EXECUTIVE SUMMARY

SHERIDAN AREA WATER SUPPLY INVESTIGATION - LEVEL II

Prepared For Wyoming Water Development Commission

November 1985
November 8, 1985

State of Wyoming
WATER DEVELOPMENT COMMISSION
Herschler Building
Cheyenne, Wyoming 82002

Gentlemen:

We are pleased to submit the Executive Summary for the Sheridan Water Supply Investigation - Level II. This report summarizes the results of our engineering, hydrologic, geologic/geotechnical, groundwater exploration, economic analysis, and public input.

Our primary tasks included determining the water available for development in the Big Goose Creek Basin, providing a raw water transmission system with hydropower to satisfy Sheridan's long-term needs, and providing water service to residents in Big Goose Creek Valley.

We would like to thank the Wyoming Water Development Commission and their staff for the opportunity to undertake this very complex multi-faceted project. We would also like to extend our appreciation to the WWDC staff and the City staff for their unyielding guidance, cooperation and understanding during this study.

If HNTB can be of assistance to answer any questions, or serve the Commission and our State any further, please contact us at your convenience. We look forward to working with you, your staff, and the City of Sheridan on the 1986 Phase 2 Program.

Respectfully submitted,

HOWARD NEEDLES TAMMEN & BERGENDOFF

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Prepared For

WYOMING WATER DEVELOPMENT COMMISSION
CONTRACT NO. 8-05847

EXECUTIVE SUMMARY

November 1985

Howard Needles Tammen & Bergendoff (HNTB) -- Project No. 9559

Subconsultants:
Anderson and Kelly
PRC Engineering
ACKNOWLEDGEMENTS

The HNTB Team wishes to express their appreciation to the following individuals for their cooperation in supplying information and assistance essential to the successful and timely completion of this project:

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# SHERIDAN AREA WATER SUPPLY INVESTIGATION
## LEVEL II
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EXECUTIVE SUMMARY

PURPOSE

The purpose of this project is to identify and evaluate alternative development programs to provide a dependable water supply for the Sheridan area through the year 2035.

BACKGROUND AND AUTHORIZATION

The Level I phase of this project was completed by Banner and Associates in January, 1985. At that time the project was identified as TONGUE RIVER - LEVEL I. The Level I study identified the surface water potential in the Little Goose and Big Goose drainage and groundwater well sites to be drilled in Level II.

In June 1985, the Wyoming Water Development Commission (WWDC) entered into an agreement with Howard Needles Tammen & Bergendoff (HNTB) to perform the Level II investigation for the Sheridan Area Water Supply project. The project was divided into two phases. The Phase 1 findings summarized in this report will be the basis for establishing the Phase 2 1986 Program. A project location map is shown on Figure 1.

OBJECTIVES

The objectives of this study are as follows:

• Determine the water needs for the Sheridan area through the year 2035.
FIGURE 1
LOCATION MAP
• Determine the potential of obtaining groundwater supplies in the Big Goose Valley and Little Goose Valley.

• Determine the feasibility of developing additional surface water storage at selected sites in the Big Goose Basin above the City water intake.

• Identify and evaluate other sources of surface water supply.

• Identify and evaluate alternative means of supplying potable water to residents in the Big Goose Valley.

• Determine the economic feasibility of using water in the transmission pipelines to generate hydropower which could be used in the operation of the City Wastewater Treatment Plant (WWTP).

• Develop a listing of feasible improvements for further development in the 1986 Phase 2, Level II Program.

PROJECT GOAL

The goal of this project is to identify and evaluate the many individual design elements and to integrate the feasible elements into a water development plan for the Sheridan area. The procedure followed and the results are summarized below for each portion of this study.

STUDY APPROACH

The study approach concentrated on accomplishing the overall objectives and goals of the project. The study approach was divided into the following sections:

• Water Supply and Demand
• Groundwater Supplies
• Surface Water Supplies
Water Transmission Pipeline Improvements
Water Supply for Big Goose Valley
Hydropower Feasibility

Each of these items was examined in detail and used to solve the overall goals and objectives. A summary of the findings and recommendations for each section follows.

WATER SUPPLY AND DEMAND

This portion of the study develops future water demands to the year 2035 and establishes a storage requirement for the City of Sheridan based on present water rights and future demands. For the purposes of this study, the year 2035 was used as the design year because the expected design life of a new transmission main is approximately 50 years. Historical population growth patterns over the last 20 years were utilized to assist in developing a reasonable population projection representative of Wyoming's boom-bust economic cycles. Water demands were then developed utilizing present water usage rates. Sheridan's water rights were then analyzed in conjunction with the projected water demands to determine the long-term storage needs. Development of water demands was divided into three sections: City of Sheridan; Sheridan Municipal Golf Course; and VA Hospital. The results are presented below.

Supply and Demand Summary of Findings

City of Sheridan Existing Conditions

1. The 1980 U.S. Census Figures indicate the City of Sheridan's Population was 15,146. The growth from 1980 to 1985 has not been significant.

2. The 1985 water utility service population is approximately 16,100.
3. The annual growth rate from 1960 to 1980 for Sheridan was 1.32 percent. The growth rate from 1970 to 1980 was 3.4 percent.

4. The average per capita water usage for Sheridan is approximately 190 gallons per capita per day (gpcd).

5. The peaking factors for the last ten years of record have ranged from 3.0 to 4.5.

6. Historically the City of Sheridan has comprised approximately 61 percent of the County population.

7. Sheridan acquired a 16 cfs municipal water right appropriation in 1882 and several changes upstream from the original Point-of-Diversion (POD) have been identified.

8. Sheridan has storage rights totaling 1,709 acre-feet of useable storage in Twin Lakes 1 and 2, Park, Sawmill, and Dome Lake Reservoirs.

9. Regulation of water appropriations upstream of Sheridan on Big Goose and Little Goose Creeks is required each year. Downstream of Sheridan the water has not been regulated in the past 23 years.

City of Sheridan Future Conditions

10. Based on historical growth patterns, a future annual growth rate of 1.5 percent was used to develop population projections.

11. The Wyoming Department of Economic Planning estimates the 1994 population to be 18,910.

12. Based on a 1.5 percent annual growth rate, the year 2035 population projection is 35,000.
13. For a population of 35,000 people, the future Sheridan peaking factor is expected to be near 2.7.

