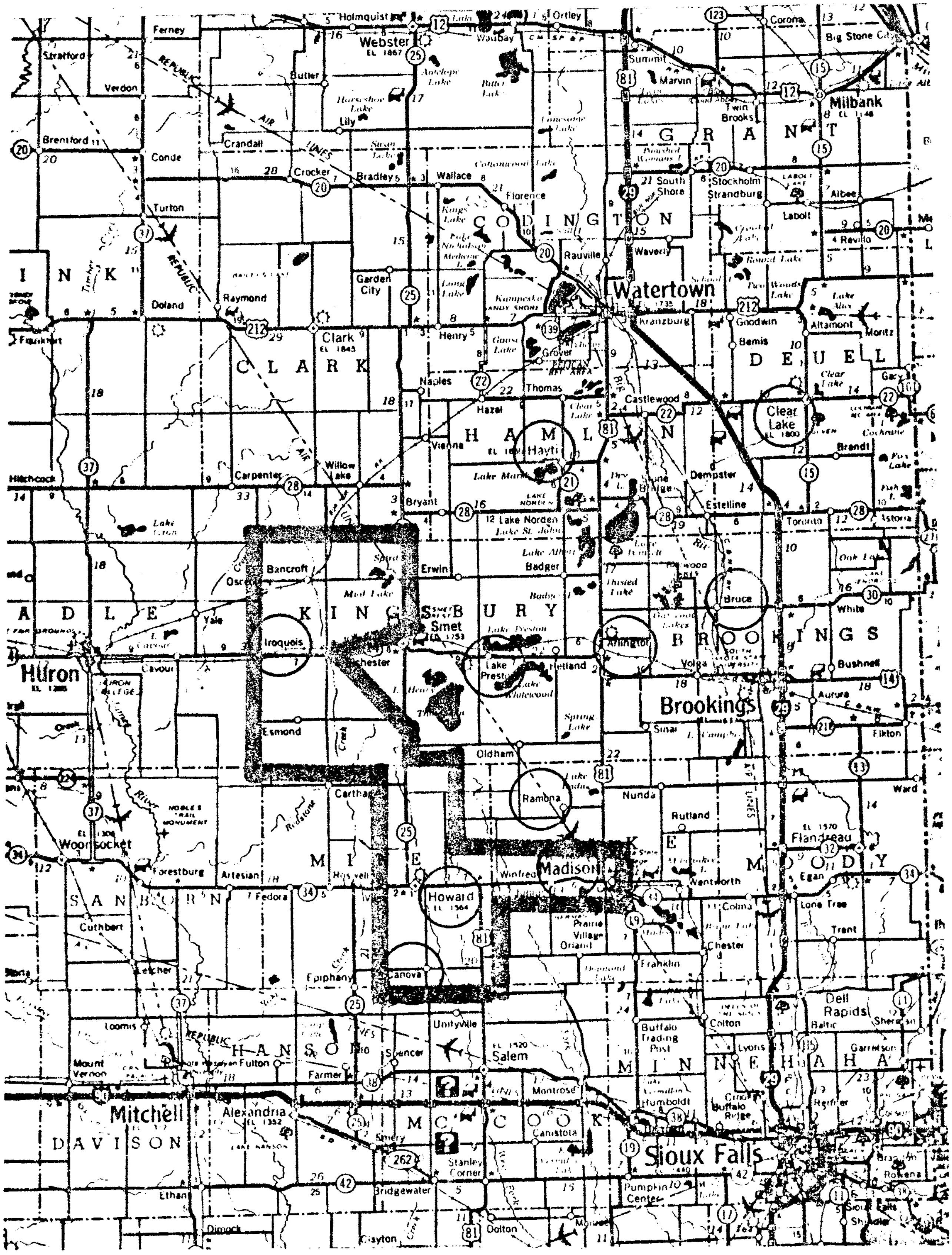


Figure 1. Location of Study Unit and Communities.

Municipal Water Supply

The Corps of Engineers and the Sub-District identified ten municipalities within the Sub-District boundaries that had identifiable water supply problems. One main objective of this study was to analyze the water problems and needs in these communities and to suggest possible solutions. This objective was accomplished.

Initially, the contract called for investigation of four municipalities identified in earlier work by the Corps. They were Bruce, Canoya, Iroquois and South Shore. The Sub-District expanded the analysis to include seven communities that had requested Sub-District assistance to develop a better water supply. They were Arlington, Clear Lake, Hayti, Howard, Lake Preston, Madison and Ramona. South Shore was dropped from this investigation because the Sub-District determined in the early stage of this investigation that a number of South Shore residents are served by the Sioux Rural Water System on an individual basis and that the other residents have the option to do so.

A questionnaire was mailed to each of the ten selected municipalities asking them to supply information about their community's present water demand, water quality problems and water supply needs. A copy of the questionnaire is attached at the end of this report. Communities were also asked to explain any alternatives formulated at the local level to resolve identified problems. If a community responded that they were having water related problems, the Sub-District made additional contacts to analyze their problem and explore possible solutions. Several communities requested additional Sub-District assistance. The Sub-District is actively working with Howard, Hayti, Iroquois, Arlington and Clear Lake to resolve their current problems. The information provided in the following pages represents data generated in the analysis of the ten selected community water supplies.

Municipal Water Demand

Current Water Demand

Current water demand data is presented in Table 1 on page 4. It shows average and peak daily use and was secured from the returned questionnaires. Each community was asked if they provided sufficient municipal water supply during peak use periods to determine whether their supply volume was adequate. All ten communities indicated that water demand during peak use periods does not exceed present water supply availability.

It can be concluded from the questionnaire and the discussions with community representatives, that except during extreme drought conditions and barring unexpected industrial or population growth, water quantity should not be a

Table 1. Current and Projected Municipal Water Demand, 1982 to 2020.

	Present Water Use (1982) (1000 gallons/day)		Projected Peak Daily Water Demand (1000 gallons/day)											
			1990 Scenairo			2000 Scenairo			2010 Scenairo			2020 Scenairo		
	Average Daily Use	Peak Daily Use	A	B	C	A	B	C	A	B	C	A	B	C
Arlington	228	400	380	412	440	360	424	480	340	436	520	320	448	560
Bruce	10	15	14.7	16	17	14	16.4	18.6	13	17	20.1	12.4	17.4	21.7
Canova	17.5	30	28.5	31	33	27	32	36	25.5	33	39	24	34	42
Clear Lake	129	197	187	203	217	180	209	236	168	215	256	158	221	276
Hayti	20.5	28	26.4	29	30.8	25	30	33.6	23.6	30.5	36.4	22	31.4	39.2
Howard	110	150	142	154	165	135	159	180	127	163	195	120	168	210
Iroquois	33	45	42.7	46	49	40	48	54	38	49	58.5	36	50.4	63
Lake Preston	100	125	118	129	137	112	132	150	106	136	162	100	140	175
Madison	890	1.5*	1.4*	1.55*	1.65*	1.35*	1.59*	1.8*	1.27*	1.6*	1.95*	1.2*	1.68*	2.1*
Ramona	14.5	20	18.6	29.6	22	17.6	21.2	24	16.6	21.8	26	15.7	22.4	26

*Million gallons/day

NOTE: 1. Scenarios A - Minus 5 percent decrease per decade

B - No growth to slight increase - 3 percent increase per decade

C - Maximum 10 percent increase per decade

2. Water Demand decreases and increases are calculated on 1982 Peak Daily Use figures.

SOURCE: Present Water Demand figures were received from representatives from each of the ten municipalities.

problem for these ten communities. This assumes that Arlington is able to develop an additional well during 1983 and that Clear Lake and Hayti are able to replace their present wellfields if contamination problems continue to develop.

Projected Water Demand

Table 2 contains the past population as determined by U.S. Census Data for the ten selected communities. As a general rule, there has been a loss of population in the smaller rural communities during the past 30 years. Clear Lake and Madison, two of the large communities, have shown a steady population increase.

Discussions on projecting populations of these communities were held with two local experts. They were James Satterlee, Professor - Department of Rural Sociology, South Dakota State University, and Willim Folkerts, Director - First District Association of Local Governments. Based on their suggestions and examination of the data in Table 2, it was determined that the population of all ten communities would most likely remain fairly constant or show a small increase over the next two decades.

Table 2. Historical Population Trends of Ten Eastern South Dakota Muncipalities -- Population from 1930 to 1980.

Municipality	1950	1960	1970	1980
Arlington	1096	996	954	988
Bruce	305	272	217	254
Canova	340	247	204	194
Clear Lake	1105	1137	1157	1310
Hayti	413	425	393	371
Howard	1251	1208	1175	1169
Iroquois	357	316	320	299
Lake Preston	957	955	812	789
Madison	5153	5420	6315	6210
Ramona	278	247	227	241

Source: South Dakota - Census of Population.

Peak daily water demand in Table I was projected to the year 2020 using three possible scenarios. Scenario A represents a constant 5% decline each decade and Scenario C represents a constant 10% per decade growth scenario. Scenario B was selected to represent a slight growth scenario roughly midway between the declining and significant growth scenarios.

Municipal Water Quality

All ten municipal water systems were analyzed to determine if water quality problems exist in their present water supplies. If a problem was identified, its extent and severity was examined. Comments on each individual community are contained in the following section.

Each community was asked in the questionnaire if they were receiving complaints regarding poor quality water from their residents. Seven out of the ten municipalities indicated they have received complaints. The complaint heard most often was "water hardness." Hard water as a rule exists throughout the Sub-District. Officials from many of the communities stated their water quality has always been poor but the problem had only recently gained sufficient public attention to warrant resolution of the problem. State Water Plan activities during 1981 and 1982 are credited with creating a great deal of focus on these problems.

Detailed information on community water quality is located in Appendix A, Sections 2 and 3. Information provided in these two tables was extracted from the questionnaire and also from the South Dakota Public Water Supply H_2O report. prepared by the South Dakota Department of Environmental Protection in 1979.

The water quality data shows that although the water utilized by most of the communities is of poor general quality, it does not violate any primary drinking water standards so should not cause serious health problems. The water violates recommended secondary drinking water standards for constituents such as sulfates, total dissolved solids, iron and manganese. These constituents are associated with aesthetic quality of water and cause nuisance problems to individual users and to the community distribution system. Iron and manganese affect costs of water treatment; lack of treatment can result in expensive replacement of water mains and service lines plugged with deposits, plus other problems such as staining of clothes and plumbing fixtures.

Background Information, Problem Identification and Possible Solutions

Background information on each of the ten municipality's water supply and quality problems are presented in this section. The solutions outlined were generated during discussions with officials from the community and other experts such as consulting engineers, S.D. Geological Survey officials and officials from the Office of Drinking Water - Department of Water & Natural Resources. Water quality data for each community is found in Appendix 1, Sections 2 and 3.

ARLINGTON

Background -- The City of Arlington has only one producing well and as such could face serious problems if the well failed, particulary during severe weather conditions. They also have a water quality problem. Their sulfate content of 910 ppm exceeds the recommended limit of 250 ppm and their TDS of about 2075 exceeds the recommended limit of 500 ppm.

Possible Solution -- The city has developed sufficient local capital reserves to finance construction of an additional well. Thus, they did not need to be added to the State Water Facilities Plan during the fall of 1982 to develop the needed finances. The city, however, wishes to have sufficient test drilling done to find a new well location that optimizes three factors: (1) sufficient water yield, (2) best available quality, (3) as close to their existing well as possible to reduce new pipeline costs.

Thus, the city on August 11, 1982 asked the East Dakota Conservancy Sub-District to provide cost-sharing for a S.D. Geolgical Survey community groundwater study to be conducted in 1983. The Sub-District has a written policy of providing 50% of the local costs (currently $1,000/week) for such studies. The S.D. Geological Survey will be starting the second year of a comprehensive county groundwater study in Kingsbury County in 1983. It is likely that the needed test drilling work can be accomplished.

BRUCE

Background -- Bruce installed a community water system in 1976. The City of Bruce was selected by the Corps of Engineers for inclusion because they lie on the fringes of two rural water systems. Bulk water delivery to Bruce was continued in the initial plans for the Brookings-Deuel Rural Water System. Community officials changed about the time the rural water system went into construction, however, and they decided to maintain their own supply.

Sub-District communication with Town Board President Lavalle Holter determined that the community has no current water quality problems and that their only supply problem is the need for a backup water pump to use during peak use periods or in case of breakdown of the other pump. The city is presently exploring ways of purchasing the new pump.

CANOVA

Background -- This community was identified as a community just outside the service area of the Kingbrook Rural Water System that might benefit from rural water service. Sulfate levels (876-924 ppm) exceed the recommended 250 ppm while total dissolved solids (1659-1765 ppm) exceed the recommended 500 ppm.

A community official contacted the Sub-District office in April, 1982 during mid-year update of the State Water Plan. He reported they had severe problems involving frequent breaks in three blocks of city water mains. They had recently spent $15,000 on water main and sewer lift repairs. The city had replaced these water mains, however, during the summer of 1982.

Because Canova officials had contacted the Sub-District earlier about water problems, the community was specifically invited during the fall of 1982 to submit a water project for inclusion in the State Water Plan during the annual update. No proposal was submitted, indicating that the community was not planning further water improvements.

Questionnaire results and a followup telephone conversation with the Mayor confirmed that Canova is not planning any water improvements. Residents do not perceive their present water quality as being bad. In the event that major problems develop, Canova is within a mile of the Kingbrook Rural Water System. Engineering studies would need to be made to determine what system improvements would be required to serve the community.

CLEAR LAKE

Background and Water Problems -- The city has a small ion-exchange softening plant in their wellfield area. A major accidental spill of sodium chloride brine occurred in 1971. A city well close to the spill was immediately contaminated and a second well has shown elevated levels of sodium chloride.

