EXECUTIVE SUMMARY

SHERIDAN AREA WATER SUPPLY INVESTIGATION - LEVEL II

PHASE 2
1986 PROGRAM

Prepared For Wyoming Water Development Commission

January 1987
December 15, 1986

State Of Wyoming
Water Development Commission
Herschler Building
Cheyenne, Wyoming 82002

Gentlemen:

We are pleased to submit the Executive Summary for the Level II Sheridan Water Supply Investigation - 1986 Program. This report summarizes the results of our engineering, hydrologic, geotechnical, and economic analysis studies.

Our primary tasks included rehabilitation of Twin Lakes Reservoirs, determination for potential enlargement of the reservoirs at the existing site, resolving the EPA concerns regarding raw water taps, and analysis of alternative supply sources and delivery systems for residents of Big Goose Valley.

We would like to thank the Wyoming Water Development Commission 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 of Sheridan staff for their unyielding guidance, cooperation, and understanding during this study.

If HNTB can be of assistance to answer any questions, or service 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 in the future.

Respectfully submitted,

HOWARD NEEDLES TAMMEN & BERGENDOFF

RANDY L. FULTZ, P.E.
SENIOR ENGINEER
SHERIDAN AREA WATER SUPPLY INVESTIGATION - LEVEL II
PHASE 2 - 1986 PROGRAM

Prepared For:
Wyoming Water Development Commission

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

Subconsultants
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:

WYOMING WATER DEVELOPMENT COMMISSION

Evan Green, Water Division II Project Manager

CITY OF SHERIDAN

Cliff Sanders, City Engineer
Doyl Miller, Assistant City Engineer
Brian Borgstadt, Assistant City Engineer
Al Kinter, Water Superintendent
Bob Graves, Water Intake Facility

Other City personnel who operated City equipment and assisted in determining condition of existing pipelines and in digging test pits at a potential reservoir site.

UNITED STATES FOREST SERVICE

Fred Fichtner, District Ranger

SHERIDAN COUNTY

Les Jayne, County Planner
# SHERIDAN AREA WATER SUPPLY INVESTIGATION - LEVEL II

## PHASE 2 - 1986 PROGRAM

### EXECUTIVE SUMMARY

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PURPOSE

The Sheridan Area Level II Water Supply Investigation was undertaken by the Wyoming Water Development Commission (WWDC) to evaluate alternatives for resolving a number of water supply and delivery problems in Sheridan County. In its various aspects, the study examined alternative supply sources and delivery systems for residents of Big Goose Valley, Little Goose Valley and the City of Sheridan. A major portion of the study focused on rehabilitating the existing water supply system for the City, on increasing the City's surface storage capacity and on providing a treated water source for residents of Big Goose Valley now served from raw water lines.

The purpose of Phase 2 of the Sheridan Water Supply Investigation is to: evaluate the rehabilitation of the Twin Lakes Reservoirs to satisfy the Corps of Engineers Safety of Dams Report (on Twin Lakes No. 1); determine the potential for enlargement of the Twin Lakes Reservoirs; determine the water losses from the 80 year old 8-inch and 10-inch pipelines; develop alternative water systems to resolve the raw water tap problems in Big Goose Valley; and develop an instrumentation system that will provide controls on Sheridan's raw water supply system to match reservoir releases with Sheridan's fluctuating demands.

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 evaluated the surface water development and storage potential in the Little Goose and Big Goose drainages, and identified groundwater well sites which were drilled during the Level II Study.
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. Phase 1 was completed November 1, 1985. The findings of the Phase 1 study were presented in Sheridan Area Water Supply Investigation - Level II, Volume I Report of Findings. The Phase 2 findings presented in this report and the results of earlier studies will be used in establishing the Level III and IV programs. The pipeline corridor and hydropower plant location proposed in the Phase 1 study are graphically shown on the Location Map presented as Exhibit 1.

OBJECTIVES

The objectives of the Phase 2 study are as follows:

- Perform a geotechnical investigation at the Twin Lakes Reservoirs site to determine feasibility of enlargement.
- Prepare preliminary plans for the rehabilitation of Twin Lakes Reservoirs.
- Develop a feasibility analysis and cost estimate for the enlargement of Twin Lakes Reservoirs.
- Determine the amount of water losses in the existing 8-inch and 10-inch City raw water transmission pipelines.
- Identify service area boundaries for alternative water distribution systems to serve Big Goose Valley.
- Evaluate water treatment alternatives to supply potable water to Big Goose Valley.
- Determine the feasibility of point-of-use treatment.
- Perform an analysis of the alternative water systems and recommend the most cost effective means for supplying water to Big Goose Valley.
- Develop a preliminary design and cost estimate for telemetering control of the raw water transmission system.
PROJECT GOALS

The goal of this project is to: develop a raw water supply system for the City of Sheridan that will satisfy their long term needs to the year 2035; provide a feasible solution for the elimination of the raw water tap problem on the existing transmission mains; and evaluate a centralized water distribution system to the Big Goose Valley residents. The procedure followed and results are summarized below for each chapter of this study.