14. The average per capita water usage of 190 gpcd is not expected to change significantly in the future.

15. The City of Sheridan peak flow for a population of 35,000 will be approximately 18.0 mgd.

16. The projected total future water storage requirement for the City is 3,600 acre-feet for a population of 35,000 people, assuming an available flow rate of 9 cfs at the water intake.

**Sheridan Municipal Golf Course Existing Conditions**

17. The golf course receives water from the Sheridan 8-inch main, a 4-inch tap to one of the twin 20-inch mains, and a 2-inch tap to the 8-inch Veterans Administration (VA) Hospital main.

18. The golf course uses approximately 450,000 gpd for irrigation.

19. The irrigation supply water is stored in a 20.1 acre-foot reservoir at the golf course.

**Sheridan Municipal Golf Course Future Conditions**

20. An irrigation rate of 0.5 million gallons per day (mgd) was used for future conditions over a 6-month period from April to September.

21. If a new transmission main was placed to serve the City of Sheridan, one of the existing raw water mains could be used to satisfy irrigation needs.
VA Hospital Existing Conditions

22. The maximum daily demand occurs during the irrigation season and is approximately 0.98 mgd, of which approximately 0.46 mgd is domestic and 0.52 mgd is irrigation usage.

23. The VA Hospital presently receives their raw water supply through an 8-inch main placed in about 1904. The minimal pretreatment facilities provided at the Big Goose Creek Intake are inadequate to meet Environmental Protection Agency (EPA) primary drinking water standards.

24. A previous study determined the VA 8-inch main had a capacity of 0.66 mgd.

25. Water consumption records indicate the demands exceed the capacity of this line during the months of July, August, September and November.

26. A previous study for the VA Hospital indicated the frequency of repairs is increasing and the condition of the pipeline is becoming increasingly worse.

27. The VA Hospital enjoys the use of 3 cfs of the original 1882 Sheridan water right.

28. The VA Hospital has storage rights of approximately 55 acre-feet in Big Goose Park Reservoir.

VA Hospital Future Conditions

29. There are known raw water taps on the VA 8-inch main. Ten taps were reported during this study. However, determination of the number of taps and location was not included in the scope of this study.

30. The projected future peak day demand is 1.2 mgd, of which 0.5 mgd would be allocated to domestic needs and 0.7 mgd to irrigation needs.
31. The VA Hospital may irrigate approximately 62 to 79 acres in the future.

32. Supplying the VA Hospital's present demands of 1.0 mgd from the Sheridan Water Treatment Plant (WTP) will require immediate expansion of the plant.

33. Expansion of the Sheridan WTP could possibly be temporarily deferred if only the domestic needs were satisfied.

Supply and Demand Recommendations

1. The conveyance systems should be sized to convey the future demands from the City of Sheridan, Sheridan Municipal Golf Course, and VA Hospital. These demands total 18.0 mgd for a population of 35,000 people in the City of Sheridan, 18.5 mgd with the golf course and 19.7 mgd with the golf course and the VA Hospital.

2. If surface storage facilities are developed, they should be sized to provide a minimum firm yield of 3,600 acre-feet to satisfy Sheridan's future needs.

GROUNDWATER SUPPLIES

This portion of the project determined the quantity of groundwater available at the Big Goose and Little Goose well sites and developed recommendations for additional development of groundwater at these sites. The drilling programs also provided data to refine interpretations and understanding of the hydrogeology on the east flank of the Big Horn Mountains.
Groundwater Summary of Findings

General

1. The water quality from both wells meets all Environmental Protection Agency (EPA) primary and secondary drinking water standards.

Big Goose Well

2. The Big Goose well is drilled to a depth of 2,538 feet, to the top of the Gros Ventre Formation.

3. Final long-term flow in the Big Goose well was 25 gallons per minute (gpm), with a shut-in pressure of 230 psi, storage coefficient of $5 \times 10^{-3}$ and transmissivity of 100 gallons per day per foot (gpd/ft).

4. If the increased flow from the middle Gros Ventre Formation to the upper Flathead Formation is the result of the geologic structure around the Little Goose site, it is doubtful whether the same increases in flow could be realized at the Big Goose site. If the increased flow is not a result of structure, then additional flow from the Big Goose well can probably be obtained by drilling deeper; but it is very difficult to predict how much the flow may increase, given the present available information.

5. From an exploration point of view it is important that deepening the existing Big Goose well would be a considerably less expensive approach to investigating the groundwater potential of the Gros Ventre Formation and Flathead Sandstone than would construction of a new well.

Little Goose Well

6. The Little Goose well was drilled to a depth of 2,499 feet, approximately 90 feet into the Flathead Sandstone Formation.
7. The geology in the vicinity of the Little Goose well is very complex compared to that at the Big Goose site.

8. Flow was first noted at a depth of 1,560 feet, and increased intermittently to a maximum of 240 gpm during the remainder of the drilling.

9. The well apparently was collapsing during the flow test.

10. Before the well collapsed, an increase of about 90 gallons per minute (gpm) in flow was experienced from the mid-Gros Ventre Formation through the upper part of the Flathead Sandstone. This represents about 35 percent of the flow measured from the well immediately after drilling.

11. Final flow in the Little Goose well was 90 gpm, primarily from the Gallatin Formation. The shut-in pressure was 260 psi, the storage coefficient was $1 \times 10^{-4}$, and the transmissivity was 400 gpd/ft.

12. A Little Goose well field could produce a long-term yield of up to 200 to 300 gpm. This yield would provide water for about 250 to 375 dwelling units.

Groundwater Supply Recommendations

Big Goose Well

1. In order to get the maximum potential for increased flow, the well should completely penetrate the Flathead Formation. This will require deepening it another 1000 feet. However, the Engineering Department of the City of Sheridan does not consider additional work to deepen the Big Goose well to be a cost-effective expenditure.
Little Goose Well

2. In order to maximize the potential from the Little Goose well, the well should be deepened another 400 feet and cased.

3. Locate potential well sites to develop a well field that has the capability to yield 300 gpm.

4. Once the well field capacity has been established, perform a preliminary design study to develop service boundaries and costs for water distribution.