Clear Lake asked the Sub-District, in early summer of 1982, to cost-share a S.D. Geological Survey community groundwater study to diagnose the location and movement of the contamination plume and to suggest where a new good quality well could be safely developed. The Sub-District Board agreed to provide $500/week cost-sharing for three weeks of groundwater study work.

During July, the S.D. Geological Survey did some test drilling work and installed some observation wells to determine the direction of groundwater flow and the water quality at various locations. They found a non-contaminated section of aquifer about one-fourth mile up-gradient from the city's existing wells. The S.D. Geological Survey intends to continue water quality monitoring of the observation wells to determine whether the contamination plume is moving out of the wellfield area and will make a recommendation in early 1983.

The city is also having a water main breakage problem. Their distribution system is over 60 years old. They have replaced three blocks of water main and have had about six major line repairs each year. A community official stated the city could use a larger storage reservoir. The wells provide an adequate water supply; during a large fire, however, the city reservoir would not provide sufficient water quantities.

Possible Solution -- The city submitted a proposal to the Sub-District for developing a new well or wells for inclusion in the State Water Plan in October, 1982. The Sub-District Board recommended the project for inclusion but the project was not authorized by the State Board of Water & Natural Resources because it was not well formulated and ready to proceed. The city will be able to formulate a definite project once the S.D. Geological Survey recommendations are made and will likely submit a proposal for the State Water Plan in 1983. Replacement of additional water mains and development of additional storage has been overshadowed by the city's need for a new well.

HAYTI

Background and Problems -- The State Office of Water Quality has been increasingly concerned over the deteriorating water quality of Hatyi's community water supply. The total dissolved solids level increased from 58 ppm in 1956 to 2196 ppm in 1978. The Sioux Rural Water System also has wells located north of Hayti's wells. The TDS level in the system's wells has increased from 500 ppm to 1100 ppm during their 6-7 years of operation.

In addition, the city has significant problems with manganese encrustation in city mains and individual consumer lines even though the community distribution system was not installed until 1948. Five household service lines and one commercial service line had to be replaced during the fall of 1982.

Because of the deteriorating water quality, the state selected Hayti as an area for special water quality study as a part of the Big Sioux Aquifer Water Quality Study which is being financed by EPA. Bob Stach of the S.D. Geological Survey, who is doing most of the water quality evaluation work, has developed and sampled a number of observation wells in the area. Preliminary results indicate that highly mineralized water from Lake Marsh, which lies adjacent to the community, is moving into the aquifer.

Possible Solutions -- The Sioux Rural Water System submitted a proposal for inclusion in the State Water Plan in October, 1982 which received both Sub-District and State Board of Water & Natural Resources approval. Part of that proposal involves development of a new wellfield in the Hayti area and possibly as a joint venture with Hayti. Hayti, thus, is included in the State Water Facilities Plan under the umbrella of this proposal.

The Sub-District is working closely with the S.D. Geological Survey, Hayti, and Sioux Rural Water System to develop the best solution for the noted problems. A joint meeting of all the interested parties will be set up in early 1983. It may be necessary to have a community/rural groundwater study conducted by the S.D. Geological Survey to locate the best replacement water source since the current water quality study was aimed at diagnosing the problem, not on finding a replacement source. If so, the Sub-District will share a portion of the study costs.

There seem to be two options available to the City of Hayti. The first would be to develop a new well in an area close to the community that will not be effected by contamination from the lake. Their second option would be to join the Sioux Rural Water System as a bulk customer. This is the community's least preferred alternative because they want to keep their independence, if possible.

HOWARD

Background and Problems -- Although the City of Howard does not violate any primary drinking water standard, the city has some of the poorest chemical water quality in the Sub-District. Total dissolved solids range from 1941 ppm to 2116 ppm and sulfate between 1030 ppm and 1110 ppm. Hardness, iron and manganese levels are also very high.

Two S.D. Geological Survey community groundwater studies have been completed for Howard. The first during 1959 and the second during 1969. Both examined four sources: (1) buried outwash, (2) Sioux Quartzite wash, (3) Dakota Sandstone, and (4) surface outwash along the Vermillion River. All appear to have generally poor quality water.

In 1982, Howard asked the S.D. Geological Survey to suggest possible alternative groundwater supplies by examining information generated in the two previous community groundwater studies plus the comprehensive Miner County groundwater study which was completed a few years ago. The city submitted a proposal to the Sub-District for developing a replacement water supply for inclusion in the State Water Plan in October, 1982. The Sub-District gave the proposal a very high priority. The State Board of Water & Natural Resources did not authorize the project in November, however, because a definite proposal had not been formulated and because Howard's water did not violate any primary drinking water standard.

Shortly thereafter, however, the Sub-District learned Howard's water had recently had bacterial contamination problems and their fire insurance rating had been dropped from 7 to 8, making insurance more expensive. In addition, a local meat cutting industry announced it was expanding its operations. The Sub-District staff put considerable efforts into evaluating Howard's alternatives during November and December to formulate a definite project for inclusion in the State Water Plan.

The Sub-District (1) asked the S.D. Geological Survey to evaluate possibilities for a better quality groundwater source using two community groundwater studies and the recently completed Miner County groundwater study, (2) asked the State Office of Drinking Water to evaluate costs of improved water treatment, and (3) worked with the project engineers and Kingbrook Rural Water System officials to evaluate the potential for hookup to the system. In response, (1) the S.D. Geological Survey found a Codell aquifer well which had a little better water quality; they feel, however, that this and other groundwater alternatives need further testing; (2) the Office of Drinking Water suggested a reverse-osmosis treatment as the best alternative for improved water treatment; construction costs would be close to $0.5 million and operational costs would be high; (3) hookup to Kingbrook would involve construction of additional wells, treatment plant capacity, and pumps plus over 30 miles of larger diameter pipeline, making the alternative quite expensive.

Based on these three findings, Howard officials and the Sub-District staff mutually decided against asking the Board of Water & Natural Resources, on December 14, to reconsider and place Howard in the State Water Facilities Plan this fall.

In addition to the three alternatives noted above, the Corps is evaluating the possibility of serving Howard and other communities as part of a proposed pipeline from the Missouri River along Highway 34. All of Howard's alternatives will likely be epxensive.

IROQUOIS

Background and Water Problems -- The community has two deep Dakota Sandstone wells developed in 1929 and 1952. In 1980, unrepairable leakage developed in one of the wells. The city asked for a S.D. Geological Survey community groundwater study and requested Sub-District cost-sharing. The Sub-District agreed to provide cost-sharing for two weeks for study of the Pearl Creek aquifer which lies several miles east of town. The field work study was completed during 1980 and the results presented to community officials. The study indicated good quality water could be secured about three miles west of town. At that time, however, city officials decided to develop another Dakota Sandstone well instead.

In addition, Iroquois contributed a "Good Intention Fee" several years ago indicating interest in becoming a part of Phase II of the Kingbrook Rural Water Sysem. Due to the low density of rural users between the system's current western boundary and Iroquois, the proposed service to Iroquois was not feasible at that time.

Iroquois water is extremely high in sulphates (1070-1125 ppm), total dissolved solids (2088 ppm-2116 ppm) and sodium (693-736 ppm).

The city is also experiencing severe water main breakage problems. Their mains are well over 60 years old and the cast iron mains are slowly being corroded to the extent that the city's entire water distribution system needs replacement. The city has replaced about ten percent of its mains and will need financial assistance to replace the remaining lines. The Sub-District will be working with the city to get the water main replacement proposal into the State Water Plan so that financial assistance can be secured.

Possible Solutions -- Community residents are not satisfied with the quality of their present Dakota Sandstone source and community officials have recently expressed interest in following the S.D. Geological Survey's recommendation to secure water from Pearl Creek. The Sub-District corresponded with John Hatch, Chief Engineer - Division of Water Rights, in October, 1982, however, and learned the Pearl Creek aquifer is now fully appropriated. In fact, the City of Huron's recent request for a future water permit from Pearl Creek was turned down.

Thus, hookup to the Kingbrook Rural Water System, even though it would be expensive, may be the most likely replacement source. There are no serious discusssions at this time about joining the rural system. It is unlikely that the city will formulate such plans until they have replaced their failing water mains.

LAKE PRESTON

Background -- The city has poor water quality. Sulfate (1050 ppm), sodium (707 ppm) and total dissolved solids (2255 ppm) levels are all extremely high. They have experienced difficulty securing a reliable water supply because of the extreme variability of shallow outwash deposits near the city. Citizen complaints have been received about the water hardness and the bad odor from high sulfates.

Two S.D. Geological Survey community groundwater studies have been made; the first during 1961 and the second in the early 1970s. Unfortunately, these studies indicate high quality water does not exist in close proximity to the city. Therefore, if the city decides to locate another groundwater source, costs will likely be high.

Possible Solutions -- The community has been offered bulk water delivery through the Kingbrook Rural Water System several times during the past. The community submitted a proposal for development of a new water source for inclusion in the State Water Plan in 1981. The proposal was rejected by the Department of Water & Natural Resources because the community would not consider rural water hookup which the state felt was the best alternative in terms of overall state and federal financial resources.

MADISON

Background -- Madison obtains water from two aquifers, one very shallow at about 30-50 ft. depth. The other deeper at about 250 ft. depth. Madison's water is of poor quality. Total dissolved solids levels ranging from 683 ppm to 2107 ppm and sulfates 208 ppm-1153 ppm exceed recommended limits. Although iron and manganese levels are high in the raw water, Madison removes these constituents in their treatment plant. The treatment process reduces hardness about 25%. Madison was included in a 10-community desalting study by J. T. Banner & Assoc. which was completed in 1973. The primary need for the City of Madison is to develop an expanded water supply and to make distribution system improvements to service industrial expansion and residential growth areas on the northeast side.

Proposed Solutions -- The city asked the Sub-District to cost-share a S.D. Geological Survey community groundwater study in 1981 for the purpose of studying the availability of larger quantities of water in the deeper aquifer for industrial purposes. Both the city and the Sub-District provided $1600 for up to four weeks of test drilling work. In addtion, a study of all the aquifers of Lake County has been underway since 1980. The Survey determined there is sufficient water in the deeper aquifer for significant industrial growth.

Madison's proposed water improvements were included in the State Water Facilities Plan in both 1981 and 1982.

RAMONA

Background -- Ramona secures water from two wells, the first in buried outwash 400 ft. deep, the second in the Codell aquifer 820 ft. deep. Their water has high sulfate (910 ppm-1059 ppm), total dissolved solids (1863 ppm to 2124 ppm), sodium (108 ppm to 590 ppm), iron (0.4-4.0 ppm) and manganese (0.02-4.60 ppm) levels. Because of this, development of an improved water supply for Ramona was placed in the State Water Facilities Plan in 1981. The proposal was dropped from the State Water Plan in 1982, however, because the community had not taken any further steps to formulate a definite project.

Possible Solutions -- A comprehensive groundwater study has been underway in Lake County since 1980. Geologists have determined that the quality of water in the buried outwash is better southwest of Ramona. More intensive test drilling and water quality sampling through a S.D. Geological Survey community groundwater study is needed, however, before definite recommendations could be made.

The community lies adjacent to a 4" main line of the Kingbrook Rural Water System. They have not expressed an interest in joining the system. If such interest develops, engineering evaluations would need to be made to determine the rural system improvements needed to adequately supply Ramona's needs.

RURAL WATER SUPPLY

The Sub-District was directed by the Corps of Engineers to investigate rural domestic and livestock water needs by county within the study unit. The general boundary of this rural area is shown in Figure 1; the attached maps show the exact locations of the Kingbrook Rural Water System distribution lines. The study unit boundary is generally described as being the area bounded on the west by the Sub-District boundary and on the east by the service area of the Kingbrook Rural Water System. Examination of the attached maps show the study area encompasses roughly forty percent of the total area of Kingsbury County and roughly ten percent of the total area of Miner County. Due to the lower density of farmsteads in western Kingsbury County, the rural population in the study area is less than 40% of the total non-incorporated rural population in the county.

Rural Household

Rural/farm population figures from 1950 through 1980 are presented in Table 3 below. This rural area has experienced an average decrease in population of 18 percent per decade. Dr. James Satterlee, SDSU Rural Sociologist, stated this loss is similar to the loss experienced in other rural areas of South Dakota.

Table 3. Rural/Farm Population for portions of Miner and Kingsbury County, 1950-1980.

County & Township	1950	% Chg	1960	% Chg	1970	% Chg	1980	% Chg
Miner County 10%	6268	-8	5398	-13	4454	-17.5	3739	-19
Grafton	182		135		143		133	
Adams	326		266		242		176	
Howard	245		192		174		126	
Canova	278		241		185		106	
Total Township	1031	-8	834	-19	744	-11	541	-27
Kingsbury County (40%)	9962	-8	9227	-7	7656	-17.0	6679	-12
Le Suer	300		296		236		145	
Iroquois	167		186		98		73	
Esmond	308		225		159		84	
Spirit Lake	416		351		230		188	
Manchester	307		234		152		131	
Mathes	500		414		317		212	
Total Township	1998	-5	1706	-15	1192	-30	833	-30

NOTE: Township population figures do not include communities.

SOURCE: S.D. Census of Population, 1950, 1960, 1970 and 1980.

Livestock Water Use

Past livestock numbers and estimated livestock water use information are located in Tables 6 and 7 on page 17. It was noted earlier that 40% of Kingsbury County and 10% of Miner County are in the study area. It is further assumed here that livestock numbers are uniform across these two counties. Thus, 40% of total Kingsbury County livestock and 10% of Miner County livestock numbers are shown in Tables 6 and 7. Poultry numbers and use were not included for two reasons. Recent data shows no significant poultry industry in the study area and the manner of reporting poultry numbers was changed dramatically in recent years making it difficult to compare current populations with historic data. Past livestock population trends for both counties are similar. They show that livestock numbers increased from 1950 through 1968, then gradually decreased to the 1978 levels.