STUDY APPROACH

The study approach concentrated on accomplishing the overall objectives and goals of this project. The investigations and evaluations were divided as follows:

- Twin Lakes Geotechnical Investigations
- Rehabilitation of Twin Lakes Reservoirs
- Enlargement of Twin Lakes Reservoirs
- Transmission Pipeline Water Losses
- Big Goose Valley Water Distribution Alternatives
- Centralized Water Treatment Alternatives
- Point-of-Use Treatment
- Analysis of Water System Alternatives
- Instrumentation and Control

The culmination of these activities was the development of a conceptual design for the Sheridan and Big Goose Valley water supply systems. The conceptual design presents design criteria, facilities sizing, preliminary layouts, and cost estimates of alternative improvements.
A summary of the findings of the Level II investigations and data collection activities are contained in this document, the Executive Summary. A Final Report with Appendices was prepared and also submitted to the Water Development Commission. The Final Report provides considerably more detail than presented herein and serves to substantiate the conclusions made in the Executive Summary.

**TWIN LAKES GEOTECHNICAL INVESTIGATION**

Geotechnical investigations were initiated to evaluate existing conditions and the maximum feasible reservoir capacity for the Twin Lakes Reservoirs.

**Twin Lakes Geotechnical Investigation Summary of Findings**

**General**

1. The project area is located in a region of the Big Horn Mountains that has had a low level of earthquake occurrence and is assessed to have relatively low potential for seismic activity.

2. The nearest evidence of faulting was identified approximately one mile to the northwest of the project. These faults and other faults in the Bighorns do not exhibit evidence of movement within the last five million years and are considered inactive and not capable of generating earthquakes of significance at the site.

3. Based on available information, the potential for foundation displacement of the Twin Lakes Dams appears to be very low.

**Twin Lakes Dam No. 1**

4. Twin Lakes Dam No. 1 has a structural height of approximately 54 feet, a crest length of 270 feet and a crest elevation of 8547 feet.
5. The embankment material of Twin Lakes Dam No. 1 consists of a medium dense to dense silty sand to clayey silty sand with gravel. Bedrock lies directly below the embankment. The bedrock consists of coarse-grained granitic rock which is moderately jointed.

6. The drill hole in the embankment and foundation of Twin Lakes Dam No. 1 provided no evidence of a cut-off trench and grout line.

7. Both the embankment and bedrock in Twin Lakes Dam No. 1 appear to have low to moderate permeabilities. Piezometer readings indicate seepage movement is horizontal and that multiple phreatic surfaces probably do not exist.

Twin Lakes Dam No. 2

8. Twin Lakes Dam No. 2 has a structural height of approximately 24 feet, a crest length of 250 feet and a crest elevation of 8516.5 feet.

9. The embankment material of Twin Lakes Dam No. 2 consists of soft to firm silty sandy gravel to clayey sandy gravel. The morainal ridge forms the foundation and consists of medium dense to dense silty sandy gravel with cobbles and boulders.

10. Permeability within the embankment is fairly low while it is moderately high within the moraine.

11. Piezometer readings at Twin Lakes Dam No. 2 suggest a high water level along the downstream slope of the dam and relatively free draining foundation materials.

12. The morainal ridge between the two reservoirs consists of medium dense to dense gravely silty sand to silty sandy gravel with cobbles and boulders. Based on field permeability tests, permeability within the moraine appears to be moderately high.
13. Discussions with the Forest Service indicated marshes in the region, which were potential sources of borrow material, are considered environmentally sensitive and permission for even preliminary testing would be difficult to obtain, much less develop as a borrow source. Thus, these areas were not considered further as potential borrow sources.

**Twin Lakes Geotechnical Investigations Recommendations**

1. The project is located in an area assessed to have low potential for seismic activity and a maximum design acceleration of 0.06g is recommended. It is not necessary that the embankment be designed for surface faults of fractures.

2. Analysis of data from this investigation indicates that enlargement of the existing reservoir by raising either one or both of the existing dams and adjacent areas is feasible from a geotechnical standpoint.

3. An alternative source of borrow material may be located within the Twin Lakes Reservoir basins. The reservoirs were full during the field investigation and it was not possible to investigate these sediments. However, they were mapped as fine-grained lacustrine sediments in an earlier study and would likely be good core material. These sediments should be investigated during the final design phase of the project.

**REHABILITATION OF TWIN LAKES RESERVOIRS**

The purpose of the evaluation of the Twin Lakes Reservoirs was to address the deficiencies of existing structures and prepare a Level II feasibility analysis and cost estimate for rehabilitation and possible increase in storage.
Rehabilitation of Twin Lakes Reservoirs Summary of Findings

General
1. In September 1978, the Corps of Engineers conducted a Phase 1 dam inspection of Twin Lakes No. 1. The Corps found the dam to be unsafe due to inadequate spillway capacity.

2. Twin Lakes No. 1 Reservoir is in reasonably good condition. However, tarps are used behind the dam to minimize erosion.

3. Between 10 to 12 gpm of seepage occurs along the left side of the Twin Lakes No. 1 outlet conduit.

4. The spillway and outlet works at Twin Lakes No. 2 appear to be in good condition but also have inadequate spillway capacities.

Hydraulic Conditions
5. Twin Lakes No. 1 spillway was designed to pass 750 cubic feet per second (cfs) at a design head of 2.5 feet. The estimated 100-year frequency flood for Twin Lakes No. 1 is 325 cfs. It appears the Twin Lakes No. 1 spillway was designed for a flood magnitude greater than a 100-year frequency. The maximum capacity of the spillway before overtopping the dam is 2,660 cfs. The estimated peak PMF for Twin Lakes No. 1 is 31,805 cfs.