SURFACE WATER SUPPLIES

This portion of the project provided an evaluation of potential surface water supply sources to augment the City's existing resources with either additional storage capacity or direct surface water rights.

Surface Water Supplies Summary of Findings

Stull Reservoir

1. Although the enlargement of Stull Reservoir was originally considered a possible alternative, it was eliminated as a feasible alternative after a recent change of the Cloud Peak Wilderness Area boundary which now includes Stull Reservoir. Construction activities and motorized vehicles necessary for maintenance activities will not be allowed.

Twin Lakes Reservoirs

Existing Conditions

2. Twin Lakes No. 1 discharges through Twin Lakes No. 2 and the present spillway capacity at Twin Lakes No. 2 is less than the spillway capacity at Twin Lakes No. 1.
3. The Corps of Engineers (COE) Phase I Dam Safety Inspection indicated Twin Lakes No. 1 cannot pass the Probable Maximum Flood (PMF).

4. The lower portion of Twin Lakes No. 1 spillway is deteriorated and needs to be rehabilitated.

5. For the four years of available storage release records at Twin Lakes No. 1 and No. 2, the carry-over storage ranged from 800 to 1,200 acre-feet.

Twin Lakes Hydrology

6. The active storage in Twin Lakes No. 1 is 1,317 acre-feet, and in Twin Lakes No. 2 is 203 acre-feet.

7. It was assumed that 50 percent of the active storage is filled during May and 50 percent is filled during June.

8. Typically, Twin Lakes storage releases average 50 percent during August and 50 percent during September.

9. Presently, the U.S. Forest Service has no instream flow requirements. However, they may be required in the future. The calculated amount of water available for development was reduced by 20 percent to allow for future instream requirements, seepage losses and evaporation losses. This percentage is subject to negotiation during the permitting process.

10. The worst 2-year drought period for the 31 years of record was in 1960 and 1961. During this drought period the water available for development was 1,317 acre-feet per year. The corresponding statistical recurrence interval for this 2-year drought period is 100 years.
11. The water availability is controlled by the downstream water rights on Big Goose Creek, on the Tongue River, and by the Yellowstone River Compact.

12. The Banner Report concluded 3,700 acre-feet per month must pass USGS gauge 3020 during the irrigation season at the Sheridan Water Intake in order to satisfy downstream requirements.

13. The Yellowstone River Compact restricts the total use of Wyoming water rights with a priority after January 1, 1950 to 40 percent of the total unused and unappropriated flow in the Tongue River System.

**Twin Lakes Water Availability**

14. Two operation studies were performed to determine the safe yield for the following conditions:

- The entire 31 years of record were used with no water shortages allowed.
- Water shortages were allowed during the 1960-1961 critical period.

15. The water availability study for the first scenario indicated an average inflow of 5,145 acre-feet to the Twin Lakes Reservoirs for the 31 years of record from 1954 to 1985. If all the water is captured for development, a 10,100 acre-foot reservoir would be needed. The corresponding firm yield would be 4,450 acre-feet per year.

16. For the second operation scenario, shortages were allowed to occur in 1960 and 1961. Without these two drought years, the average inflow increased from 5,145 acre-feet to 5,594 acre-feet. If all of the water is captured under this scenario, a 7,360 acre-foot reservoir would be required. The corresponding firm yield would be 5,430 acre-feet per year. If water conservation measures ever became necessary, the City's senior water right on Big Goose Creek would serve as a minimal supply source for their basic needs.
Twin Lakes Reservoir Enlargement Alternatives

17. Results of the hydrologic study indicate there is a significant amount of water available for development at the Twin Lakes Reservoir site. Because of the magnitude of the available water, three alternate reservoir enlargements were evaluated to determine the most economical alternative. These alternatives were as follows:

- **Alternative 1** - Raising Twin Lakes No. 2 dam 30.5 feet to the elevation of Twin Lakes No. 1 dam. This will increase the existing combined storage capacity from 1,520 acre-feet to 2,400 acre-feet. The firm yield would be increased from 1,450 acre-feet under existing conditions to 1,760 acre-feet. The present outlet works at Twin Lakes No. 1 will be upgraded and Twin Lakes No. 2 outlet works will be replaced.

- **Alternative 2** - Raising both dams to create a reservoir to capture as much water as possible. This alternative will require raising Twin Lakes No. 1 and Twin Lakes No. 2 dams 65.5 feet and 96.0 feet, respectively. The storage capacity will be increased from 1,520 acre-feet to 10,100 acre-feet. The firm yield will be increased an additional 3,000 acre-feet to 4,450 acre-feet. Outlet works improvements would be the same as Alternative 1.

- **Alternative 3** - An intermediate storage volume was selected to produce a firm yield of 2,600 acre-feet. This would require raising Twin Lakes No. 1 and Twin Lakes No. 2 dams 24.0 feet and 54.5 feet, respectively. The storage capacity will be increased from 1,520 acre-feet to 4,810 acre-feet. The firm yield will be increased an additional 1,150 acre-feet to 2,600 acre-feet. The Twin Lakes No. 2 outlet works was costed to allow the entire discharge through it. This alternative was developed because it was felt it represented a maximum probable size based on the limited soils information. The maximum probable size can better be defined following a geotechnical investigation.
Twin Lakes Geotechnical Considerations

18. Enlargement of the Twin Lakes Reservoirs incorporates morainal ridges into the dam itself. Data indicates the ridges are composed of glacial materials and must be considered highly variable in terms of engineering properties due to the general nature of glacial deposits. For this reason it is necessary to locate the dam so as not to rely on the ridges for excessive stability.

19. As the Twin Lakes No. 2 dam height is increased above the Alternative 1 30.5 foot level, the uncertainties associated with the stability of the ridges become more critical for the reasons identified above (Item 18). Therefore, it is felt that the feasibility of Alternative 2 is limited by geotechnical considerations, and a new dam may be more feasible than enlargement of the existing dams.

20. Alternative 3 represents an intermediate storage volume that should not create excessive concerns regarding the stability of the morainal ridges. However, the uncertainties associated with Alternative 2 also need to be addressed for Alternative 3 in further detail before enlargement at the existing site.