The following livestock water consumption rates were used for this analysis:

Dairy cows Beef cattle & yearlings	average 20 gal per head per day
Hogs	3 gallons per head per day
Sheep and Lambs	2 gallons per head per day

Projected Livestock Use

Projecting livestock numbers over the long term is difficult as it depends on economic conditions, governmental policies, and short-term changes in climatic conditions. Art Sogn, Agricultural Economist at South Dakota State University, stated that during the late 60s and early 70s when livestock numbers were high, state range lands were being overgrazed. He further noted there is reason to believe that livestock numbers would not exceed the 1968 levels, but range somewhere between 1968-1978 numbers.

In addition, the Sub-District staff made a number of telephone calls to livestock producers in the area and determine that livestock numbers in this area have not been limited by extremely poor quality water or by lack of water. It can, therefore be logically argued that livestock populations and, consequently, livestock water use in the year 2020 will lie somewhere within the range of livestock numbers and livestock water use that has occurred during the last 30 years.

Thus, livestock water use in the year 2020 in that portion of Kingsbury County in the study area will likely range from 353,200 gal/day to 721,500 gal/day and livestock water use in the year 2020 for that portion of Miner County in the study area will likely range from 63,400 gal/day to 122,000 gal/day.

Table 4 contains summary information on the rural study area; the data provided shows that the study unit encompasses 521 square miles and includes approximately 444 households with a total population of 1374. This amounts to .85 occupied farmsteads per square mile in 1982. These rural people are consuming approximately 82,400 gallons per day for their household water uses.

Table 4. Rural Household Water Use for Portions of Western Kingsbury and Miner Counties, 1982.

	Miner County	Kingsbury County	Total
Rural Population[1]	541	833	1374
Estimated Number of Households	164	280	444
Individuals/Household	3.3	3.0	-
Total Household Water Consumption (1982)	32,460 gal/day	49,980 gal/day	82,400
Total Square Miles in Study Unit	144	377	521
Households per square mile	.9	.75	.85

NOTE: 1. Figures represent 10 percent of Miner County, 40 percent of Kingsbury County, and do not include communities.

SOURCE: S.D. Census of Agriculture, 1978.

Rural household water demand was projected to the year 2020. A conservative projection of -5 per decade was selected to show possible future water use. Table 5 shows the projections for the two counties. Realistically, farmstead numbers and population figuress cannot continue to show an 18 percent decline. Instead, they should be expected to stabilize sometime in the future. However, when this will happen and at what level is not known.

Table 5. Future Domestic Water Demand, 1982-2020.

County	1000 gal/day				
	1982	1990	2000	2010	2020
Miner (10%)	32.5	30.9	29.3	27.6	26.0
Kingsbury (40%)	50.0	47.5	45.0	42.5	40.0

Table 6. Livestock Numbers and Estimated Livestock Water Consumption for the 40% Portion of Kingsbury County in the Study Area, 1950-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1950	14,700	300,000	14,800	44,400	4,400	8,800	353,200
1960	21,100	442,000	14,800	44,400	11,400	22,800	509,200
1964	28,400	568,000	14,300	42,900	14,100	28,200	639,100
1968	31,200	624,000	14,400	43,200	11,600	23,200	690,400
1974	33,600	672,000	9,500	28,500	10,500	21,000	721,500
1978	24,000	480,000	12,800	38,400	5,000	10,000	528,400

NOTE: 40% of all livestock in Kingsbury County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota
U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Kingsbury County Agriculture.

Table 7. Livestock Numbers and Estimated Livestock Water Consumption for the 10% Portion of Miner County in the Study Area, 1950-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1950	2800	56,000	2100	6,300	550	1,100	63,400
1960	3850	77,000	1900	5,700	1700	3,400	86,100
1964	5150	103,000	2200	6,600	1400	2,800	112,400
1968	5650	113,000	1750	5,250	1300	2,600	120,800
1974	5600	112,000	2600	7,800	1100	2,200	122,000
1978	4290	86,000	2500	7,500	800	1,600	95,100

NOTE: 10% of all livestock in Miner County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota
U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service, Miner County Agriculture.

Background, Problem Identification, and Proposed Solution

In western Kingsbury and central Miner counties, farm unit density gradually decreases from east to west. Farms are larger and carry larger herds of cattle. Table 4 shows there are approximately .85 farm units per square mile which is less than in most areas of the Sub-District. As user density decreases, the capital costs per user to develop a rural water system increases, making a rural water system less feasible when compared to other water sources.

Telephone contacts were made with a representative number of farmers located throughout the study unit to determine localized water problems and needs. There was no water quantity problems indicated. Farmers stated they have sufficient quantities to meet their domestic and livestock water needs although the quality of water utilized in most instances is poor. The Kingsbury County Agent indicated that water quality may be poor enough in southwestern areas of the county to restrict livestock numbers. The above-noted telephone contacts could not verify any such cases. Thus, there is a strong possibility that severe water quality problems are not widespread but confined instead to small areas or individual farm wells.

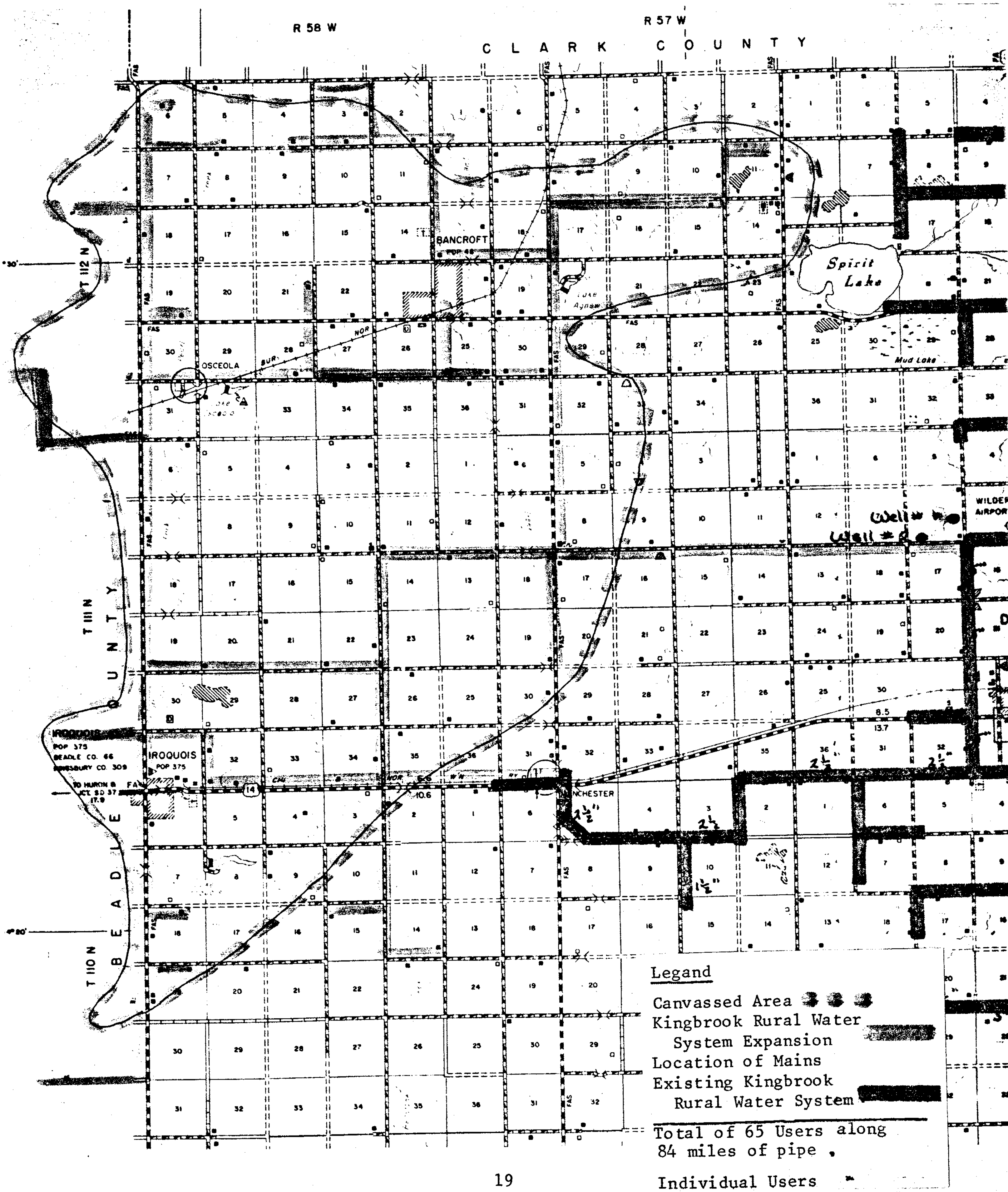
Since construction of the Kingbrook Rural Water System, there have been several efforts initiated to explore the interest in expanding the system further west. In June of 1981, a group of people, headed by Arlene Schoenfelder of rural Iroquois, began a rural water system signup campaign. This drive resulted in about 65 landowners contributing $50.00 each as a good intention fee. Figure 2 shows the general location of the canvassed area and a proposed pipeline layout from the Kingbrook System to the interested users. The proposed pipeline layout involves 84 miles of new pipeline. With 65 users, the density would be roughly .75 users per mile of pipeline.

During 1981, interest rates were extremely high. This, combined with the relatively low user density, forced local organizers to drop efforts to implement the proposal. If interest redevelops, the area would need to be completely recanvassed as land ownership and landowner interest may have changed.

It was noted earlier in the municipal section of this report that Iroquois expressed interest in joining the Kingbrook Rural Water System in the late 1970s whe Phase II was developed. It appears that a proposal combining service to Iroquois and other small communities, plus service to rural users, would have the greatest chance for success.

Also, it was noted earlier that expansion of the Kingbrook Rural Water System is one aternative for providing Howard with an alternative water source. However, because the water delivery capacity of the system's facilities in the Howard

Figure 2. Kingbrook Rural Water System Expansion Drive in 1981.



area are committed, service to Howard would involve additional wells, treatment plant capacity, pumps, and storage facilities plus over 30 miles of new main line capacity. The water would need to be brought either from the wellfield northwest of Chester in Lake County or the wellfield northwest of DeSmet in Kingsbury County.

For all three of the proposals explained above, it should be noted there are no active efforts underway by either the unserved rural users, Iroquois officials, Howard officials, or Kingbrook Rural Water System officials to develop them.

There was some consideration given toward service to western Kingsbury being provided by the Clark Rural Water System. Also, there is some possibility of service to the area coming from a new rural water system developing in western Beadle County or from a Highway 34 system from the Missouri River. It appears, however, that expansion of the Kingbrook Rural Water System offers the only real chance for success.

RURAL WATER SYSTEM BOUNDARIES

All boundaries of existing and/or proposed rural water systems are plotted on appropriate county maps. There are eleven rural water systems located either in or touching the Sub-District boundary. Of these eleven systems, only the Kingbrook Rural Water System is located in close enough proximity to be considered for this analysis. Maps showing the portion of the Kingbrook Rural Water System distribution system in Kingsbury and Miner Counties are attached to this report. These maps show locations of reservoirs, all water lines, and wellfields; the size of the various water lines is noted.

Potential Water Use if a Rural Water System Delivery System Served the Study Area

It is strongly believed that rural water system service would not result in increased water use in the rural study area. Instead, the water source would change from individual wells to centrally located high capacity wells.

If the Kingbrook Rural Water System planned a major expansion into the rural study area in Miner and Kingsbury Counties, and if the State of South Dakota was able to provide some financial assistance through Community Development Block grant funds and lower interest Water Facilities Construction fund loans, it is likely that the selected communities of Iroquois, Howard and Canova, plus individual residents of the very small communities of Bancroft (41 population) and Esmond (19 population) in Kingsbury County, and Vilas (28 population) in Miner County would be served as well.

There are currently about 280 farmsteads in Kingsbury County and 164 in Miner County for a total of 444 farmsteads in the study area. Table 8 below shows that there are 833 rural residents in Kingsbury County and 541 rural residents in Miner County within the study area. In order to design water delivery capacity for a typical rural water system to serve this rural area, the following assumptions were made:

(1) 40% of the livestock in Kingsbury County and 10% of the livestock in Miner County are within the study area.

(2) 75% of the rural landowners would hook up to the system.

(3) 50% of those hooking up would use rural water for household purposes only, the other 50% for household and livestock watering purposes.

(4) Average per capita household use of 60 gal/day.

(5) Livestock numbers from 1968 and the livestock water consumption rates were used to prepare Tables 6 and 7.

(6) Design capacity to serve rural household use and livestock is twice the average water use.

(7) 75% of the residents of the three small communities noted above are shown as part of the rural household use in Table 8.

Table 9 summarizes the water delivery capacity that would be rquired in a community water system designed to serve the rural study area plus Iroquois, Howard and Canova.

Table 8. Required Water Delivery Capacity for Rural Domestic, Livestock and Community Uses.