6. The Twin Lakes No. 2 spillway also was designed for a discharge capacity of 750 cfs at a design head of 2.5 feet. The maximum capacity before overtopping the dam is only 900 cfs. The estimated peak PMF inflow is 44,878 cfs which includes the peak inflow from Twin Lakes No. 1 Reservoir.

7. Current dam safety hydrologic evaluation guidelines require both Twin Lakes No. 1 and 2 to have sufficient capacity to pass the PMF without overtopping.
8. If a PMF event of 31,805 cfs occurred at Twin Lakes No. 1, the dam and morainal ridge would overtop by approximately 4.7 feet. Overtopping would most probably result in a sudden break of the dam which could cause extensive damage and loss of life downstream.

**Twin Lakes No. 1 Reservoir Spillway Improvements**

9. Alternatives considered for the rehabilitation of Twin Lakes Dam No. 1 to safely pass the PMF without overtopping included the following:

- Raise the dam and ridge to a height such that the PMF would pass through the existing 50-foot wide spillway without overtopping.
- Provide an emergency spillway in the right abutment of the dam to bypass inflows in excess of the capacity of the existing spillway.
- Widen the existing ogee spillway so that the PMF can be passed without overtopping the dam.
- Provide a labyrinth spillway, to replace the existing ogee spillway, which will safely pass the PMF without overtopping the dam.
- Provide a fuse plug embankment in combination with the existing spillway to pass the PMF without overtopping the dam.

10. Of the above alternatives, a fuse plug embankment and a labyrinth spillway are the most practical and lowest cost solutions. The construction cost estimate of the fuse plug alternative is $707,000 and the labyrinth spillway construction cost estimate is $875,000. Schematics of these two spillway alternates are shown on Exhibit 2.

11. All or part of the fuse plug spillway will need to be reconstructed if the dam is overtopped. Annual maintenance of the fuse plug to prevent plant growth on the downstream slope of the embankment is essential. A labyrinth spillway is relatively maintenance free. The downstream slope of the spillway may require periodic maintenance of the riprap material.

**Twin Lakes No. 2 Reservoir Improvements**

12. The topography at Twin Lakes No. 2 does not permit additional spillway capacity. The left abutment of Twin Lakes Dam No. 2 is too low for an
emergency spillway or fuse plug. The left abutment is approximately one to one and one-half feet lower than the top of the dam and thus forms a natural emergency spillway.

13. It appears to be impossible to prevent overtopping of Twin Lakes Dam No. 2 during an extreme flood event. Therefore, structural measures are needed to prevent the dam from failing when overtopped.

14. Modifications to Twin Lakes Dam No. 2 to ensure safety of the structure during overtopping requires construction of a roller compacted concrete (RCC) face on the downstream face of the dam and abutment areas adjacent to the dam.

15. The estimated construction cost for rehabilitation of Twin Lakes Dam No. 2 with roller compacted concrete is $114,800. The cost estimate includes miscellaneous repairs to the upstream face of the dam, and trashrack.

Rehabilitation of Twin Lakes Reservoirs Recommendations

1. The recommended plan for rehabilitation at the Twin Lakes Reservoirs consists of the following:

   o Close the existing Twin Lakes No. 1 spillway.
   o Construct a labyrinth spillway at Twin Lakes No. 1.
   o Construct a RCC face on the downstream slope of Twin Lakes Dam No. 2 and abutments.
   o Perform the recommended remedial repairs and improvements identified in the dam inspection report.

2. The total estimated cost of the recommended rehabilitation plan is $1,270,000. This expenditure would meet dam safety requirements, but would not increase the storage capacity of the reservoirs.

3. Recently installed piezometers should be monitored on at least a quarterly basis to provide information to assess structural behavior of the two dams.
ENLARGEMENT OF TWIN LAKES RESERVOIRS

The results of the geotechnical investigation was used to determine the potential for reservoir enlargement at the existing site. Storage requirements were determined for 8, 9 and 10 out of 10 year levels of protection. Cost curves were generated for the various levels of protection.

Enlargement of Twin Lakes Reservoirs Summary of Findings

General

1. An average annual inflow of 5,145 acre-feet is available for development.

2. The water availability study conducted during the 1985 Program assumed a 20 percent instream flow requirement. A specific amount or procedure for determining instream flow requirements has not been determined. However, the firm yield is not sensitive to the assumed inflow stream requirements up to an assumed instream requirement of 40 percent.

3. Sheridan's water demands are primarily residential domestic demands. Storage facilities are typically designed to provide a 9 out of 10 year level of protection for residential demands.

4. Sheridan's yield requirements are 3,600 acre-feet per year to satisfy year 2035 needs. The corresponding storage capacity for a 9 out of 10 year level of protection is 3,900 acre-feet.

Geotechnical Considerations

5. Based on the geotechnical investigations, it is concluded that the reservoirs can be enlarged up to the maximum water surface elevation of 8605. However, the embankment raises would have to incorporate seepage barriers and drainage zones to adequately handle potential embankment and foundation conditions.
6. Stability and seepage analysis indicate that both of the existing dams have adequate factors of safety and can be enlarged without increasing the risk of dam failure.

7. It is anticipated that the moraines can be incorporated into the embankment system of the raised embankments.

8. Permeability tests performed on the existing embankment materials and the proposed fill materials indicate that the permeabilities are relatively low.

9. To reduce potential seepage beneath Twin Lakes Dam No. 2, a cutoff trench is proposed to be constructed immediately upstream of the existing toe of the dam.

**Hydrologic Conditions**

10. A preliminary design of the spillway for a single dam at Twin Lakes was based on the probable maximum flood (PMF) of 44,878 cfs.