Weston Reservoir

21. The Weston Reservoir has an active storage volume of 370 acre-feet.

22. A reconnaissance visit indicated the dam to be in relatively good condition with no indications of cracking or differential settlement.

23. The average annual amount of water available for storage is 1,140 acre-feet. This is approximately 20 percent of the water available at the Twin Lakes site.

24. Enlargement of the Weston Reservoir would not satisfy Sheridan's long-term needs, however, Weston Reservoir could be developed as a supplemental supply.
Reservoir at Water Treatment Plant (WTP)

25. Potential storage facilities in the form of a 210 acre-foot raw water reservoir could be located near the Sheridan WTP.

26. The potential dam and reservoir area exhibit surficial evidence of slope instability. This includes localized hummocky terrain, sloughing, and seepage exiting the slope. Although the majority of the foundation and reservoir slopes are presently stable, instability problems may occur once the reservoir is filled and soils become saturated. It is not anticipated that large sudden failures will occur, but that the failures will be primarily slow creep type movement at relatively shallow depth. However, during rapid drawdown conditions a larger slide could possibly occur.

27. Experience indicates the unit cost of developing a smaller reservoir on this site will be greater than the cost of enlargement at the Twin Lakes site. Therefore, based on limited storage capacity and development cost, it is felt this alternative does not warrant further evaluation.

Intake Structure West of Sheridan

28. The possibility of locating a water intake on Big Goose Creek immediately west of Sheridan was investigated to determine the feasibility of recovering 4 cfs of the original direct water right lost when the intake was moved upstream.

29. The Board of Control has not regulated the stream flow downstream of Sheridan in over 20 years. Since the new intake would be immediately west of Sheridan and downstream of the majority of the irrigation water rights, this point of diversion (POD) should provide a reliable source.
30. Minimum stream flow records indicate there should be sufficient water immediately west of Sheridan during the irrigation season to augment their existing water rights.

31. The proposed site is on Big Goose Creek approximately 0.6 miles west of the Sheridan City limits.

32. The new intake would be equipped with a traveling water screen, removable sediment plates, and pump capacity of 4 cfs.

33. The raw water suspended solids and turbidity concentrations would exceed the EPA Drinking Water Standards during the spring runoff and irrigation season. However, this water would be suitable for irrigation without prior treatment.

Surface Water Alternative Cost Summary

34. A cost summary for the surface water alternatives investigated is included in Table 1. The cost per acre-foot was developed assuming financial assistance from the State with a 50 percent grant and a loan at 4 percent over 50 years. The Intake Structure West of Sheridan alternative was an energy intensive alternative, therefore a present worth energy cost value was developed assuming money was worth 8 percent over 50 years. The present worth energy cost also allowed for energy cost increases of 4 percent per year. No cost was prepared for the Twin Lakes - Alternative 2 due to geotechnical concerns.

Surface Water Supply Recommendations

1. The Twin Lakes Enlargement represents the most feasible storage alternative, and the Intake Structure West of Sheridan represents the most feasible direct water right alternative. The enlargement of Twin Lakes at a downstream site should be investigated in the Phase II 1986 Program for various levels of protection. The development of Weston Reservoir in conjunction with an enlargement of the Twin Lakes at the existing site should also be considered in 1986 Phase II Program.
### Table 1
COST SUMMARY FOR SURFACE WATER ALTERNATIVES

<table>
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<tr>
<th>ALTERNATIVE</th>
<th>ADDITIONAL FIRM YIELD (Acre-Feet)</th>
<th>PROJECT COST ($)</th>
<th>1985 PRESENT WORTH ENERGY COST ($)</th>
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<td>773,000</td>
<td>46</td>
</tr>
<tr>
<td>Expansion of Twin Lakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 1 -</td>
<td>310</td>
<td>3,260,000</td>
<td>N.A.</td>
<td>3,260,000</td>
<td>245</td>
</tr>
<tr>
<td>Alternative 3 -</td>
<td>1,150</td>
<td>8,350,000</td>
<td>N.A.</td>
<td>8,350,000</td>
<td>169</td>
</tr>
</tbody>
</table>

**NOTES**

1) Assumes the money worth at 8% and energy costs escalated at 4% per year over 50 year period.

2) Assumes 50% grant and 4% on loan over 50 year period.

3) Present worth energy costs annualized at 8% over 50 years; construction costs annualized at 4% over 50 years with 50% grant.

N/A = Not Applicable
2. If the enlargement of Twin Lakes reservoir is not undertaken, the City of Sheridan should proceed to correct the present deficiencies at these damsites which include: the spillway inadequacies; deterioration of Twin Lakes No. 1 spillway; and rehabilitation work to observed areas of seepage. This remedial work should be performed to lessen the risk of a dam failure.

3. Further consideration should be given to establishing an Intake Structure west of Sheridan to divert water from Big Goose Creek to satisfy the future peak demands. Additional study is needed to determine the effect on treatability at the water treatment plant by introducing water from the lower diversion point.

WATER TRANSMISSION PIPELINE IMPROVEMENTS

This portion of the study identifies alignments of existing raw water transmission pipelines, estimates conveyance capacities, determines useful life of pipelines, and evaluates the need for additional conveyance capacity. The determination of the pipeline condition was performed by visual inspection at various locations and by performing leakage tests. The need for a new water transmission pipeline is evaluated based on the condition and capacities of the existing pipelines, and on existing and projected water demands. The results of this study indicate a new 30-inch pipeline is needed to satisfy Sheridan's long-term needs. The location of the existing mains and proposed 30-inch main is shown in Figure 2. The bold line on Figure 2 indicates the corridor of the proposed 30-inch pipeline. The 30-inch main begins at the Sheridan water intake and generally parallels the existing 20-inch pipeline until it connects to the existing twin 20-inch mains leading to the Sheridan WTP. The 30-inch main would be approximately 59,000 feet long and would have an elevation drop of 750 feet between the intake and the twin 20-inch pipelines.
BEGIN NEW 30-INCH PIPELINE

PLACE MOTORIZED VALVE ON EXISTING 30-INCH MAIN

DISCHARGE PIPE FOR TREATED WATER

NEW 30-INCH PIPELINE

10-INCH PIPELINE TO BE ABANDONED

18-INCH PIPELINE TO BE USED FOR TREATED WATER

MOTORIZED CONTROL VALVES

NEW 12-INCH IRRIGATION WATER MAIN

NEW 12-INCH IRRIGATION WATER MAIN

WATER TREATMENT PLANT

NEW 12-INCH IRRIGATION WATER MAIN

WATER TREATMENT PLANT

WATER TREATMENT PLANT

FIGURE 2
30-INCH TRANSMISSION PIPELINE
The potential for supplying water to the Sheridan Municipal Golf Course and the VA Hospital was also investigated. The location of a 12-inch pipeline to supply the needs of the golf course and VA Hospital is also shown on Figure 2. Finally, the operation of the new water transmission pipeline in conjunction with a hydropower plant, raw water bypass pipeline, and telemetry controls was investigated to achieve maximum beneficial use of available raw water supplies.