County	Livestock Water Use (gal/day)	Rural Household Water Use (gal/day)	Community Water Use (gal/day)
Miner	46,000	90,000	45,000
Kingsbury	80,000	520,000	180,000
Total	126,000	610,000	225,000

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WATER QUALITY DATA

City	Date of Sample	Langelier Index A 50^oF	pH	P Alkalinity ppm	T Alkalinity ppm	Total Hardness $CaCO_3$ ppm	Calcium Ca ppm	Magnesium MG ppm	Bicarbonate HCO_3 ppm	Sulfate SO_4 ppm	Iron Fe ppm	Manganese Mn ppm	Sodium Na ppm	Potassium K ppm	Chloride Cl ppm	Fluoride F ppm	Nitrate NO_3 as N ppm	Total Solids ppm
Arlington	04/77(R)	+0.34	7.7	0	399	353	86	33	487	910	3.0	0.17	560	16	190	0.4	0.1	2077
	04/77(T)	+0.38	7.7	0	399	358	87	34	487	910	1.0	0.17	560	16	189	0.3	0.1	2072
Canova	03/65	-	7.7	0	298	784	212	60	364	876	3.2	0.20	207	13	24	0.8	1	1659
	09/76(T)	+0.34	7.5	0	272	688	192	51	332	924	0.1	0.12	273	16	19	0.9	1.2	1765
Clear Lake	11/75(R)	+0.70	7.6	0	254	1458	381	123	310	190	0.1	0.02	330	13	1214	0.2	3.4	3029
	11/75(R)	+0.30	7.6	0	295	505	128	45	360	195	0.1	0.02	14	6	27	0.2	1.6	675
Hayti	05/75	+0.68	7.5	0	393	1303	331	116	479	1000	0.3	1.88	85	11	39	0.2	0.7	1967
	05/75	+0.31	7.6	0	284	549	142	47	346	233	0.1	0.85	31	6	52	0.2	1.1	855
Howard	09/76	+0.45	7.9	0	174	585	154	49	212	1030	2.2	0.06	374	19	109	2.4	1	1941
	09/76	+0.20	7.5	0	186	695	196	50	227	1110	1.8	0.09	376	20	134	2.6	1	2116
	09/76	+0.24	7.4	0	314	666	191	46	383	1030	1.2	1.45	337	20	18	0.6	1	1944
Iroquois	01/77	-0.42	8.2	0	246	30	8	3	300	1070	0.3	0.02	693	7	164	2.1	1	2088
	02/59	-	8.3	12	272	33	10	2	332	1125	0.2	0.02	736	9	150	4.2	1	2215
Lake Preston	12/77	-0.11	8.4	8	329	32	8	3	381	1050	0.2	0.04	787	7	191	5.8	0.1	2255
Madison	08/71(R)	-	7.3	0	300	920	280	51	366	709	4.0	1.60	147	12	165	0.3	1	1707
	08/71(R)	-	7.6	0	235	690	200	41	287	450	9.6	1.90	138	11	210	0.2	1	1380
	08/71(R)	-	7.6	0	274	840	216	72	334	666	1.2	1.40	97	11	43	0.5	1	1438
	08/71(R)	-	7.9	0	244	615	146	61	298	442	0.1	0.10	114	10	118	0.5	1	1163
	08/71(R)	-	8.0	0	180	353	96	29	220	209	0.1	0.30	93	9	100	0.3	1	683
	08/71(R)	-	7.4	0	290	899	280	44	354	551	0.5	1.70	150	10	273	0.2	1	1687
	08/71(R)	-	7.6	0	275	1201	344	83	336	1153	0.1	0.40	95	18	8	0.5	1	2107
	08/71(R)	-	7.6	0	276	1112	336	66	337	1030	0.3	0.50	95	16	10	0.6	1	900
	02/77(RC)	+0.13	7.2	0	285	889	224	80	348	600	0.7	1.68	97	13	110	0.3	0.1	1525
	08/71(TC)	0	8.9	12	26	700	184	58	32	599	0.1	0.02	149	13	254	1.0	1	1420
Ramona	09/75	-	7.3	0	270	1147	324	79	329	1059	4.0	4.60	108	12	10	0.5	1	2124
	07/77	+0.09	7.8	0	395	146	39	12	482	910	0.4	0.02	590	26	96	1.7	0.2	1863

SOURCE: South Dakota Department of Environmental Protection. Office of Water Hygiene, South Dakota Public Water Supply Chemical Data, January 1979.

SECTION D

OAHE CONSERVANCY SUB-DISTRICT

EASTERN SOUTH DAKOTA WATER SUPPLY STUDY

For

U.S. Corps of Engineers, Omaha District
and
South Dakota Department of Water and Natural Resources

by

OAHE CONSERVANCY SUB-DISTRICT
Aberdeen, South Dakota

Thomas L. Knutson, Projects Manager

July, 1983

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PROJECT SUMMARY

The study area was selected by the Omaha District - Corps of Engineers and the Oahe Conservancy Sub-district to represent (1) the rural area bounded on the east, west and south by the Sub-district boundary and on the north by the Clark Rural Water System and the WEB Rural Water System and (2) communities in the Sub-district that were identified as experiencing water quantity or quality problems. These were Agar, Blunt, Bradley, Broadland, Cavour, Garden City, Gettysburg, Grenville, Harrold, Hecla, Highmore, Hitchcock, Houghton, Iroquois, Kidder, Lebanon, Long Lake, Miller, Onida, Pierpont, Ree Heights, St. Lawrence, Tolstoy, Tulare, Veblen, Waubay, Wessington, Willow Lake, Wolsey and Yale.

The results of this analysis indicate that both the selected rural areas and municipalities are having similar water supply problems. In most cases, there is an ample supply of water available for use; however, its quality is poor. Conversations with municipal officials show that "water hardness" is a major problem throughout the study unit. Water quality problems are greatest for the Municipalities of Garden City, Hitchcock, Tolstoy, Tulare, Veblen, Wessington and Wolsey. The communities do not view their problems lightly. Presently, they are attempting to develop a better water source.

It is determined that rural and community population levels have fallen at a steady rate for the past 20 years. This population loss directly affects the amount of water consumed by the municipalities and the rural domestic uses. Water demand is projected to remain fairly constant, unless an unexpected population increase occurs.

The rural areas livestock numbers are expected to continue fluctuating between the 1969 level and the 1978 herd sizes. Area farmers, if given the opportunity to hook up to a rural water system, could initially expect to use what they presently use. However, this usage figure would likely increase because some ranchers would build up their herd size because of better quality water.

It is unlikely that the WEB Rural Water System, Clark Rural Water System, or Southern Spink-Northern Beadle Rural Water System will expand into the study area. With .46 farmsteads per square mile, an expansion would not be cost effective. However, if the CENDAK Project is built, the potential exists to provide rural water to portions of Hughes, Sully, Hyde, Hand and Beadle Counties. The CENDAK Project which is an irrigation project could provide water to towns and cities. Those towns and cities would have to provide storage and treatment for the water. A distribution system would have to be built from the towns and cities to the rural areas.

EASTERN SOUTH DAKOTA WATER SUPPLY STUDY

Introduction

This report contains information gathered by the Oahe Conservancy Sub-district staff as a part of the Omaha District - Corps of Engineers Eastern South Dakota Water Supply Study under a contract with the South Dakota Department of Water and Natural Resources. The overall purpose of the Corps study is to fully examine the water supply problems and needs of eastern South Dakota.

Role and Scope

The role of the Sub-district in this study is identify, analyze and propose recommendations to resolve community, rural domestic and livestock water problems and needs.

The scope of our community investigation included the municipalities of Agar, Blunt, Bradley, Broadland, Cavour, Garden City, Gettysburg, ~~Grenville,~~ Harrold, Hecla, Highmore, Hitchcock, Houghton, Iroquois, Kidder, Lebanon, Long Lake, Miller, Onida, Pierpont, Ree Heights, St. Lawrence, Tolstoy, Tulare, Veblen, Waubay, Wessington, Willow Lake, Wolsey, and Yale. The scope of the rural area investigation includes the area bounded by the Sub-district boundary on the east, west, and south side and by the Clark Rural Water System and WEB Rural Water System on the north side. Figure 1 shows the general location of the communities and rural areas included in the study area.

Objectives

The Sub-district's main objectives, as outlined in the contract with the Department of Water & Natural Resources, are to: (1) estimate present and 2020 average and peak day water use for designated communities; and (2) estimate present and 2020 rural domestic and livestock water needs within the study area; (3) identify the boundaries of all existing, proposed and potential rural water systems within the study area.

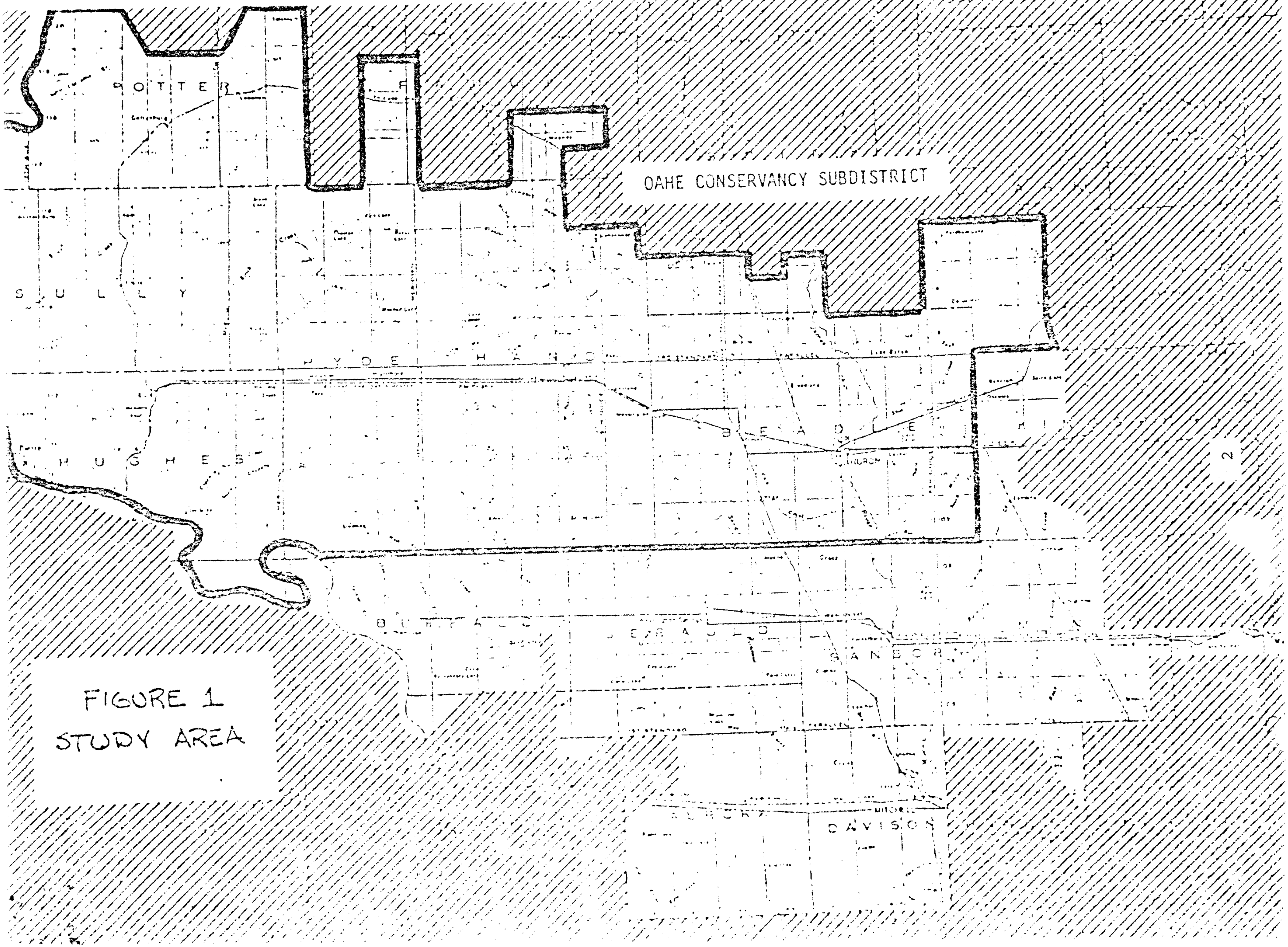

FIGURE 1
STUDY AREA

Municipal Water Supply

The Corps of Engineers and the Sub-district identified thirty municipalities within the Sub-district boundaries that may have water supply problems. One objective of the study was to analyze the water problems and needs of these communities and to suggest possible solutions.

Initially, the contract called for investigation of nineteen municipalities. They were Agar, Blunt, Bradley, Cavour, Garden City, Grenville, Harrold, Hecla, Houghton, Kidder, Lebanon, Long Lake, Pierpont, St. Lawrence, Veblen, Waubay, Wessington, Willow Lake and Yale. The Sub-district expanded the analysis to include eleven other communities. They were Broadland, Gettysburg, Highmore, Hitchcock, Iroquois, Miller, Onida, Ree Heights, Tolstoy, Tulare and Wolsey.

A questionnaire was mailed to each of the thirty selected municipalities asking them to supply information about their community's present water demand, water quality problems and water supply needs. A copy of the questionnaire is attached at the end of this report.

Figure 2 shows the location of those municipalities in the study area.

Municipal Water Demand

Current and Future Water Demand

Current and future water demand data is presented in Table 1 and Table 2. They show the average and peak daily water use. Average daily water use was obtained from twenty-five of the municipalities through the questionnaires. A factor of 75 gallons per person per day was used to determine the average daily use for the other five towns. A factor of fifty percent above average daily use was used to determine peak daily use figures for all thirty municipalities.

It can be concluded from the questionnaire and the discussions with community representatives, that except during extreme drought conditions and barring unexpected industrial or population growth, water quantity should not be a problem for these thirty communities. This assumes that the Southern Spink-Northern Beadle Rural Water System is built to provide a much needed supply to the Hitchcock, Tulare, and Wolsey communities.

Project Water Demand

Table 3 contains the past population as determined by U.S. Census Data for the thirty selected communities. As a general rule, there has been a loss of population in the rural communities during the past 20 years. Broadland, Long Lake, Onida, Tulare and Wolsey are the only communities that have shown some population increase during the past 20 years.

In examining the data in Table 3, it is determined that the population of all thirty communities would most likely remain fairly constant with a small increase in some communities over the next two decades.