11. Because of the magnitude of the PMF, a two-spillway system consisting of a service spillway and an emergency spillway was selected. The service spillway was sized to accommodate the 100-year storm, and the emergency spillway is designed to pass inflows of storms in excess of the 100-year storm and up to the PMF.

12. The existing spillway at Twin Lakes Dam No. 2 can accommodate the 100-year storm. Therefore, this spillway could be used as the service spillway for the reservoir enlargement. The inlet of the morning-glory spillway would need to be moved to the required upstream location.

13. The emergency spillway design would allow a portion of the dam embankment to be overtopped. Armouring the crest and downstream slope with roller compacted concrete to provide protection against erosion would be required. To accommodate the PMF, a spillway with a crest length of 800 feet is needed.
Cost Estimates

14. Cost estimates were developed for reservoir enlargements for three storage capacities that would increase the storage capacity from the present 1,520 acre-feet to 2,400 acre-feet, 4,810 acre-feet and 10,100 acre-feet.

15. The estimated total project costs for the three alternative reservoir enlargements are:

<table>
<thead>
<tr>
<th>Alternative 1</th>
<th>(2,400 acre-feet)</th>
<th>$5,007,200</th>
</tr>
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<tbody>
<tr>
<td>Alternative 2</td>
<td>(10,100 acre-feet)</td>
<td>$23,882,500</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>(4,810 acre-feet)</td>
<td>$10,160,400</td>
</tr>
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16. The results of the cost estimates were used to develop total storage versus project cost curves. The storage vs. cost curve was used in conjunction with the storage vs. firm yield curve for the 8, 9 and 10 out of 10 year levels of protection. The cost versus yield curves are shown on Exhibit 3.

17. The project cost for a 3,900 acre-foot reservoir is $8.2 million.

Enlargement of Twin Lakes Reservoirs Recommendations

The Twin Lakes Reservoirs should be enlarged to satisfy the long-term storage needs of 3,600 acre-foot for the year 2035 with a 9 out of 10 year level of protection. This will require enlargement of the reservoirs to 3,900 acre-foot.

TRANSMISSION PIPELINE WATER LOSSES

A field investigation to estimate the water losses in the 80-year old 8-inch and 10-inch water transmission mains was performed to determine the future usefulness of the lines.
Field Survey

1. The 12-inch pipeline between the intake and the point where the pipeline divides into the 8-inch and 10-inch pipeline is in good condition with very little water losses.

2. A total of 139,700 gallons per day (gpd) or 28 percent of the water entering the 8-inch main is lost to leakage before it reaches the Sheridan Municipal Golf Course.

3. A total of 868,800 gpd or 48 percent of the water entering the 10-inch main is lost to leakage before it reaches the Sheridan Water Treatment Plant.

4. When water from the 8-inch is not being used at the Golf Course, an additional 0.30 mgd is wasted to a draw to Big Goose Creek. This discharge occurs since the pipeline cannot withstand additional pressures developed if the line is valved off at the downstream end.

5. The total water losses from the 8-inch and 10-inch pipelines is 1.01 mgd during the irrigation season and 1.31 mgd during the remainder of the year. Assuming an irrigation season of six months, the annual water loss is estimated at 423 million gallons (1,298 acre-feet).

6. If water is assumed to be worth $0.60 per 1000 gallons, the value of the water lost is equivalent to $254,000 per year.

Transmission Water Losses Recommendations

The water losses in the 8-inch and 10-inch pipelines is excessive and it is recommended the pipelines be abandoned.

BIG GOOSE VALLEY WATER DISTRIBUTION ALTERNATIVES

Residents in Big Goose Valley receive their water supplies from either the Sheridan raw water supply, Veteran’s Administration raw water supply, or
individual wells. The Environmental Protection Agency has determined that the City of Sheridan is in violation of provisions of federal regulations and the Safe Drinking Water Act by allowing the delivery of raw water to domestic users from the City's transmission lines. EPA may enforce sanctions against the City unless the City terminates delivery or provides a potable water supply. Alternatives were defined in this chapter to provide a potable water supply to the 116 identifiable Sheridan raw water users and determine the feasibility of providing a centralized water distribution system to the remaining 164 residents identified in Big Goose Valley.

Water Distribution Alternatives Summary of Findings

General
1. The City of Sheridan Water Department billing records indicate 116 taps on the Sheridan raw water transmission mains. Additional taps may exist for which there are no records.

2. Approximately 164 additional residences in Big Goose Valley are served from individual wells or taps to the V.A. Hospital raw water transmission main.

3. A total of 280 dwellings along Big Goose Valley was used as the maximum number of locations requiring water service at this time.

4. The water distribution alternatives assumed the 8-inch and 10-inch transmission mains were abandoned.

Distribution System Design Criteria
5. The future peak day demand per user described in the Phase 1 1985 Study was 0.80 gpm. The peak hour demand is assumed to be twice the peak day demand, or 1.6 gpm per user.
6. Where the number of homes to be connected to the distribution system was less than 50, 5 gpm per unit was used to size the distribution system. Beyond 50 homes the peak hour demand of 1.6 gpm per home was used to size the mains.

7. Although the centralized water distribution system alternatives were not designed to provide fire protection, ten fire hydrants are included in the cost estimate for each alternative. The intent of these hydrants along Big Goose Road is to provide a water source for fire trucks.