Water Transmission Summary of Findings

Existing Raw Water Transmission System

1. The City of Sheridan has four raw water transmission pipelines, as follows:

- 8-inch cast iron placed prior to 1900 with a capacity 0.5 MGD.
- 10-inch cast iron placed about 1905 with a capacity 1.0 MGD.
- 16-inch welded steel placed in 1936 with a capacity 4.5 MGD.
- 20-inch ductile iron placed in 1968 with a capacity 6.8 MGD.

The conveyance capacity and future demands are graphically shown on Figure 3.

2. The 8-inch pipeline is in poor condition and cannot be pressurized.

3. The 10-inch pipeline is in fair to poor condition. The capacity of this pipeline does not justify the cost of repair and maintenance.

4. There are approximately 73 raw water taps connected to the 8-inch and 10-inch pipelines.

5. The 16-inch and 20-inch pipelines are in very good condition with minimal leakage losses. Approximately 43 raw water taps exist on these two pipelines.
Figure 3

Transmission Line Capacities
Peak Day Water Demands and

Time (Year)

Existing 20′ Pipeline
Existing 20′, 16′, & 10′ Pipelines

Sheridan
Sheridan Golf Course
Sheridan Golf Course, & V.A. Hospital

1975

Peak Day Water Flows (MGD)
20
18
16
14
12
10
8
6
4
2
0

1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
6. The VA Hospital receives water through its own 8-inch pipeline which is 80 years old and reportedly in fair to poor condition. Ten raw water taps to the VA pipeline were reported during this study. The VA Hospital is also connected to the Sheridan system and can receive water from this source.

7. The only electronic control on the raw water supply system is at the beginning of the twin 20-inch pipelines at Big Goose Road. With the present control system, the City cannot adequately regulate the flow of raw water to match the fluctuating treated water demand. Since 1976 the unaccountable water has ranged from 26 to 42 percent of the water sold. In 1981-82 approximately 1,550 acre-feet of water was lost because of inefficient manual controls. The present system cannot respond rapidly to changing demand conditions.

**Future Raw Water Transmission System**

8. The City is in need of a new raw water transmission pipeline to meet projected water demands. The combined capacity of the existing 16-inch and 20-inch mains will be exceeded by the peak day demand of the City of Sheridan in about 1993. If the VA Hospital and golf course demands are included, the 20-inch and 16-inch pipelines combined are now insufficient to meet current peak day demands. This is graphically shown in Figure 3.

9. A new 30-inch pipeline could supply the projected peak day water demands of the City, VA Hospital, and Sheridan Municipal Golf Course for a population of 35,000 people.

10. A new 30-inch pipeline would provide sufficient head to allow for hydropower production.

11. The existing 20-inch pipeline could serve as a back-up to the new 30-inch pipeline, and also provide water to the golf course and the VA Hospital. The sprinkler system at the golf course could be operated directly off a new 12-inch main from the 20-inch pipeline, eliminating the need for the existing pumps at the golf course.
12. The VA Hospital could eliminate about 12 miles of the 80-year-old 8-inch VA pipeline by connecting near the golf course and obtaining irrigation water from the City's existing 20-inch pipeline. If the VA Hospital elected to treat the water themselves, the 20-inch line could satisfy the future potable and irrigation demands. An optional connection would be to obtain irrigation water from the 20-inch connection and obtain potable water from the connection to the City system.

Raw Water Transmission Costs

13. The cost of a new 30-inch steel pipeline from the intake on Big Goose Creek to the twin 20-inch pipelines is estimated to be $8.39 million. The cost of providing steel pipe is approximately $1 million less than ductile iron (D.I.) Class 53. A summary of the costs is presented in Table 2.

14. Depending on the route and location, the approximate cost of a new 12-inch main between the existing 20-inch pipeline and the 8-inch VA pipeline to serve the golf course and VA Hospital is estimated to be $252,000.

15. A telemetering system on all components of the raw water supply system could reduce unaccountable water losses by about 25 percent or 388 acre-feet per year. If water is assumed to be worth $0.60 per 1,000 gallons, this would result in an estimated savings of $76,000 per year.

16. The cost of telemetering with a radio transmitter system is estimated to be $200,000. A power source will be required at Twin Lakes. It is not economically feasible to extend existing power service lines to Twin Lakes to operate the control gates. It may be more economical to provide a generator or solar collector facility at the reservoir to serve as a power source for the control gate actuators.
### TABLE 2