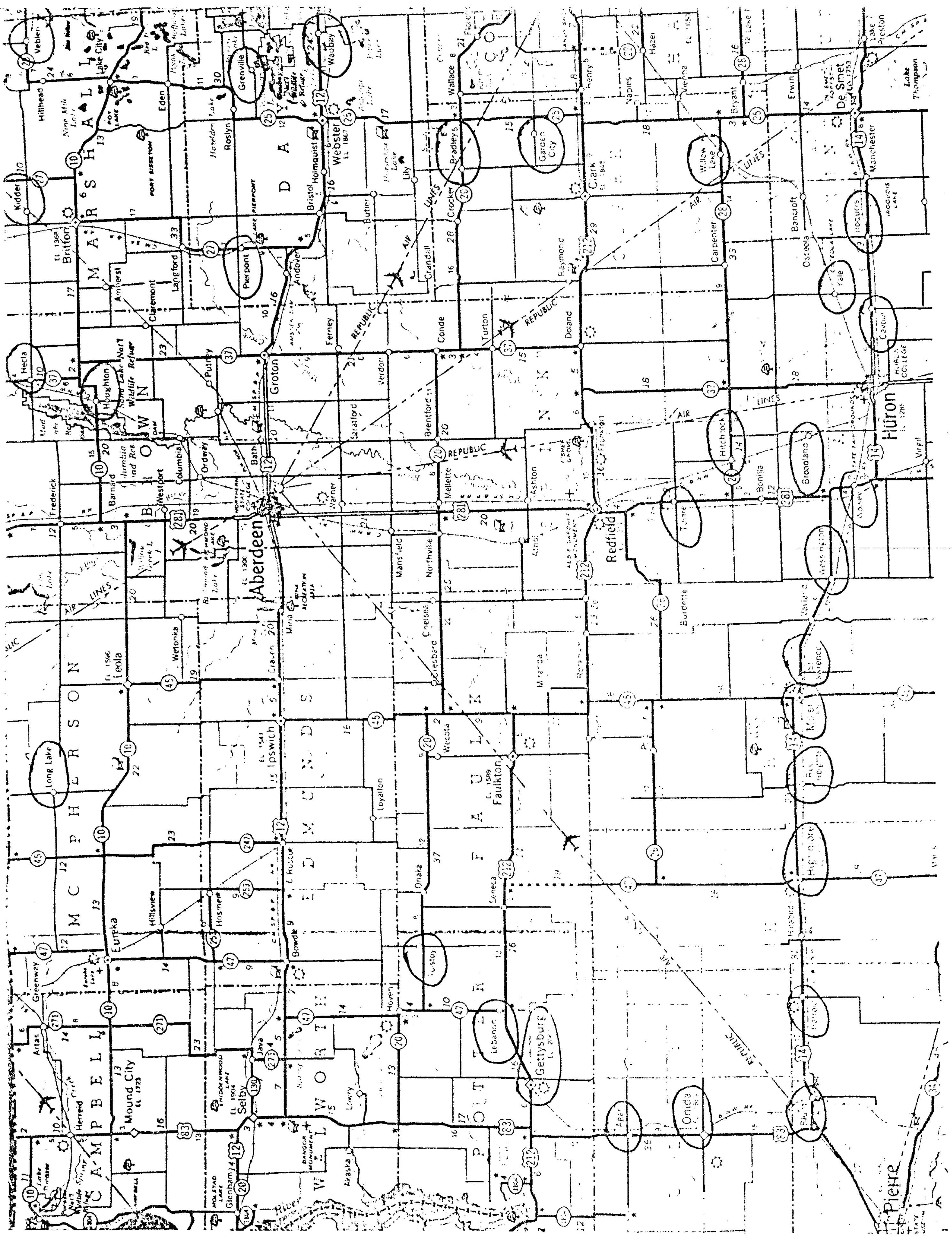

FIGURE 2 - Location of Municipalities in study area.

Peak daily water demands in Tables 1 and 2 were projected to the year 2020 using three possible scenarios. Scenario A represents a constant 5% decline each decade. Scenario C represents a constant 10% per decade growth scenario. Scenario B was selected to represent a slight growth scenario roughly midway between the declining and significant growth scenarios.

Municipal Water Quality

All thirty municipal water supplies were analyzed to determine if water quality problems exist in their present water supplies. Sixteen out of the thirty indicated they had a hardness problem and eleven indicated they had an odor problem. Comments on each individual community are contained in the following sections.

Detailed information on community water quality is located in Appendix A. Information provided in this table was obtained from the South Dakota Public Water Supply Data report prepared by the South Dakota Department of Water and Natural Resources in 1979.

Table 2 Future Average Daily Use Table, 1982 to 2020.

	Present Water Use (1982) (1000 gallons/day)		~~Projected Peak~~ AVERAGE Daily Water Demand (1000 gallons/day)											
			1990 Scenairo			2000 Scenairo			2010 Scenairo			2020 Scenairo		
	Average Daily Use	Peak Daily Use	A	B	C	A	B	C	A	B	C	A	B	C
Agar	20	30	19	21	22	18	22	24	17	23	26	16	24	29
Blunt	50	75	48	52	55	46	54	61	44	56	67	42	58	74
Bradley	15	23	14	15	17	13	16	18	12	16	20	11	17	22
Broadland	7	11	7	7	8	7	7	9	7	23	10	7	24	11
Cavour	17	25	16	18	19	15	19	21	14	20	23	13	21	25
Garden City	10	15	10	10	11	10	10	12	10	10	13	10	10	14
Gettysburg	220	330	209	227	242	199	234	266	189	241	293	180	248	322
Grenville	13	20	12	13	14	11	13	15	10	13	17	10	13	19
Harrold	30	45	29	31	33	28	32	36	27	33	40	26	34	44
Hecla	40	60	38	41	44	36	42	48	34	43	53	32	44	58
Highmore	187	280	178	193	206	169	199	227	161	205	250	153	211	275
Hitchcock	21	32	20	22	23	19	23	25	18	24	28	17	25	31
Houghton	7	11	7	7	8	7	7	9	7	7	10	7	7	11
Iroquois	33	50	31	34	36	29	35	40	28	36	44	27	37	48
Kidder*	6	9	6	6	7	5	6	8	5	7	9	5	7	10
Lebanon*	10	15	9	10	11	9	11	12	8	11	13	8	12	14
Long Lake*	9	14	9	9	10	8	10	11	8	10	12	7	11	13
Miller	220	330	209	227	242	199	234	266	189	241	293	180	248	322
Onida	130	205	124	134	143	118	138	157	112	142	172	106	146	189
Pierpont*	14	21	13	13	15	12	14	17	11	14	19	10	15	21
Ree Heights	12	18	11	12	13	10	12	14	10	12	15	10	12	17
St. Lawrence*	17	25	16	18	19	15	19	21	14	20	23	13	21	25
Tolstoy	8	12	8	8	9	8	8	10	7	8	11	7	8	12
Tulare	50	75	48	52	55	46	54	61	44	56	67	42	58	74

Table 2 Future Average Daily Use Table, 1982 to 2020.

	Present Water Use (1982) (1000 gallons/day		AVERAGE ~~Projected Peak~~ Daily Water Demand (1000 gallons/day)											
			1990 Scenairo			2000 Scenairo			2010 Scenairo			2020 Scenairo		
	Average Daily Use	Peak Daily Use	A	B	C	A	B	C	A	B	C	A	B	C
Veblen	40	60	38	41	44	36	42	48	34	43	53	32	44	58
Waubay	50	75	48	52	55	46	54	61	44	56	67	42	58	74
Wessington	50	75	48	52	55	46	54	61	44	56	67	42	58	74
Willow Lake	65	98	63	67	72	59	69	79	56	71	87	53	73	96
Wolsey	50	75	48	52	55	46	54	61	44	56	67	42	58	74
Yale	13	20	12	13	14	11	13	15	10	13	17	10	13	19

*A factor of 75 gallons per person per day was used to determine Average Daily Use for this town.

NOTE: 1. Scenarios A - Minus 5 percent decrease per decade

B - No growth to slight increase - 3 percent increase per decade

C - Maximum 10 percent increase per decade

2. Water Demand decreases and increases are calculated on 1982 Peak Daily Use figures.

SOURCE: Present Water Demand figures for Average Daily Use were received from representatives from twenty five of the municipalities. A factor of fifty percent above Average Daily Use was used to determine Peak Daily Use figures.

Table 3 Historical Population Trends of Thirty Eastern South Dakota Municipalities -- Population from 1960 to 1980

Municipality	1960	1970	1980
Agar	139	156	139
Blunt	532	445	424
Bradley	188	157	135
Broadland	33	45	49
Cavour	140	134	117
Garden City	226	126	104
Gettysburg	1.950	1,915	1,623
Grenville	151	154	110
Harrold	255	184	196
Hecla	444	407	435
Highmore	1,078	1,173	1,055
Hitchcock	193	150	132
Houghton	N/A	N/A	75
Iroquois	385	375	348
Kidder	N/A	N/A	85
Lebanon	198	182	129
Long Lake	109	128	117
Miller	2,081	2,148	1,931
Onida	843	785	851
Pierpont	258	241	184
Ree Heights	188	183	88
St. Lawrence	290	249	223
Tolstoy	142	99	97
Tulare	225	211	238
Veblen	437	377	368
Waubay	851	696	675
Wessington	378	380	327
Willow Lake	467	353	375
Wolsey	354	436	437
Yale	171	148	136

Source: South Dakota - Census of Population, 1960, 1970, 1980.

AGAR

Background -- The town of Agar has only one producing well serving all of its population and as such could face serious problems if the well failed. However, the well was drilled in 1980, is 1820 feet deep and has a normal pumping rate of 20,000 gallons per day. They have a storage tank that holds 12,000 gallons and is 125 feet off the ground and was installed in 1925. They do not treat their water and their water does not have any objectional characteristics and therefore they consider their water supply to be adequate.

BLUNT

Background -- The town of Blunt has two producing wells serving its population. One well is 60 feet deep while the other is 72 feet deep. The wells were drilled in 1950 and 1976 and has a normal pumping rate of approximately 50,000 gallons per day. They have a 60,000 gallon storage tank that stands 12 feet off the ground and was installed in 1923. They do chlorinate their water and they do have a manganese and iron problem but they feel their water supply is adequate.

BRADLEY

Background -- The town of Bradley has two wells serving its population. Both wells are approximately 300 feet deep and were drilled in 1952 and 1962 respectively. They have a 10,000 gallon storage tank which is approximately 40 years old. They do not treat their water but it is hard and even though they feel it is adequate they do plan to hook up to the Clark Rural Water System this year.

BROADLAND

Background -- The town of Broadland has only one producing well serving its population. The well is 1060 feet deep and was drilled in 1977 and has a normal pumping rate of 7,000 gallons per day. They do not have a storage tank and they do not treat their water and it is hard but they feel the water is adequate.

CAVOUR

Background -- The town of Cavour has only one producing well serving its population. The well is 240 feet deep and was drilled 1978 and has a normal pumping rate of 17,000 gallons per day. They have a 75 foot, 3000 gallon storage tank and they do chlorinate their water and they feel the water supply is adequate.

GARDEN CITY

Background -- The town of Garden City has two producing wells serving its population. Both wells are approximately 500 feet deep and were drilled in 1955 and 1978. The wells have a normal pumping rate of 10,000 gallons per day and the water is not treated. They do have a 15,000 gallon underground storage reservoir which was installed in 1976. The water is high in sodium content has an odor and is hard. They also have a manganese and iron problem and are checking into costs and methods of removing the iron from the water.

GETTYSBURG

Background -- The town of Gettysburg during the late 1970's constructed a pipeline from the Oahe Reservoir to serve its water needs. They have a 120 foot 500,000 gallon storage tank which was installed in 1960. They do treat their water but definitely feel they have an adequate supply.

GRENVILLE

Background -- The town of Grenville has two producing wells serving its population. The wells are 77 feet deep and 422 feet deep and were drilled in 1975 and 1979 respectively. The wells have a normal pumping rate of 13,000 gallons per day and is stored in eight hydro cells which were installed in 1975 and 1979. They do not treat their water even though there is an occasional odor and they feel the water supply is adequate.

HARROLD

Background -- The town of Harrold has one producing well serving its population. The well is 45 feet deep and was drilled in 1977. It has a normal pumping rate of 30,000 gallons per day and is stored in a 40,000 gallon tank, 125 feet high, which was installed in 1923. They do chlorinate the water because of taste and odor problems but they do feel the water is adequate.

HECLA

Background -- The town of Hecla has four producing wells serving its population. The wells are all approximately 100 feet deep and were drilled in 1958, 1959, 1962 and 1981. They have a normal pumping rate of 40,000 gallons per day and is stored in a 100,000 gallon reservoir and 10,000 gallon pressure system. They do not treat their water even though it is hard and it stains but they do feel their water is adequate.

HIGHMORE

Background -- The town of Highmore has two producing wells serving its population. The wells are 138 and 140 feet deep and were drilled in 1952 and 1976 respectively. They have a normal pumping rate of 187,000 gallons per day and the water is stored in a 50,000 gallon storage tank 110 feet high which was installed in 1911. They do flouridate their water because of hardness and staining but they do feel that the water supply is adequate.

HITCHCOCK

Background -- The town of Hitchcock has one producing well serving its population. The well is 1040 feet deep and was drilled in the late 1930's. The well has a normal pumping rate of about 21,000 gallons per day and is treated with chlorination. The town has a 75 foot water tower with a 50,000 gallon storage tank and a 50,000 gallon concrete ground reservoir and both were installed in the early 1920's. The water has numerous objectional characteristics such as odor, color, hardness and staining. The town of Hitchcock feels their water supply is inadequate and they are looking for a backup supply. At present, they are a part of the Southern Spink-Northern Beadle Project and they are waiting for that system to be built.