8. The distribution mains were sized to maintain a water pressure of between 35 and 100 psi wherever possible.

9. Storage facilities were sized to provide one average day storage plus 50 percent of one peak day for operating storage.

Alternative Water Distribution Systems

10. A summary of the components of the Big Goose Valley Alternatives is presented in Table 1. Alternative 1 would serve the lower portion of Big Goose Valley from the City of Sheridan water supply system. The central portion of the valley would be provided with potable water from a 250,000 gpd package water treatment plant (WTP) at the upper end of the developed portion of Big Goose Valley. The treated water would be stored in a 150,000 gallon tank. The existing 16-inch pipeline would be used to supply water to the proposed treatment plant. The upper portion of the valley would be served with treated water through cluster treatment and point-of-use treatment facilities. Four booster stations would be required.

11. Alternative 2 would provide treated water to all of Big Goose Valley east of Beckton Hall Road from a new 350 gpm package WTP and a 250,000 gallon storage tank. Because the existing Sheridan WTP does not provide any water to Big Goose Valley, the proposed package WTP and water storage tank must have greater capacity than described for Alternative 1.
<table>
<thead>
<tr>
<th>ALTERNATIVE NO.</th>
<th>POTENTIAL CUSTOMERS</th>
<th>SHERIDAN WTP DEMAND</th>
<th>PACKAGE TREATMENT WTP</th>
<th>POINT-OF-USE UNITS</th>
<th>CLUSTER UNITS</th>
<th>STORAGE RESERVOIR (GAL.)</th>
<th>NO. OF BOOSTER STATIONS</th>
<th>NO. OF TRANSMISSION MAINS</th>
<th>NO. OF UNECONOMICAL SERVICES</th>
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<tr>
<td>1</td>
<td>273</td>
<td>66 GPM</td>
<td>10175 GPM</td>
<td>14</td>
<td>2 - (24 Homes)</td>
<td>150,000</td>
<td>4</td>
<td>New 12&quot; Main</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>273</td>
<td>-</td>
<td>10350 GPM</td>
<td>11</td>
<td>2 - (24 Homes)</td>
<td>250,000</td>
<td>4</td>
<td>New 12&quot; Main</td>
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<tr>
<td>3</td>
<td>273</td>
<td>-</td>
<td>10350 GPM</td>
<td>15</td>
<td>2 - (24 Homes)</td>
<td>250,000</td>
<td>4</td>
<td>Existing 16&quot; Main</td>
<td>4</td>
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<tr>
<td>4</td>
<td>274</td>
<td>-</td>
<td>10350 GPM</td>
<td>4</td>
<td>-</td>
<td>300,000</td>
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<tr>
<td>5</td>
<td>116</td>
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<td>-</td>
<td>116</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
12. Alternative 3 would provide treated water to all of Big Goose Valley east of Beckton Hall Road from a new 350 gpm package WTP. Alternative 3 serves the same area as Alternative 2. Therefore, the package WTP and storage tank have the same capacities as presented for Alternative 2. Alternative 3 would utilize the existing 16-inch transmission pipeline to convey potable water in Big Goose Valley. The existing 16-inch pipeline forms the backbone of the new distribution system, and significantly reduces the amount of necessary water main and right-of-way acquisition necessary for Alternatives 1 and 2.

13. Alternative 4 would provide treated water to the entire Big Goose Valley from a new 350 gpm package WTP located at the top of the valley near the existing intake on Big Goose Creek. Placing the WTP at the intake will allow the majority of the valley to be served by gravity and minimizes booster stations. The existing 16-inch transmission pipeline will form the backbone of the distribution system. The storage tank capacity will be increased to 300,000 gallons.

14. Alternative 5 would provide point-of-use treatment systems to each of the 116 known existing raw water taps. The only improvements required are the point-of-use treatment devices and new service lines from the 8-inch and 10-inch pipelines to the 16-inch and 20-inch pipelines. It is assumed the existing meter pits are used.

15. Alternatives 1, 2, 3, and 4 all result in four existing raw water taps where water service from existing or proposed water lines is uneconomical. These four taps are presently served raw water from the 8-inch and 10-inch pipelines, and are located a considerable distance from the 16-inch or 20-inch pipelines. Individual wells could be installed to supply water following abandonment of the 8-inch and 10-inch pipelines.

**Water Distribution Alternative Recommendations**

Alternative package water treatment plant and point-of-use treatment systems were evaluated in the next two sections and the results incorporated into the Analysis of Water System Alternatives portion of this study.
CENTRALIZED WATER TREATMENT ALTERNATIVES

Distribution Alternatives 1, 2, 3, and 4 would require centralized water treatment facilities to provide a potable water supply system to Big Goose Valley residents. The results of the centralized water treatment facilities evaluation is incorporated into the Analysis of Water System Alternatives section.

Centralized Water Treatment Plant Alternatives Summary of Findings

1. Centralized water treatment alternatives considered included:

   o Provide a potable water supply to Big Goose Valley and Sheridan with a new water treatment plant at the intake.
   o Provide a potable water supply to Big Goose Valley from the Sheridan water treatment plant.
   o Provide a potable water supply to only Big Goose Valley with a new package water treatment plant.

2. If a new water treatment plant were constructed at the intake to serve Big Goose Valley and Sheridan, it would be necessary to increase the design capacity of the existing Sheridan WTP from 10 MGD to approximately 13 mgd. The cost to construct a 13 mgd water treatment plant will approach $13 million.