**CONSTRUCTION COSTS - 30-INCH PIPELINE**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT PRICE</th>
<th>COSTS</th>
<th>UNIT PRICE</th>
<th>COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Costs</td>
<td>59,000 ft.</td>
<td>$51.00</td>
<td>$3,009,000</td>
<td>$47.00</td>
<td>$2,773,000</td>
</tr>
<tr>
<td>Fittings (15%)</td>
<td>-</td>
<td>-</td>
<td>451,000</td>
<td>-</td>
<td>416,000</td>
</tr>
<tr>
<td>Add. Coating</td>
<td>59,000 ft.</td>
<td>13.00</td>
<td>767,000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Installation</td>
<td>59,000 ft.</td>
<td>20.00</td>
<td>1,180,000</td>
<td>20.00</td>
<td>1,180,000</td>
</tr>
<tr>
<td>Welded Joints</td>
<td>36,000 ft.</td>
<td>-</td>
<td>-</td>
<td>4.00</td>
<td>144,000</td>
</tr>
<tr>
<td>Bedding</td>
<td>59,000 ft.</td>
<td>9.00</td>
<td>531,000</td>
<td>9.00</td>
<td>531,000</td>
</tr>
<tr>
<td>Select Backfill (STA. 180+00 to 310+00)</td>
<td>38,000 ft.</td>
<td>6.00</td>
<td>228,000</td>
<td>6.00</td>
<td>228,000</td>
</tr>
<tr>
<td>Foundation Materials (Same Stations)</td>
<td>38,000 ft.</td>
<td>3.50</td>
<td>133,000</td>
<td>3.50</td>
<td>133,000</td>
</tr>
<tr>
<td>Dewatering (STA. 340+00 to 440+00)</td>
<td>10,000 ft.</td>
<td>10.00</td>
<td>100,000</td>
<td>10.00</td>
<td>100,000</td>
</tr>
<tr>
<td>Road Crossings</td>
<td>300 ft.</td>
<td>350.00</td>
<td>105,000</td>
<td>350.00</td>
<td>105,000</td>
</tr>
<tr>
<td>Pressure Reducing Vault</td>
<td>1 ea.</td>
<td>205,000</td>
<td></td>
<td>205,000</td>
<td></td>
</tr>
<tr>
<td>Connection to Existing 20&quot; Line</td>
<td>Lump Sum</td>
<td>50,000</td>
<td>50,000</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>30&quot; Valves</td>
<td>Lump Sum</td>
<td>136,000</td>
<td>136,000</td>
<td>136,000</td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTALS:</strong></td>
<td></td>
<td></td>
<td><strong>$6,895,000</strong></td>
<td><strong>$6,001,000</strong></td>
<td></td>
</tr>
<tr>
<td>Construction Contingency (15%)</td>
<td></td>
<td></td>
<td><strong>1,034,000</strong></td>
<td><strong>900,000</strong></td>
<td></td>
</tr>
<tr>
<td>Total Construction Costs</td>
<td></td>
<td></td>
<td><strong>7,929,000</strong></td>
<td><strong>6,901,000</strong></td>
<td></td>
</tr>
<tr>
<td>Engineering &amp; Administration (15%)</td>
<td></td>
<td></td>
<td><strong>1,189,000</strong></td>
<td><strong>1,189,000</strong></td>
<td></td>
</tr>
<tr>
<td>Right-of-Way</td>
<td></td>
<td></td>
<td><strong>300,000</strong></td>
<td><strong>300,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PROJECT COSTS:</strong></td>
<td></td>
<td></td>
<td><strong>$9,418,000</strong></td>
<td><strong>$8,390,000</strong></td>
<td></td>
</tr>
</tbody>
</table>
17. An excess water bypass pipeline below the hydroelectric plant may allow for more hydropower production. This would be achieved by diverting water not called for by senior water rights at the City Intake and returning it to Big Goose Creek immediately below the proposed hydropower plant. Diversions will be restricted by downstream senior water rights. The cost of the excess water bypass pipeline is estimated to be $130,000.

**Water Transmission Recommendations**

1. A new 30-inch pipeline should be constructed in order to provide an avenue to eliminate the EPA raw water tap concerns, satisfy Sheridan's long-term needs, and provide feasibility to installing a hydropower plant.

2. Considering the age, line losses, condition and limited capacity of the 8-inch and 10-inch pipelines, these mains should be abandoned if a new 30-inch main is constructed.

3. The new 30-inch pipeline should parallel the existing 20-inch pipeline or be placed adjacent to roadways as much as possible. The exact alignment will be identified in the Level III Program.

4. If a new pipeline is constructed, the City and the VA Hospital should work out an agreement so that the VA can obtain their raw water supply from the existing 20-inch pipeline via a new 12-inch main.

5. The existing 20-inch pipeline should continue to be used for back-up conveyance capacity.

6. The existing 16-inch pipeline could be used to serve potable water to the Big Goose Valley. However, the new 30-inch pipeline must be in service before the 16-inch pipeline can be used strictly to supply potable water to Big Goose Valley.
7. Electronic telemetering controls (radio-signaled) and electronically controlled operators should be provided on all components of the raw water transmission system. The telemetering controls should be provided at the Sheridan Water Treatment Plant adjacent to the existing water system controls.

8. An illuminated systems panel, showing a line diagram of the City raw water system with the point of control and the current operating status of each control, should be installed at the water treatment plant.

9. Future pipeline construction practices should provide the same type of backfill material for a minimum of 6 inches around the entire pipe to reduce corrosion effects. A 10 mil external coating on ductile iron pipe and replacement of coating on any ductile iron coating disturbed during future construction or maintenance is also recommended.

10. The feasibility of the excess water pipeline should be evaluated in greater detail during preliminary design of the proposed hydropower plant.

WATER SUPPLY FOR BIG GOOSE VALLEY

The purpose of this section is to examine alternative means of resolving EPA concerns with the raw water taps on the four existing raw water mains and to investigate possible methods of supplying the Big Goose Valley water users with potable water. Implementation of alternatives discussed in this section will require policy decisions between City of Sheridan officials and Big Goose Valley residents.

Big Goose Valley Water Supply Summary of Findings

Existing Raw Water Taps

1. There are 116 known water taps on the four City raw water supply pipelines and 10 identifiable taps on the VA pipeline. Additional unauthorized taps may exist.
2. The raw water taps served by the City lines include 100 domestic (residential) and 16 commercial users. These taps were granted in return for an easement. Under terms of the agreement, no mention is made to long-term obligation of the City to provide a water source, let alone potable water, to the property owners.

3. The water in the four Sheridan supply pipelines is pretreated through a settling process and chlorinated at the City Intake prior to transmission. The VA line does not have adequate settling or screening facilities at their Big Goose Creek Intake.

4. Because of excessive turbidity levels, the U.S. Environmental Protection Agency (EPA) has expressed concern about possible Giardia lamblia contamination of the raw water, along with concerns about meeting satisfactory disinfection levels. Although the allowable turbidity level has been exceeded, no traces of Giardia lamblia have been identified in the Sheridan samples taken to date. The EPA has indicated that legal action will be instituted if the raw water tap problem is not resolved.