HOUGHTON

Background -- The unincorporated community of Houghton has one producing well which serves its population. The well is 800 feet deep and was drilled in about 1945. It has a normal pumping rate of about 7,000 gallons per day, with no storage facilities, and is not treated. It is high in alkaline and people with high blood pressure should not drink it. Also, people have complained about using the water for washing clothes.

IROQUOIS

Background -- The Town of Iroquois has two producing wells serving its community. The wells are approximately 875 feet and 900 feet deep and were drilled in 1908 and in 1980 respectively. These wells have a normal pumping rate of approximately 33,000 gallons per day and is stored in a 20,000 gallon tank which was installed in about 1948. The water is not treated but is adequate for current needs.

KIDDER

Background -- The unincorporated community of Kidder has one free flowing well serving its community. The well is 1057 feet deep and was drilled in 1965. Each user has a 50 gallon storage tank and even though the water is hard it is not treated. They feel the water is adequate but if the water table lowers they will need a backup supply.

LEBANON

Background -- The town of Lebanon uses 72 private wells to serve its community and they feel their water sources are adequate.

LONG LAKE

Background -- The town of Long Lake uses 53 private wells to serve its community and they feel their water sources are adequate.

MILLER

Background -- The town of Miller has four producing wells serving its community. They range from 1100 to 1200 feet deep and were drilled in 1949, 1964, 1975, and one in the 1920's. They have a normal pumping rate of 220,000 gallons per day and can be stored in two water towers, one ground tank or one underground tank with total storage capacity of 535,000 gallons. They feel that their water supply is adequate even though the water is hard.

ONIDA

Background -- The town of Onida has four producing wells serving its community. The wells are 1590 to 2100 feet deep and were drilled in 1932, 1954, 1955, and 1977. They have a normal pumping rate of 130,000 gallons per day and can be stored in 2 underground cisterns and a 50,000 gallon, 120 foot water tower. They do chlorinate their water and they do have odor, hardness, staining and scaling problems. However, they do feel that their water supply is adequate.

PIERPONT

Background -- The town of Pierpont has three producing wells serving its community. All three wells are approximately 150 feet deep and two were drilled in the early 1960's and the third was drilled in the early 1970's. They have two storage tanks which can hold 40,000 gallons and they were installed in 1910 and 1920. They do not treat their water even though it is hard and the quantity is sometimes inadequate.

REE HEIGHTS

Background -- The town of Ree Heights has two shallow producing wells serving its community. The wells are 56 feet and 40 feet deep and were drilled in 1960 and 1970 respectively. The wells have a normal pumping rate of about 12,000 gallons per day and can be stored in a 56 foot high, 20,000 gallon storage tank, installed in 1930. They do not treat their water which is hard and they find it inadequate.

ST. LAWRENCE

Background -- The town of St. Lawrence has two shallow producing wells serving its community. The wells are 135 feet and 146 feet deep and were drilled in 1952 and 1975 respectively. They have a 35,000 gallon overhead storage tank which was installed during the WPA days. They do not treat their water and they feel their supply is adequate.

TOLSTOY

Background -- The town of Tolstoy has one producing well serving its community. The well is 85 feet deep and was drilled in 1967. The well has a normal pumping rate of 115,000 gallons per day and can be stored in a 75 foot high, 50,000 gallon storage tank, which was installed in 1967. They do not treat their water even though there are some objectional characteristics. They do feel their water supply is adequate.

TULARE

Background -- The town of Tulare has one producing well serving its community. The well is 1000 feet deep and was drilled in 1961. The well has a normal pumping rate of 50,000 gallons per day and can be stored in a 33,000 gallon storage tank installed in 1919. The town feels the water is inadequate due to objectional characteristics and is interested in getting water from the Southern Spink-Northern Beadle Rural Water Project.

VEBLEN

Background -- The town of Veblen has two producing wells serving its community. The wells are 150 feet deep and were drilled in 1972 and 1975. The wells have a normal pumping rate of 40,000 gallons per day and can be stored in two storage tanks. The two tanks can hold 90,000 gallons and 220,000 gallons and both were installed in 1917. The town has treatment of chlorination and flouridation but they feel that their water source is inadequate for their needs.

WAUBAY

Background -- The town of Waubay has three producing wells serving their community. The wells are 168 feet, 170 feet and 440 feet deep and were drilled in 1954, 1967 and 1977 respectively. These wells have a normal pumping rate of 50,000 gallons per day with storage in a 120 foot high, 80,000 gallon, storage tank which was installed in 1923. The town does use flouridation in their treatment of the water and they do feel the water is adequate.

WESSINGTON

Background -- The town of Wessington has one producing well serving its community. The well is 52 feet deep and was drilled in 1977. The well has a normal pumping rate of 50,000 gallons per day with storage in a 150 foot high, 55,000 gallon, storage tank. The town does use chlorination in their treatment of the water and they do feel the water is adequate.

WILLOW LAKE

Background -- The town of Willow Lake has one producing well serving its community. The well is 56 feet deep and was drilled in 1976. The well has a normal pumping rate of 65,000 gallons per day with storage in a 100 foot high, 250,000 gallon storage tank installed in 1948. The town does use chlorination in their treatment of the water and they do feel the water is adequate.

WOLSEY

Background -- The town of Wolsey has two producing wells serving its community. The wells are 940 feet and 1150 feet deep and were drilled in 1960 and 1969 respectively. The two free flowing wells have a normal pumping rate of 50,000 gallons per day with storage in two tanks. One tank is a 65,000 gallon ground storage tank and the other is a 140 foot high, 30,000 gallon storage tank. They do not treat their water even though there is a taste, odor, hardness and corrosiveness problem. The town feels the water is adequate even though the quantity is poor.

YALE

Background -- The town of Yale has one producing well serving its community. The well is 900 feet deep and was drilled in 1976. The well has a normal pumping rate of 13,000 gallons per day with storage in a 8000 gallon cement tank installed in 1956. The town does use chlorination in their treatment of the water and they do feel the water is adequate.

RURAL WATER SURVEY

The Sub-district was directed by the Corps of Engineers to investigate rural domestic and livestock needs by counties within the study unit. The general boundary of the rural area is shown in figure 1. The study boundary is generally described as being the area bounded on the east, west and south by the Sub-district boundary and on the north by the Clark Rural Water System and the WEB Rural Water System.

The Sub-district mailed a questionnaire to 3,628 rural households within the study area. A copy of that questionnaire is attached at the end of this report. The Sub-district received 962 returns or 26.5 percent. The survey revealed that 791 feel their water sources are adequate, 61 inadequate, 38 other and 72 did not respond. Their water sources are 882 shallow wells and 581 artesian wells of which 457 are free flowing. Sixty eight percent said their water is hard, 57 percent said their water stains, 18 percent said their water smells, 16 percent said their water tastes bad, 58 percent said they treat their water, and 28 percent said they were interested in learning about development of rural water.

These farms have 3,181 stock dams, 146 cisterns and 289 springs or creeks which are used for livestock. Seven percent said their livestock operation is limited by poor water supplies. Five percent said they had to reduce their livestock herds due to quantity of water and two percent said they had to reduce their livestock herds due to quality of water. Eighty one farmers said that they irrigate and 279 said that they would be interested in irrigating.

Rural Household

Rural/farm population figures from 1960 through 1980 are presented in table 4 below. This rural area has experienced an average decrease in population of 17 percent per decade.

Table 4. Rural/Farm Population for those counties and portions of counties involved in the rural water survey 1960-1980.

County	1960	% chg.	1970	% chg.	1980
BEADLE	6,180	-15.5	5,222	-5.5	4.934
CLARK	1,318	-21.6	1,033	-20.2	824
FAULK	423	+7.6	455	-26.6	334
HAND	4,125	-20.8	3,268	-17.9	2,683
HUGHES	1,850	-29.5	1,304	+24.8	1,627
HYDE	2,602	-48.4	1,342	-24.4	1,014
POTTER	1,789	-27.4	1,299	-6.9	1,210
SPINK	1,190	-15.4	1,007	-15.5	851
SULLY	1,625	-12.6	1,421	-29.6	1,000
TOTAL	21,102	-22.5	16,351	-11.5	14,477

NOTE: Township population figures do not include communities.
SOURCE: S.D. Census of Population, 1960, 1970, 1980.

Table 5 contains summary informaton on the rural study area; the data provided shows that the study unit encompasses 6,899 square miles and includes approximately 3,186 households with a total population of 14,477. This amounts to .46 occupied farmsteads per square mile in 1982. These rural people are consuming approximately 868,620 gallons per day for their household water uses.

Table 5 Rural Household Water Use for Beadle, Hand, Hughes, Hyde, Sully and Portions of Clark, Faulk, Potter and Spink Counties, 1982.

	Beadle County	Clark County	Faulk County	Hand County	Hughes County	Hyde County	Potter County	Spink County	Sully County	Total
Rural Population[1]	4,934	824	334	2,683	1,627	1,014	1,210	851	1,000	14,477
Estimated Number of Households	933	211	80	650	244	246	329	179	314	3,186
Individuals/Household	5.3	3.9	4.2	4.1	6.7	4.1	3.7	4.8	3.2	4.5
Total Household Water Consumption (1982) (gallons per day)	296,040	49,440	20,040	160,980	97,620	60,840	72,600	51,060	60,000	868,620
Total Square Miles in Study Unit	1,260	288	180	1,440	743	864	828	288	1,008	6,899
Households per Square Mile	.74	.73	.44	.45	.33	.28	.4	.62	.31	.46

Note 1. Figures represent 30 percent of Clark County, 20 percent of Faulk County, 90 percent of Potter County, 20 percent of Spink County, and do not include municipalities.

SOURCE: S.D. Census of Agriculture, 1978.

Rural household water demand was projected to year 2020. A conservative projection of -5 percent per decade was selected to show possible future water use. Table 6 shows the projects for the nine counties.

Table 6 Future Domestic Water Demand, 1982-2020.

County	1000 gal/day				
	1982	1990	2000	2010	2020
Beadle	296.0	281.2	267.1	253.7	241.0
Clark (30%)	49.4	47.0	44.7	42.5	40.4
Faulk (20%)	20.0	19.0	18.1	17.2	16.3
Hand	161.0	152.9	145.3	138.0	131.1
Hughes	97.6	92.7	87.8	83.4	79.2
Hyde	60.8	57.8	54.9	52.2	49.6
Potter (90%)	72.6	69.0	65.6	62.3	59.2
Spink (20%)	51.1	48.5	46.1	43.8	41.6
Sully	60.0	57.0	54.2	51.5	48.9
Total	868.5	825.1	783.8	744.6	707.3

Livestock Water Use

Past livestock numbers and water use information are located on Tables 7 through 15. They show that cattle numbers decreased 7 percent from 1969 through 1978, hog numbers increased by about 1 percent, and sheep and lambs decreased substantially by nearly 37 percent.

The following livestock water consumption rates were used for this analysis:

Dairy Cows (Beef Cattle & Yearlings (	Average 20 gal per head per day
Hogs	3 gallons per head per day
Sheep and Lambs	2 gallons per head per day

Projected Livestock Use

Projecting livestock numbers over the long-term is difficult and depends on economic conditions. However, we tend to believe that livestock water use in the year 2020 will lie somewhere within the range of livestock water use between 1969-1978. We conclude this based upon past historical records and expert advice from South Dakota State University.

Thus, livestock water use in the year 2020 will likely range from 8,687,000 gallons per day to 9,602,000 gallons per day.

Table 7 Livestock Numbers and Estimated Livestock Water Consumption for Beadle County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	107,170	2,143,400	38,370	115,110	24,530	49,060	2,307,570
1974	128,170	2,563,400	40,190	120,570	20,010	40,020	2,723,990
1978	106,780	2,135,600	48,430	145,290	13,430	26,860	2,307,750

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Beadle County Agriculture.

Table 8 Livestock Numbers and Estimated Livestock Water Consumption for the 30% Portion of Clark County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	17,240	344,800	5,740	17,220	4,710	9,420	371,440
1974	21,820	436,400	4,680	14,040	4,450	8,900	459,340
1978	17,950	359,000	6,770	20,310	2,210	4,420	383,730

NOTE: 30% of all livestock in Clark County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service, Clark County Agriculture.

Table 9 Livestock Numbers and Estimated Livestock Water Consumption for the 20% Portion of Faulk County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	12,130	242,600	3,170	9,510	5,110	10,220	262,330
1974	14,420	288,400	2,740	8,220	4,450	8,900	305,520
1978	12,450	249,000	4,020	12,060	2,900	5,800	266,860

NOTE: 20% of all livestock in Faulk County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Faulk County Agriculture.

Table 10 Livestock Numbers and Estimated Livestock Water Consumption for Hand County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	109,660	2,193,200	23,880	71,640	37,220	74,440	2,339,280
1974	129,150	2,583,000	20,950	62,850	27,960	55,920	2,701,770
1978	108,770	2,175,400	21,460	64,380	19,170	38,340	2,278,120

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service, Hand County Agriculture.

Table 11 Livestock Numbers and Estimated Livestock Water Consumption for Hughes County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	39,510	790,200	5,350	16,050	5,970	11,940	818,190
1974	32,890	657,800	2,550	7,650	4,780	9,560	675,010
1978	23,980	479,600	4,420	13,260	5,120	10,240	503,100

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service, Hughes County Agriculture.

Table 12 Livestock Numbers and Estimated Livestock Water Consumption for Hyde County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	57,250	1,145,000	3,370	10,110	10,250	20,500	1,175,610
1974	73,690	1,473,800	4,200	12,600	11,360	22,720	1,509,120
1978	53,230	1,064,600	6,290	18,870	13,150	26,300	1,109,770

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Hyde County Agriculture.