3. Due to the very high cost of providing a completely new water treatment plant, the cost of obtaining sufficient land, the difficulty in ensuring access during the winter, and the inability to address transmission pipeline inadequacies, the alternative of constructing a new 13 mgd Sheridan water treatment plant near the intake was not considered feasible.

4. Providing the entire valley with water from the Sheridan WTP was found to be uneconomical due to excessive pumping costs. However, it may be desirable to serve a portion of the valley with Sheridan water which could be supplied by gravity from the existing 4 MG Sheridan water storage tank. This option was incorporated into Alternative 1.
5. Two alternative package water treatment plants (WTP) were investigated. Both employ the "contact adsorption clarifier" (CAC) which eliminates the need for conventional flocculation and sedimentation.

6. The equipment costs are similar for the two alternative package water treatment plants investigated. The estimated project costs are $360,000 for a 250,000 gpd package WTP for Alternative 1 and $460,000 for a 500,000 gpd package WTP for Alternatives 2, 3, and 4.

7. The estimated operation and maintenance costs, assuming part-time participation by Sheridan personnel, for the package water treatment plants are $23,000 per year for Alternative 1 and $29,000 per year for Alternatives 2, 3, and 4.

Centralized Water Treatment Plant Recommendations

1. The Microfloc Trident package WTP which utilizes the contact adsorption clarifier was recommended for the centralized package water treatment. A flow diagram of this treatment process is shown on Exhibit 4.

POINT-OF-USE TREATMENT

Point-of-Use treatment refers to treating the water at the location where it is consumed. Point-of-use treatment employs microfiltration, reverse osmosis, and/or carbon adsorption techniques. Point-of-use was considered under Alternative 5 for all 116 raw water users or where centralized treatment was not considered economical.

Point-of-Use Treatment Summary of Findings

EPA Guidelines

1. Presently there is no federal policy specific to point-of-use treatment. However, EPA has proposed several guidelines for the implementation of point-of-use treatment. Some of the relevant criteria for public water systems with point-of-use treatment include:
o The point-of-use system must meet a turbidity level of 1 ntu.

o Point-of-use will generally be considered only for very small public water systems (generally less than 50 homes).

o The water supplier and EPA must meet every one or two years to discuss alternatives to point-of-use for meeting the MCL.

o EPA reserves the right to disapprove further use of point-of-use devices based on non-performance or the availability of other water supplies.

o The water supplier must select the point-of-use device and demonstrate to EPA that the MCL can be met with the device.

o The water supplier must own and have access to the devices for maintenance, and must be responsible for insuring that routine maintenance occurs on a regular basis.

o A stringent monitoring schedule will be imposed to demonstrate that the units are meeting the MCL. This will be the responsibility of the utility.

2. The EPA regulations indicate point-of-use treatment is not feasible for all 116 raw water taps since this is significantly greater than the guideline of 50 services. If point-of-use were implemented and found not to be in compliance, the EPA could stop further use of the devices. Point-of-use is not considered a long term solution to meeting maximum contaminant levels.

3. Recent conversations with EPA personnel indicates treatment at the point-of-entry will be required.

Point-of-Use Alternatives

4. Point-of-use treatment presents several alternatives in terms of the location of treatment, the level of service provided and the type of treatment device. The three following point-of-use treatment alternatives were investigated:

o Point-of-use treatment at a single tap. Adequate treatment capacity could be provided to satisfy cooking and human consumption needs (approximately 5 to 10 gallons per day) or the equivalent capacity of one faucet (approximately 2 gpm).
Point-of-entry treatment of all the water going into the home. The required treatment capacity is approximately 5 gpm.

Cluster treatment requires treating all the water entering several homes. For the distribution alternatives presented in Chapter 6 for which cluster treatment is required, it was assumed that each cluster treatment device had a capacity of 100 gpm.

Pilot Testing Program

5. The raw water turbidity during the pilot testing program averaged only 2.0 ntu over the duration of the study. This turbidity level is far below peak turbidity levels of 40 ntu and higher experienced in the past during spring runoff periods.

6. The data collected during the point-of-use pilot testing program indicated none of the devices were capable of adequately treating water from Big Goose Creek to a turbidity level below the EPA standard of 1.0 ntu.

7. It appears that a substantial portion of the turbidity-causing material from Big Goose Creek is smaller than 1.0 micron.

8. The filter retention size of the pre-filter did not affect the treated water turbidity, nor did the pre-filters appear to extend the life of the final filters.

9. The units tested produced 5 to 10 gallons per minute at most, and plugged completely after treating anywhere from several hundred to several thousand gallons of water. In many cases the filters became completely plugged after less than 8 hours of operation. The devices would be very maintenance intensive.

10. None of the point-of-use devices tested have the capacity, life, or effectiveness to provide economical cluster treatment.
Point-of-Use Treatment Recommendations

Because of the remoteness of several existing raw water users, point-of-use treatment could be utilized only on a limited basis. A cost estimate for two parallel 5 micron Fulflow filters followed by a 1 micron Fulflow filter, in conjunction with an Amway filter on a single faucet was incorporated into the alternative analysis section. The reliability of this system is not known. The estimated installed cost of this system is $700. The cost will vary depending on the home and area. The estimated average maintenance costs will be $83 per month. Additional costs will be necessary for daily turbidity testing, chlorination if required, and purchase price of water from Sheridan.

ANALYSIS OF WATER SYSTEM ALTERNATIVES

The results of the centralized treatment and point-of-use treatment evaluations were incorporated into the five water distribution alternatives.