5. The total average water consumption of the 116 raw water taps is 47,500 gallons per day (gpd) or 409 gpd/tap.

6. Based on existing records the average day use of domestic taps is 300 gpd and 1,300 gpd for commercial users.

**Future Demands**

7. There will be an increase in water use when potable water is made available in Big Goose Valley.

8. For estimating purposes a peak day usage of 0.80 gpm per user was assumed for future development.
9. The proposed boundary for a utility district is shown on Figure 4 and contains 11,520 acres. Boundaries will be further refined in the 1986 Phase II Program.

10. It is assumed that initially 75 percent of the residents (233 users) will join the water district.

11. For design purposes, a future total of 500 water users has been assumed. The total projected water demands used for design are:

   - Average Day = 133 gpm
   - Peak Day = 400 gpm
   - Peak Hour = 800 gpm

**Alternative Water Sources**

12. There is a precedent established in Michigan for solving the problem of the raw water taps by discontinuing service. This is considered to require a legal interpretation rather than an engineering evaluation.

13. Five alternatives were investigated as a means of providing potable water to the Big Goose Valley. These include:

   - Providing point-of-use treatment at each service.
   - Providing water from individual groundwater sources.
   - Providing water from community groundwater sources.
   - Providing water from the Sheridan WTP.
   - Providing water from a small package water treatment plant located at the intake on Big Goose Creek.
   - Providing treatment from water treatment plant located elsewhere in the valley.

14. Based on the experience of the City and others, point of use treatment devices are not a reliable means of providing potable water. They are difficult to administer and require excessive routine maintenance.
FIGURE 4
BIG GOOSE VALLEY
WATER DISTRICT
15. The Old West Regional Commission determined individual groundwater wells was not feasible since generally the quality of water from existing wells is very poor, being extremely high in dissolved solids, hardness, sodium and sulfates.

16. With the Big Goose exploration well flowing only 25 gpm, this well is not a feasible central community water supply source.

17. A central water supply from the Sheridan WTP would require pumping water back up the Big Goose Valley. The results of this investigation found this alternative to be cost-prohibitive to satisfy the entire valley needs. Also, the Sheridan WTP is already at capacity. An expansion will be necessary to satisfy the Big Goose Valley demands. The City of Sheridan presently has an ordinance prohibiting services outside the City limits.

18. Supplying water from the City intake and treating it with a small package treatment plant at the intake prior to distribution was found to be feasible if the City or other appropriator would furnish the water.

19. Based on the interest expressed in response to the Big Goose Valley survey letter, the feasibility of centralized treatment along the valley should be evaluated further in Phase II.

Water Distribution System

20. The preliminary design of the Big Goose Valley water system assumed that the existing 16-inch raw water main would be used as the primary distribution main. However, use of the 16-inch main necessitates prior construction of a new raw water supply line from the intake into Sheridan.

21. The establishment of a water system in the Big Goose Valley requires some entity responsible for operating and maintaining the system. The administrative entity could operate in one of two ways:
1) Independent rural water system operated and maintained by itself.

2) Utility district administered and maintained by the City of Sheridan.

22. A rural water district would have no water rights and would have to buy water from the City of Sheridan or another appropriator.

23. The City of Sheridan has personnel trained in the administration, operation, and maintenance of water distribution systems. The City currently has an experienced operator at the intake who could also be trained to operate a water treatment plant for the Big Goose Valley.

**Cost Estimate**

24. The estimated cost of a water system to serve the assumed initial development of 233 units in the Big Goose Valley is $5.89 million, as shown in Table 3. This cost does not include a purchase cost of the 16-inch Sheridan pipeline or water rights from an appropriator other than Sheridan.

**Big Goose Valley Water Supply Recommendations**

1. If a new 30-inch Sheridan supply line is constructed, the existing 16-inch main could be used to serve potable water to the Big Goose Valley.

2. The existing 20-inch main could be used to supply irrigation water to the Municipal Golf Course, raw water to the VA Hospital and continue to provide conveyance capacity to the Sheridan WTP. This would necessitate a 12-inch connection to the 8-inch VA line near the Sheridan WTP. This concept would supply a better quality, pre-treated raw water supply to the VA. It will also enable the VA to abandon their intake and about 12 miles of their 80-year-old 8-inch pipeline. There is no information as to what VA plans to do about the raw water taps on their line.
TABLE 3
ESTIMATED COST
BIG GOOSE VALLEY WATER SYSTEM

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT PRICE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package Water Treatment Plant</td>
<td>1</td>
<td>$395,000 L.S.</td>
<td>$395,000</td>
</tr>
<tr>
<td>650,000 Gallon Storage Tank</td>
<td>650,000 Gal.</td>
<td>0.40 Gal.</td>
<td>260,000</td>
</tr>
<tr>
<td>Mainline Pressure Reducing Vaults</td>
<td>3</td>
<td>39,000 each</td>
<td>117,000</td>
</tr>
<tr>
<td>Distribution Lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-inch</td>
<td>31,400 L.F.</td>
<td>31.00/L.F.</td>
<td>973,400</td>
</tr>
<tr>
<td>6-inch</td>
<td>38,000 L.F.</td>
<td>27.00/L.F.</td>
<td>1,026,000</td>
</tr>
<tr>
<td>4-inch</td>
<td>32,800 L.F.</td>
<td>25.00/L.F.</td>
<td>820,000</td>
</tr>
<tr>
<td>2-inch</td>
<td>16,000 L.F.</td>
<td>18.50/L.F.</td>
<td>296,000</td>
</tr>
<tr>
<td>8-inch Gate Valves</td>
<td>31 each</td>
<td>760 each</td>
<td>23,600</td>
</tr>
<tr>
<td>6-inch Gate Valves</td>
<td>38 each</td>
<td>650 each</td>
<td>25,000</td>
</tr>
<tr>
<td>4-inch Gate Valves</td>
<td>33 each</td>
<td>550 each</td>
<td>18,200</td>
</tr>
<tr>
<td>2-inch Gate Valves</td>
<td>16 each</td>
<td>400 each</td>
<td>6,400</td>
</tr>
<tr>
<td>Creek Crossings</td>
<td>18 each</td>
<td>2,000 each</td>
<td>36,000</td>
</tr>
<tr>
<td>Air Vac-Air Release Valves &amp; Vault</td>
<td>7 each</td>
<td>4,000 each</td>
<td>28,000</td>
</tr>
<tr>
<td>Highway Crossings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-inch</td>
<td>2 each</td>
<td>8,000 each</td>
<td>16,000</td>
</tr>
<tr>
<td>6-inch</td>
<td>5 each</td>
<td>6,000 each</td>
<td>30,000</td>
</tr>
<tr>
<td>4-inch</td>
<td>4 each</td>
<td>4,000 each</td>
<td>16,000</td>
</tr>
<tr>
<td>2-inch</td>
<td>17 each</td>
<td>2,000 each</td>
<td>34,000</td>
</tr>
<tr>
<td>Tap and Meter Pit</td>
<td>233 each</td>
<td>1,000 each</td>
<td>233,000</td>
</tr>
<tr>
<td>Tap for Distribution Lines</td>
<td>30 each</td>
<td>1,000 each</td>
<td>30,000</td>
</tr>
</tbody>
</table>