Table 13 Livestock Numbers and Estimated Livestock Water Consumption for the 90% portion of Potter County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	45,550	911,000	20,990	62,970	10,720	21,440	995,410
1974	50,160	1,003,200	25,720	77,160	13,740	27,480	1,107,840
1978	37,830	756,600	18,440	55,320	11,330	22,660	834,580

NOTE: 90% of all livestock in Potter County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service, Potter County Agriculture.

Table 14 Livestock Numbers and Estimated Livestock Water Consumption for the 20% portion of Spink County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep & Lambs Numbers	Sheep & Lambs Usage (gal/day)	Total Livestock Water Use
1969	18,150	363,000	10,360	31,080	5,730	11,460	405,540
1974	21,390	427,800	8,290	24,870	5,420	10,840	463,510
1978	17,140	342,800	8,610	25,830	4,050	8,100	376,730

NOTE: 20% of all livestock in Spink County

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Spink County Agriculture.

Table 15 Livestock Numbers and Estimated Livestock Water Consumption for Sully County in the Study Area, 1969-1978.

Year	Cattle Numbers	Cattle Usage (gal/day)	Hogs Numbers	Hogs Usage (gal/day)	Sheep and Lambs Numbers	Sheep and Lambs Usage (gal/day)	Total Livestock Water Use
1969	42,870	857,400	13,840	41,520	14,050	18,100	927,020
1974	53,030	1,060,600	13,610	40,830	7,960	15,920	1,117,350
1978	29,310	586,200	10,480	31,440	4,450	8,900	626,540

SOURCE: U.S. Department of Commerce, Bureau of Census. 1978 Census of Agriculture, Vol. 1. State and County Data Part 41 South Dakota U.S. Department of Agriculture, South Dakota Department of Agriculture and South Dakota Crop and Livestock Reporting Service. Sully County Agriculture.

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Waldrop, Robert, 1983, Community of St. Lawrence, Questionnaire Respondent.

WATER QUALITY DATA

City	Date of Sample	Langelier Index A 50°F	pH	P Alkalinity ppm	T Alkalinity ppm	Total Hardness $CaCO_3$ ppm	Calcium Ca ppm	Magnesium MG ppm	Bicarbonate HCO_3 ppm	Sulfate SO_4 ppm	Iron Fe ppm	Manganese Mn ppm	Sodium Na ppm	Potassium K ppm	Chloride Cl ppm	Fluoride F ppm	Nitrate NO_3 as N ppm	Total Solids ppm
jar	02/76	+0.05	8.3	0	411	34	8	3	501	385	0.2	0.02	698	11	525	2.3	1	1968
Lunt	04/57	-	7.5	0	288	628	162	54	351	279	-0.1	1.20	167	8	277	0.1	3.0	1314
	09/77	+0.17	7.6	0	246	427	111	37	300	230	-0.1	1.17	71	7	73	0.2	0.1	749
radley	12/77 (C)	+0.61	7.7	0	284	1187	195	170	347	1110	0.2	0.11	112	6	10	0.2	0.5	2028
roadland	11/76	+0.25	7.5	0	136	1137	327	78	166	1270	5.8	0.16	185	23	116	2.6	1	2223
avour	04/77	+0.27	7.6	0	284	500	127	44	346	237	3.5	0.80	14	6	7	0.2	1	723
arden City	11/76(R)	+0.64	7.9	0	321	630	128	75	392	1020	1.7	0.33	360	10	58	0.2	1	1972
ettysburg	04/76(R)	+0.77	8.3	0	141	205	50	19	172	167	0.1	-0.02	58	4	5	-0.5	1	413
	04/76(T)	+1.37	9.6	0	64	116	39	5	78	162	-0.1	-0.02	63	4	15	0.5	1	341
renville	02/77	+0.48	7.7	0	332	499	122	47	405	560	1.4	0.40	214	11	28	0.4	0.1	1321
arrold	04/78(RC)	+0.07	7.4	0	334	349	97	26	407	131	4.7	1.09	66	9	6	0.2	0.1	619
ecla	02/58	-	7.7	0	383	356	101	25	466	226	1.1	0.20	144	12	41	0.1	1	801
	10/63	-	7.4	0	356	318	90	22	434	125	1.2	0.20	84	8	13	0.2	1	591
	05/78	+0.13	7.4	0	352	359	100	27	429	118	0.5	0.31	75	8	35	0.3	0.1	650
	05/78	+0.21	7.5	0	349	358	100	27	426	115	0.4	0.12	73	8	33	0.3	0.6	643
ighmore	09/76(TC)	+0.14	7.1	0	469	629	176	46	572	330	0.9	0.88	112	10	29	0.2	1	1065
	09/76(T)	+0.05	7.3	0	330	408	113	31	403	145	5.3	0.66	47	7	13	0.6	1	626
itchcock	04/77	+0.27	7.5	0	135	1151	324	83	165	1280	4.7	0.11	171	23	101	2.2	0.1	2275
oughton	No sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-
roquois	01/77	-0.42	8.2	0	246	30	8	3	300	1070	0.3	0.02	693	7	164	2.1	1	2088
	02/59	-	8.3	12	272	33	10	2	332	1125	0.2	-0.02	736	9	150	4.2	1	2215
idder	No sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ebanon	No sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

WATER QUALITY DATA

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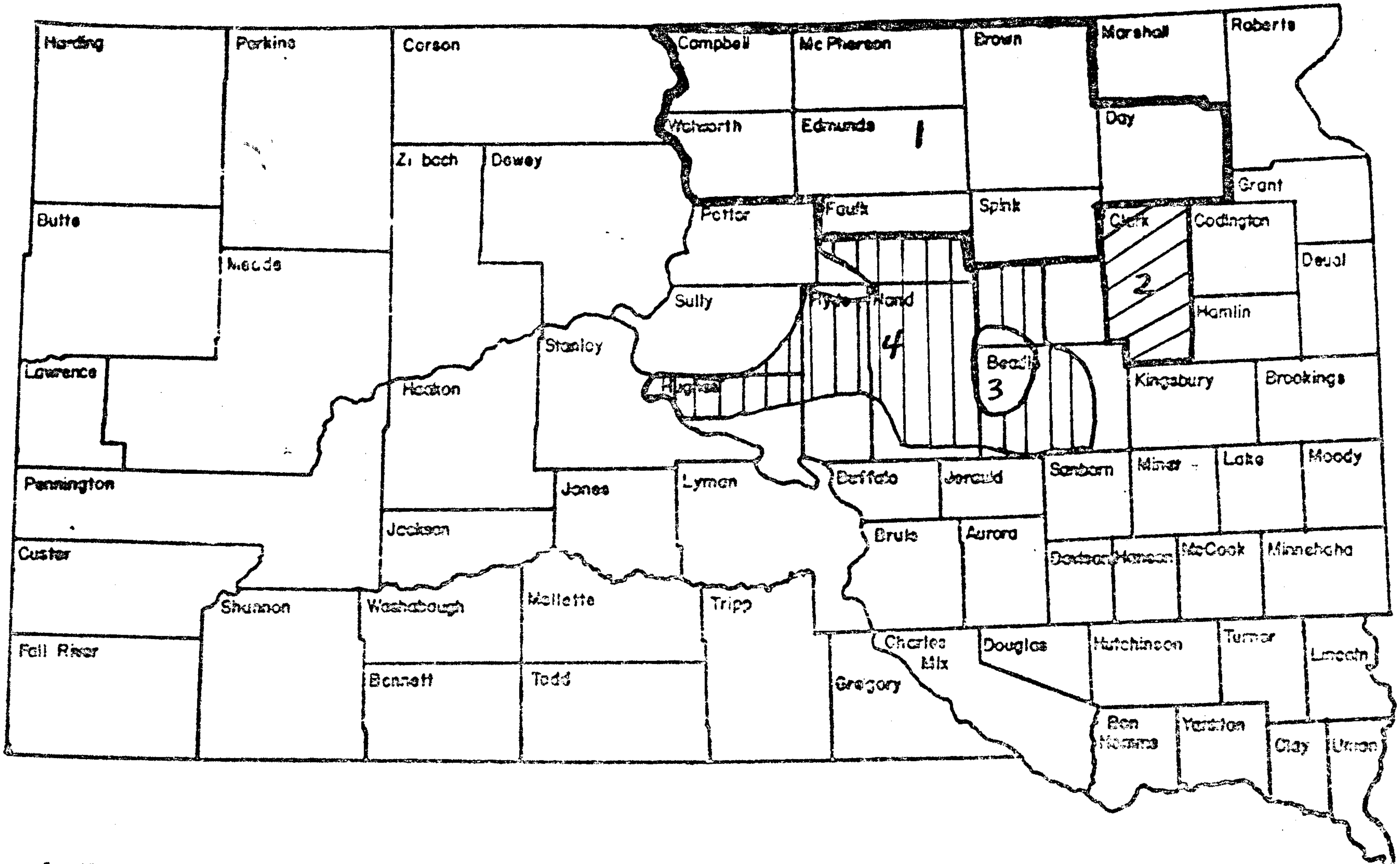
Long Lake	No sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miller	08/71	-	7.7	0	156	811	236	53	190	122	0.6	0.02	324	18	95	2.0	1	2173
	09/77	+0.20	7.6	0	144	762	209	58	176	1170	3.0	0.08	333	19	89	1.7	0.1	2104
	09/77	+0.09	7.8	0	161	345	91	29	196	1080	2.0	0.08	500	16	99	2.0	0.1	1998
	08/76	-0.33	7.3	0	141	533	141	44	172	1140	0.6	0.09	435	19	88	1.8	1	2077
Onida	09/77	+0.21	7.9	0	147	404	105	35	179	960	0.7	0.12	480	21	212	1.6	0.1	1965
	02/75(C)	+0.19	7.9	0	153	399	105	33	187	1010	0.8	0.12	487	18	206	1.9	1	1994
	09/77	+0.15	7.3	0	140	1432	402	104	171	1260	1.3	0.09	51	18	70	3.1	0.1	2314
Pierpont	07/77	+0.50	7.6	0	313	695	179	60	382	670	0.4	3.09	172	9	71	0.3	0.1	1509
	07/77	+0.39	7.8	0	314	356	89	33	383	340	0.3	0.60	230	9	170	0.3	0.1	1101
Ree Heights	02/75	+0.21	7.4	0	450	379	106	28	549	183	3.6	0.40	138	10	22	0.3	4.4	825
	04/77(C)	-	7.5	0	452	401	107	32	551	225	1.0	0.33	147	11	30	0.3	2.3	897
St. Lawrence	09/77(C)	+0.32	7.6	0	479	282	79	21	584	480	1.8	0.34	381	13	77	0.4	0.1	1386
Tolstoy	11/76	+0.16	7.2	0	393	670	176	56	479	312	4.7	0.60	25	6	3	0.2	1	926
Tulare	11/76	+0.06	7.8	0	139	361	97	29	170	1160	0.8	0.07	530	18	137	1.9	1	2128
Veblen	10/66(C springs only)	-	7.5	0	333	848	214	76	406	872	0.1	0.02	212	12	39	0.5	1.4	1764
	01/77(C)	+0.43	7.5	0	320	836	213	74	390	844	0.1	0.15	192	12	43	0.3	2.3	1824
Waubay	10/76(TC)	+0.40	7.8	0	299	431	101	44	365	137	0.1	0.94	17	3	1	1.4	1	550
Wessington	04/77	+0.18	7.3	0	368	706	175	65	449	730	0.1	1.64	217	9	71	0.5	0.8	1644
	05/65	-	7.4	0	130	838	242	56	159	1201	1.6	0.10	350	17	145	2.7	1.0	2205
Willow Lake	08/72(R)	-	7.9	0	255	340	100	22	311	99	0.1	0.02	9	4	11	0.2	2.2	477
	05/75(R)	+0.13	7.7	0	241	346	83	34	294	105	0.2	0.40	10	4	6	0.3	1	445

Appendix A

WATER QUALITY DATA

City	Date of Sample	Langelier Index A 50°F	pH	P Alkalinity ppm	T Alkalinity ppm	Total Hardness $CaCO_3$ ppm	Calcium Ca ppm	Magnesium MG ppm	Bicarbonate HCO_3 ppm	Sulfate SO_4 ppm	Iron Fe ppm	Manganese Mn ppm	Sodium Na ppm	Potassium K ppm	Chloride Cl ppm	Fluoride F ppm	Nitrate NO_3 as N ppm	Total Solids ppm
.sey	04/77	+0.14	7.4	0	129	1105	315	77	157	1260	1.8	0.13	200	21	131	2.3	0.1	2269
.e	04/77	-0.11	8.3	0	228	51	13	4	278	1130	1.1	0.05	700	9	142	1.8	0.1	2167

