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Mailing Address:
Water Resources Data System
University of Wyoming, Dept 3943
1000 E University Avenue
Laramie, WY 82071

Physical Address:
Wyoming Hall, Room 249
University of Wyoming
Laramie, WY 82071

Phone: (307) 766-6651
Fax: (307) 766-3785

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Crestview/Antelope Valley Water Supply Project
Level II

Executive Summary

Wyoming Water Development Commission

November, 1999
Executive Summary
Crestview/Antelope Valley Water Supply Project
Level II

Submitted To:
Wyoming Water Development Commission
Herschler Building
Fourth Floor West Wing
Cheyenne, WY 82002

and

Crestview Improvement and Service District
2622 Rapid Street
Gillette, WY 82718

Antelope Valley Improvement and Service District
P.O. Box 2787
Gillette, WY 82717

Prepared By:
Consultants in Engineering and Hydrogeology

P.O. Box 29
605 Plaza Court
Laramie, WY 82073

201 West Lakeway
Suite 1000
Gillette, WY 82718

November, 1999
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Section 1.0 - General

1.1 Purpose and Scope

The purpose of this investigation is to evaluate the water supplies, distribution and storage systems of the Crestview Improvement and Service District and the Antelope Valley Improvement and Service District to determine the condition of system components, and to identify improvements required for the water systems to provide for the long term needs of the two water districts. The location of these water systems is shown on Figure 1-1.

The focus of this Level II investigation is to identify the demand for the Crestview and Antelope Valley systems, to determine if additional supply is required, and to suggest changes to operational procedures to insure efficient operation and longevity of the systems. Analyses were performed as part of this study to determine the feasibility of connecting the two water systems so additional supply would need to be developed in only one of the systems instead of both. Since Antelope Valley operates at a higher hydraulic grade line elevation than Crestview, it was decided to locate a new well in the Antelope Valley system, which would provide for additional capacity to both systems without requiring a booster pumping station. Preliminary designs and cost estimates were prepared for the facilities required to create an integrated system. Figure 1-2 shows the location of the Districts' current wells, tanks and a vault constructed in 1997 for the purpose of connecting the two systems.

1.2 Conclusions

Based on a review of the data for the systems, personal communication with the system operators and the hydraulic modeling performed, the following conclusions have been made.

1.2.1 Crestview Water System

1. The Crestview Water System has marginally adequate supply.

2. The Crestview Water System is supplied by one source, Crestview Well No. 1, which leaves it vulnerable to interruptions in supply if problems were to occur with the well, the pump or the main pipeline. The well has some reported integrity problems.

3. Crestview has a large storage tank (550,000 gallon). This tank could provide 3 to 4 days of storage capacity at maximum day demand if Well No. 1 were out of service.

1.2.2 Antelope Valley Water System

1. Both Antelope Valley and Crestview need additional water supply. Rather than drill wells for each water system, it is more efficient to develop additional wells in the Antelope Valley water system and then furnish a portion of the new supply to Crestview through a piping connection.

2. While Antelope Valley currently has adequate supply, it has historically relied on Well No. 2 for over half of it’s supply. This well is now experiencing problems (discussed in Section 3.0), which means that the system now relies very heavily on Well No. 3. Therefore, there is some concern about the dependability of the present Antelope Valley water supply system.
3. Antelope Valley Tank No. 1 can not be effectively utilized. The high water line of this tank is approximately 24 feet lower than the high water line of Tanks No. 2 and No. 3. Therefore, the tank is very rarely used which creates stagnant water and icing problems.

4. The location of the chlorine feed system serves Well Nos. 2, 3, and 5 but excludes Well No. 4 and a future Well No. 6.

5. There are low level concentrations of methane and hydrogen sulfide in the water as it is pumped from the wells.

1.3 Recommendations

As a result of this study, the following recommendations are offered.

1.3.1 Crestview

1. Connect to Antelope Valley's water system to provide redundancy of supply.

2. Rehabilitate Crestview Well No. 1.

3. Evaluate the intended use for the Antelope Valley connection and select an appropriate means of control.

1.3.2 Antelope Valley

1. Connect to the Crestview Water System to supply them with an alternate supply.

2. Complete Well No. 5 which was drilled as part of this project.

3. Abandon and remove Antelope Valley Tank No. 1.

4. Install a second chlorine feed system at the tank site to disinfect water from Well No. 4 and a possible future Well No. 6.

5. Continue to pipe all well water to the storage tanks before entering the distribution system to allow methane and hydrogen sulfide to be released from the water.

Section 2.0 - Demand Estimates

Population data compiled by the City of Gillette Department of Community Development were used to estimate the projected population over the 30-year planning horizon of the study. Estimates of future and current demands were then made based on use data supplied by the City.

2.1 Current Population and Demand

Crestview

The Crestview Improvement and Service District currently serves a population of approximately 560 with 159 taps. Water use data for a five year period from 1994 through 1998 were obtained from the District and were used to examine the adequacy of the current supply. The average day
demand calculated for the period from 1994 through 1998 is 49,800 gallons for the Crestview Improvement and Service District or 89 gallons per capita per day (gpcd) based on an estimated population of 560.