SUBTOTAL: $4,383,000
Contingency (15%)  658,000
Total Construction Costs $5,041,000
Engineering And Administration (15%)  756,000
District Formation Fees  10,000
Legal Survey Fees  50,000
Right-of-Way  33,000

PROJECT COSTS: $5,890,000
3. Refine potential Big Goose Valley alternatives to eliminate raw water taps and satisfy long term needs of Big Goose Valley.

HYDROPOWER FEASIBILITY

The purpose of this section is to evaluate the technical and economical feasibility of incorporating a small-scale hydropower generating plant on the proposed 30-inch raw water pipeline for the City of Sheridan.

Hydropower Feasibility Summary of Findings

Existing Conditions

1. The available head for hydropower generation in the proposed 30-inch pipeline is approximately 550 feet.

2. The amount of flow available for hydropower production was assumed to be the projected average monthly water demand for the City of Sheridan. The flows required by the VA Hospital and the Sheridan Municipal Golf Course were not included in determining the feasibility of hydropower.

3. The net available head depends on the flow, and ranges from 293 feet for the future peak day demand of 18.0 mgd, to 546 feet for the future average day demand of 6.7 mgd.

4. The proposed hydropower plant could be used to supplement the energy requirements at the existing Sheridan Wastewater Treatment Plant (WWTP). The energy requirements at the WWTP are fairly constant, ranging from 5100 to 6700 kWh/day, and are not expected to change significantly in the near future.
Hydropower Plant Alternatives

5. Either an impulse or a reaction turbine could be used to generate hydropower. However, an impulse turbine could only be used if there were sufficient elevation below the hydropower plant for water to flow up the twin 20-inch pipelines to the WTP.

6. Five separate turbine options were considered in this study, including one impulse turbine option and four reaction turbine options. A comparison of the costs and benefits associated with using different percentages of the available flows was made for each of the five turbine options. A comparison was also made between adjustable turbines and those with fixed geometry.

7. The potential power production capacity through 1994 is less than the energy requirements at the WWTP, except during the high water demand periods of July and August. The power produced during July and August which is in excess of the WWTP requirements could be used at the water treatment plant or sold to the local electric utility. By 2035, water demand will be sufficiently high to allow excess power to be produced year-round.

Hydropower Plant Costs

8. Estimated total project costs for the five turbine options ranged from $533,000 to $605,000.

9. Annual benefits of the five turbine options were developed using present energy rates in the Sheridan area. The benefits ranged from $28,700 to $58,400 in 1985, from $48,700 to $94,500 in 1994, and from $127,000 to $289,000 in 2015.
10. Benefit-cost ratios were determined for each of the five turbine options by converting 30 years of energy cost at the WWTP to a present worth value and then dividing by the estimated 1985 total project cost. Assuming energy escalates at 4 percent per year and money is worth 8 percent, all the options have benefit-cost ratios greater than 1.0, which indicates that each option could generate a positive cash flow before 2015.

11. Benefit-cost ratios varied from 1.19 to 1.82. The turbine options utilizing adjustable blades yield positive net returns earlier because they can utilize higher discharges more efficiently. The turbine options with fixed geometry do not show an acceptable return for the first twenty years.

12. The wheeling charges to transmit the electricity generated at the hydropower plant over utility-owned electrical lines to the WWTP were not included in this study.

13. A hydropower plant located on the proposed 30-inch raw water transmission pipeline is economically feasible, based on the flows required to meet only the City of Sheridan's water demands.

**Hydropower Plant Recommendations**

1. The most suitable hydropower plant location is approximately 29,000 feet downstream of the Sheridan Intake on Big Goose Creek, as shown on Figure 1.

2. The installation of either an impulse turbine or an adjustable reaction turbine should be evaluated further in Level III.

3. Preliminary design of the hydropower plant, including type of turbine, plant layout, and determination of energy transmission costs should be performed after the City has committed to building the new 30-inch pipeline.
RECOMMENDATIONS

The 1986 Phase II Program should address the following items:

**Big Goose Valley/City of Sheridan**

1) Analysis of economic and geotechnical attributes of alternative storage sites in the Big Goose drainage including: Weston reservoir, enlargement of Twin Lakes reservoirs; and an alternate site below Twin Lakes to capture storable flows. The advantages and disadvantages of constructing smaller reservoirs to incrementally develop water resources in the Big Goose Drainage should be considered. A preferred development plan should be established after consultation with WWDC.

2) A computer model of the Big Goose drainage in accordance with WWDC specifications should be prepared to verify storable flows in the basin.

3) Design and conduct a geotechnical testing program to establish the technical feasibility of construction at the preferred storage site.

4) Refine Big Goose Valley Water Improvement District alternatives based on information presented in this study, data received during the Public Meeting and in response to the Big Goose Valley survey letter, and supplemental data developed in the 1986 Program.

**Little Goose Valley** - Groundwater exploration indicated this was a feasible source of water to develop. The WWDC has decided to separate future Little Goose Valley work from this project. Future Little Goose Valley work should include:

5) Expand on the Little Goose Well exploration program to include deepening and casing of the existing well another 400 feet and placement of two additional wells.
6) Perform additional studies to develop a water service area, water demands, treatment and supply alternatives, and user fees based on results of previous step. Develop an implementation program.