Appendix B   Present, Proposed and Potential Rural Water Systems

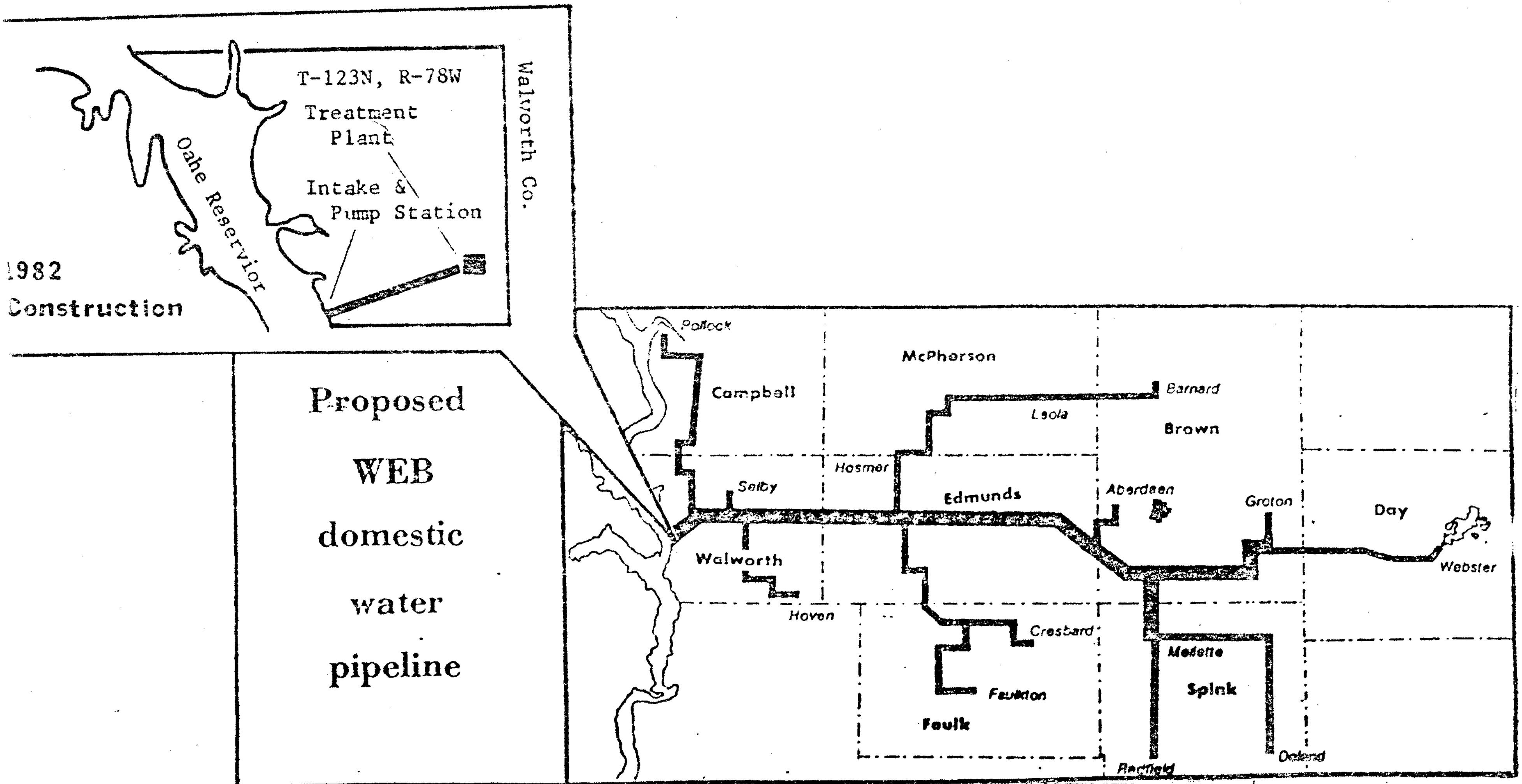


1 WEB

2 Clark

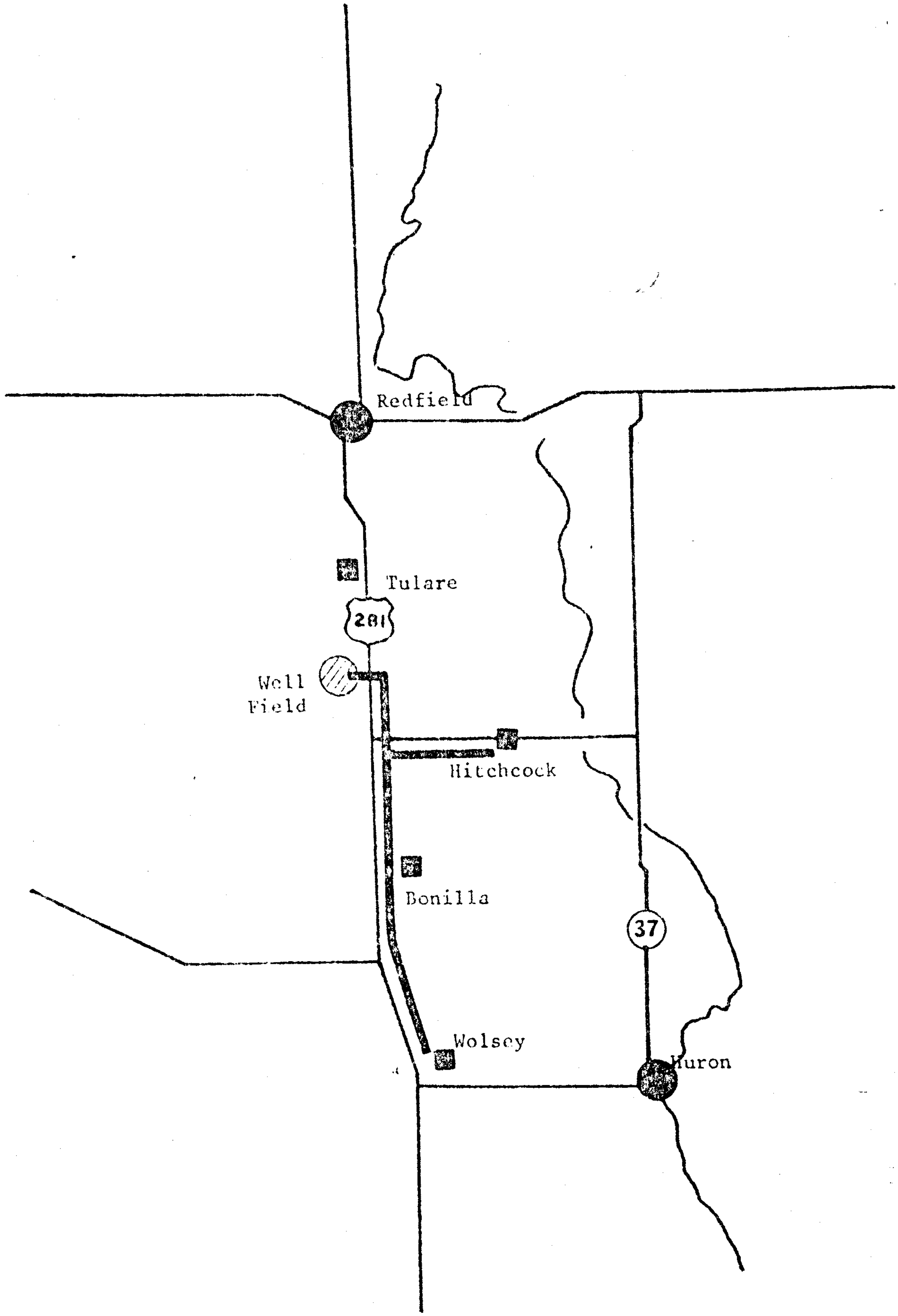
3 Southern Spink-Northern Beadle

4 CENDAK Potential

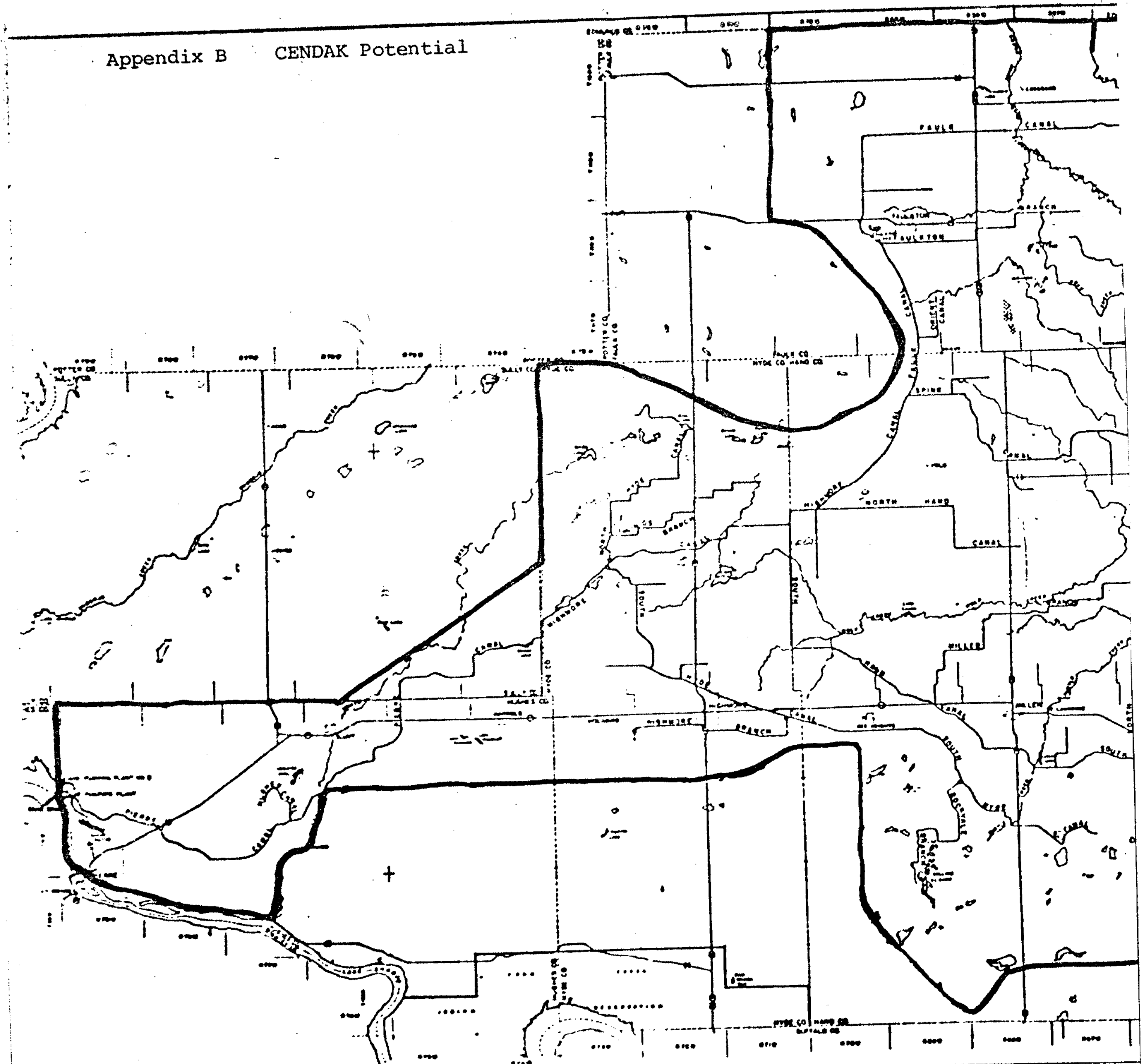


(Scheduled for Completion in 1985)

Appendix B Southern Spink-Northern Beadle Rural Water System



Appendix B CENDAK Potential



COMMUNITY WATER SURVEY

1. City ______________________ 1980 Population ______________________

2. County ______________________ Person Contacted ______________________

3. Approximate population served by municipal water system ______________________

   Approximate number of services ______________________

   Water Rates ____________ ____________ ____________

4. Present source of supply ______________________

5. City Well Information

   a. Name or number ________ ________ ________ ________

   b. Depth ________ ________ ________ ________

   c. Year drilled ________ ________ ________ ________

   d. Normal pumping rate (gpm) ________ ________ ________ ________

   e. Max. pumping rate (gpm) ________ ________ ________ ________

   f. Annual maintenance costs ________ ________ ________ ________

6. Are there any private wells in use in town? ________

   Approximate number ________

   Use ________ (% of total volume)

7. Type of storage

   Size ________ Height ________ Year Installed ________

8. Type of treatment presently employed, if any

   Chlorination ________, Fluoridation ________, Coagulation ________,

   Lime ________, Softening ________, Filtration ________, Desalination ________

9. Does your water have any objectional characteristics such as taste, odor, color, hardness, staining, scaling and corrosiveness?

10. Your water sources are: (check one)

    ________ Adequate ________ Inadequate ________ Other (please explain)

    ____

    ____

    ____

RURAL WATER SURVEY

Name of Person or Ranch ____________________

Mailing Address ____________________ Zip ________

Township ____________ Range ____________ Section ________

1. What is the present source of your water supply? Please provide the information requested for each well.

A.

Depth of Well	Age	Free Flowing?	Annual Cost
			$
			$
			$
			$
			$
			$
			$
			$
		TOTAL	$

B. Stock Dams

Number ____________

Provides what percent of the water for livestock ________%

Annual cost $____________

C. Number of cisterns ____________

D. Springs or creeks ____________

Provide what percent of the water for livestock ________%

2. Rate your household water before treatment.

Hard:	Yes____	No____
Stains Fixtures:	Yes____	No____
Smells:	Yes____	No____
Tastes Bad:	Yes____	No____

3. Do you treat or soften your water for household use?

Yes____ No____

Total investment $____________

Monthly cost $____________

APPENDIX D

4. Your water sources are: (check one)

_____ Adequate

_____ Inadequate

_____ Other (Please explain) ____

5. Have you been forced to reduce your livestock herds due to a lack of:

<u>Quality</u> water _____Yes _____No

<u>Quantity</u> of water _____Yes _____No

6. How many head of livestock have you lost in dams or mudholes during the past 5 years?

____________ Value: $____________

7. If you hauled water, what is the annual cost? $____________

8. Is your livestock operation limited by poor or inadequate water supplies?

Yes_____ No_____

9. Are you interested in learning more about the possible development of rural water supplies in your area?

Yes_____ No_____ Undecided_____

10. Do you irrigate?

A. Number of acres ____________

B. Annual cost per acre $____________

C. Would you expand your irrigation if more water were available?

Yes_____ No_____

11. If you do not irrigate, would you consider doing so if water of adequate quantity and quality were available?

Yes_____ No_____

Further Comments:

APPENDIX D