Alternative Analysis Summary Of Findings

General

1. It is assumed the 8-inch and 10-inch transmission pipelines will be abandoned. The Sheridan, Big Goose Valley and Sheridan Golf Course demands will exceed the conveyance capacity of the 16-inch and 20-inch pipelines near 1988. Installation of a new 30-inch transmission pipeline will satisfy Sheridan's long term needs and allow for implementation of the hydropower facilities.

2. The point-of-use treatment for Alternative 5 will have the highest O&M cost; provide a limited water supply to 116 residents; would be subject to frequent EPA review; and would not meet the Drinking Water Standards the majority of the time.
Big Goose Valley Alternative Cost Estimates

3. The costs were prepared for the five alternatives and are summarized on Table 2. Alternatives 1 and 2 provide a centralized distribution system to the majority of Big Goose Valley at a premium cost, $5.42 to $5.82 million, respectively. Alternatives 3 and 4 utilize the existing 16-inch main to assist in satisfying the transmission main along Big Goose Road for Alternatives 1 and 2. The cost estimate for Alternative 3 is $4.14 million and for Alternative 4 is $4.23 million.

4. The incorporation of the existing 16-inch pipelines for Alternatives 3 and 4 indicates it has a useful value of approximately $1.7 million.

Alternative Analysis Recommendations

Alternative 4 is the recommended water distribution system. It provides a centralized system to approximately 280 existing homes and has the lowest annual O&M cost. It requires O&M of only one booster station and only four point-of-use systems. It also has the largest potential service area that could be served by gravity. A conceptual layout of this alternative is presented in Exhibit 5.

INSTRUMENTATION AND CONTROL

Improved electronic telemetering controls on the raw water supply system will enable the City to conserve water and improve their operational characteristics of their water supply system. The components of the system were evaluated individually for the existing 16-inch and 20-inch pipelines; proposed 30-inch pipelines; hydropower facilities; and Twin Lakes Reservoirs.

Instrumentation And Control Summary Of Findings

General

1. The City staff must travel approximately 20 miles to the outlet of the Twin Lakes Reservoirs to manually regulate the flow.
**TABLE 2**

**BIG GOOSE VALLEY COST SUMMARY WATER SYSTEM ALTERNATIVES**

<table>
<thead>
<tr>
<th>ALT.</th>
<th>UNIT(S)</th>
<th>SUBTOTAL CONTING.</th>
<th>CONSTR. COST</th>
<th>ENGR.</th>
<th>RIGHT-OF-WAY</th>
<th>PROJECT COST</th>
<th>ANNUAL O&amp;M COST</th>
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<td>3,972,200</td>
<td>595,800</td>
<td>4,568,000</td>
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<td>162,000</td>
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<td>2</td>
<td>3,205,500 397,400 170,600 330,000 158,700</td>
<td>17,300</td>
<td>4,279,500</td>
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<td>1,916,000 606,400 122,600 319,500 152,400</td>
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<td>3,119,700</td>
<td>468,000</td>
<td>3,587,700</td>
<td>538,300</td>
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<tr>
<td>5</td>
<td>-</td>
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<td>-</td>
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</tr>
</tbody>
</table>

(1) Engineering fees include: design and construction services; geotechnical investigations; corrosion investigations; right-of-way surveys; plans and documents; bidding plans and documents; construction testing; and construction administration with full time inspection.

(2) Combined with Service Area 1.

(3) Includes cost for service lines to reconnect all raw water taps from the 8-inch and 10-inch mains to the 16-inch or 20-inch mains.
2. The controls at the Twin Lakes Reservoirs, intake facilities and existing pressure reducing valves must be hand operated. The City sets the controls to meet peak demands and makes periodic adjustments to meet seasonal demands. Excess water is discharged into draws.

3. The present control system is inadequate to meet fluctuating demands at the water treatment plant.

4. Signals would be transmitted to the Sheridan WTP utilizing a radio based telemetering system. This system would provide the lowest long term cost and provide compatibility with the Twin Lakes radio telemetry system.

Existing 16-Inch And 20-Inch Transmission Pipelines

5. Four existing 20-inch plug valves would be equipped with pressure transmitters to measure upstream and downstream pressure, motor operators where necessary, and remote telemetry unit (RTU) that would monitor pressures, valve position, and power failure and radio this information to a master terminal unit (MTU) at the Sheridan WTP.

6. Similar control to the two existing 16-inch plug valves would be provided.

Proposed 30-Inch Transmission Pipeline And Hydropower Plant

7. Pressure in the 30-inch pipeline would be monitored and controlled by two valves.

8. Flow through the hydropower plant would be controlled by one of the 30-inch valves above the plant, 20-inch bypass line around the plant, and 20-inch discharge line used to generate additional hydropower providing water is available.

Twin Lakes Reservoir Outlet

9. The discharge from Twin Lakes Reservoir would be monitored and controlled from the MTU located at the Sheridan WTP. The telemetry equipment would be solar powered.
10. The RTU would have the capabilities to activate a motor to control the outlet gates upon command from the MTU. A small bank of solar batteries would be capable of operating a 10 HP motor for a 10 minute period once per day.

11. A radio signal repeater would be necessary to deliver the signal from Twin Lakes Reservoir to the Sheridan WTP. The repeater would be solar powered to avoid the costs of extending a power line.

**Master Terminal Unit (MTU)**

12. MTU alternatives investigated included: free standing panel with graphics display; and a computer-based master with a graphics panel.

13. The computer-based MTU offers the largest advantage in terms of upgradability. With the free standing panel MTU, the number of RTU's to be monitored should be known prior to manufacture. To add future RTU's the panel MTU must be reprogrammed and hardware added. With the computer, the addition of an RTU only requires reprogramming.

14. Data management, daily reporting, graphic capabilities, flexibility, identification of problem areas, cost trends, peak flows by quadrants, tank level and recording of time and sequence of failures are also offered by the computer-based MTU.

15. Assuming the 30-inch pipeline and hydropower plant were constructed, the estimated instrumentation and control project cost is $402,000.

**Instrumentation And Control Recommendations**

1. Instrumentation and control equipment should be provided at the Twin Lakes Reservoirs, raw water transmission main valves, and hydropower facilities to maximize the use of Sheridan's water supplies.

2. Radio-based remote telemetry equipment on the transmission mains will provide compatibility with the Twin Lakes Reservoir equipment.
3. Solar powered equipment at Twin Lakes Reservoir will provide an inexpensive, reliable, low maintenance alternative to generator powered equipment.

4. A computer-based MTU at the Sheridan WTP will satisfy Sheridan's needs and provide the greatest degree of flexibility.

RECOMMENDATIONS

The 1986 Phase 2 Program recommendations include the following:

**Sheridan Water Supply Improvements**

**Twin Lakes Reservoir Enlargement**

1. The Twin Lakes Reservoirs should be enlarged to satisfy Sheridan's growth patterns to the year 2035. It is recommended the yield from the reservoir enlargement provide a 9 out of 10 year level of protection.

2. The Twin Lakes Reservoirs should be enlarged to 3,900 acre-feet and provide a yield of 3,600 acre-feet per year.

**Water Transmission Pipeline**

3. A 30-inch raw water transmission main with hydropower facilities is recommended to satisfy Sheridan's long term needs to the year 2035.

4. An instrumentation and control system utilizing solar power to operate the control gates at Twin Lakes Reservoirs should be implemented. Control of the control valves on the raw water transmission mains should also be provided. Signals indicating pressure, valve position, and power failure should be sent to a computer-based master terminal unit (MTU) at the Sheridan WTP.

5. A 12-inch raw water pipeline to the Sheridan Municipal Golf Course is recommended.
Big Goose Valley Water Distribution System

6. If the City of Sheridan provides water to the Big Goose Valley, it is recommended a centralized treatment and water distribution system be provided. The recommended system, identified as Alternative 4 in this study, includes the following components:

- 350 gpm package water treatment plant (WTP) near the existing water intake on Big Goose Creek. The package water treatment plant should utilize the contact absorption clarification process.
- Utilize existing 16-inch transmission main for backbone of water distribution system.
- Provide 300,000 gallon storage facilities at the package WTP.
- Size the distribution system to satisfy a peak day demand of 0.8 gpm. No fire protection will be provided. For distribution lines serving less than 50 homes, the line should be sized for 5 gpm per home.

Cost Summary

7. A project cost summary for the Sheridan Water Supply Improvements and Big Goose Valley Water Supply System are shown in Table 3.
TABLE 3

SHERIDAN AND BIG GOOSE VALLEY WATER SYSTEM IMPROVEMENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHERIDAN WATER SUPPLY IMPROVEMENTS</td>
<td></td>
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<tr>
<td>Water Transmission Pipeline</td>
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<tr>
<td>30-Inch Class 53 D. I. Transmission Pipeline</td>
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<td>Hydropower Plant</td>
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<tr>
<td>Excess Water Discharge Pipeline Hydro Plant</td>
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<tr>
<td>Instrumentation And Control System</td>
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<tr>
<td>12-Inch Diameter Golf Course Water Main</td>
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<tr>
<td>Reservoir Improvements</td>
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<tr>
<td>Twin Lakes Enlargement</td>
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<td>SHERIDAN WATER SUPPLY SUBTOTAL</td>
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<tr>
<td>BIG GOOSE VALLEY WATER SUPPLY</td>
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<td>Package Water Treatment Plant</td>
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<td>300,000 Gallon Storage Tank</td>
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<td>Distribution System</td>
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<td>Point-of-Use Treatment</td>
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<td>BIG GOOSE VALLEY WATER SUPPLY SYSTEM SUBTOTAL</td>
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<tr>
<td>SHERIDAN AND BIG GOOSE VALLEY TOTAL</td>
<td>$23,232,000</td>
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EXHIBIT 2
TWIN LAKES REHABILITATION

NOTES:
1. Topography is as shown on 1985 construction drawings prepared by Black & Veatch for Twin Lakes No. 2 dam and 1969 construction drawings prepared for Twin Lakes No. 1 dam. Dashed topographic lines interpolated from USGS Quadrangle: Doe Lake 1964.
2. Stationing is approximate. STA 0+00 is Twin Lakes No. 2 dam stationing taken from Black & Veatch 1969 construction drawings. Stationing progresses left and right, looking downstream.

SCALE OF FEET
EXHIBIT 3
TWIN LAKES RESERVOIR ENLARGEMENT
YIELD VS TOTAL COST
FILTRATION MODE

CLARIFIER FLUSH CYCLE

WATER LEVEL

ADSORPTION CLARIFIER
FLUSH CYCLE

WASTE AND OVERFLOW CONNECTION

BACKWASH CYCLE

EXHIBIT 4
TRIDENT CAC SYSTEM