Antelope Valley

The Antelope Valley Improvement and Service District serves approximately 1200 residents with 315 taps. Again, water use records for the five period from 1994 to 1998 were used to evaluate the current water supply needs, and the average day demand for Antelope Valley was calculated to be approximately 119,000 gallons, which equates to a per capita demand of 99 gpcd. The District's operator reviewed this data, and he thought that the values shown seemed low. Therefore, he put together production data from the District's master meter for the period of January 1998 to August of 1999. When this data was compared with the meter reading data, a difference of 18.5% was found, and this difference was fairly consistent over those months that were compared. Because of this discrepancy, the average day demand for Antelope Valley was increased 18.5%, yielding a value of 141,000 gallons per day or 117 gpcd.

2.2 Maximum Day Demand

Daily records do not exist for the Crestview or Antelope Valley systems; therefore, a maximum day demand factor was calculated using data from other Wyoming cities. Records from several communities throughout the state including the City of Gillette were examined to determine a ratio between average and maximum day use. These data show that the values for the ratio of the maximum day demand (MD) versus the average day demand (AD) range from approximately 2 to just over 3 for the communities studied. Therefore, an average value of 2.5 was chosen for the Crestview and Antelope Valley systems. Applying this ratio to the average day demand yields the maximum day demand. Tables 2-1 and 2-2 summarize the average day and estimated maximum day demands for Crestview and Antelope Valley.

### Table 2-1
Existing Average Daily Water Demands

<table>
<thead>
<tr>
<th>Area</th>
<th>Gallons/Day</th>
<th>GPM</th>
<th>Population</th>
<th>GPCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>49,800</td>
<td>35</td>
<td>560</td>
<td>89</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>141,000</td>
<td>98</td>
<td>1,200</td>
<td>117</td>
</tr>
<tr>
<td>Outside Area</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>190,800</td>
<td>133</td>
<td>1,760</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 2-2
Existing Maximum Daily Water Demands (Gallons) (Average Day x 2.5)

<table>
<thead>
<tr>
<th>Area</th>
<th>Gallons/Day</th>
<th>GPM</th>
<th>Population</th>
<th>GPCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>124,500</td>
<td>86</td>
<td>560</td>
<td>222</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>352,500</td>
<td>245</td>
<td>1,200</td>
<td>294</td>
</tr>
<tr>
<td>Outside Area</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>422,000</td>
<td>331</td>
<td>1,760</td>
<td>-</td>
</tr>
</tbody>
</table>
2.3 Population Projections

Population projections for the 30-year planning horizon of this study were made using data compiled by the City of Gillette Department of Community Development Planning Division (1998). Population estimates for the City of Gillette and the Unincorporated Urban Service Area (unincorporated entities serviced by the City) for the 10 year period from 1988 to 1998 were compiled and a linear projection was performed as illustrated in Figure 2-2. The 1998 estimated total population of the City of Gillette and the Urban Service Area was reported to be 24,675. Using a linear extrapolation of the 10-year data, the projected total population in the year 2029 was found to be 36,272. This equates to a total increase of approximately 45%, yielding an annual growth rate of 1.5% per year.

The total current population of a combined Crestview/Antelope Valley system is approximately 1760. By applying a growth rate of 1.5%, the projected population in the year 2029 was calculated to be 2,545. Table 2-6 shows the existing and estimated future populations for the Crestview and Antelope Valley and for outlying areas adjacent to the subdivisions where the potential for development exists. These areas could be serviced by a combined Crestview/Antelope Valley system.

### Table 2-3
Existing and Projected Future Populations

<table>
<thead>
<tr>
<th>Area</th>
<th>Existing Population</th>
<th>Future Growth</th>
<th>Projected Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>560</td>
<td>-</td>
<td>560</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>1,200</td>
<td>225</td>
<td>1,425</td>
</tr>
<tr>
<td>Outside Area</td>
<td>-</td>
<td>560</td>
<td>560</td>
</tr>
<tr>
<td>Totals</td>
<td>1,760</td>
<td>785</td>
<td>2,545</td>
</tr>
</tbody>
</table>

2.4 Projected Water Demands

2.4.1 Future Demand Estimates

The average and maximum day demands for the projected population were calculated simply by multiplying the per capita use by the future population. These demands are presented in Tables 2-7 and 2-8.

### Table 2-4
Estimated Future Average Daily Water Demands

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
<th>GPCD</th>
<th>Gallons/Day</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>560</td>
<td>89</td>
<td>49,800</td>
<td>35</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>1,425</td>
<td>117</td>
<td>167,000</td>
<td>116</td>
</tr>
<tr>
<td>Outside Area</td>
<td>560</td>
<td>100</td>
<td>56,000</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>2,545</td>
<td>-</td>
<td>246,900</td>
<td>190</td>
</tr>
</tbody>
</table>
Table 2-5
Estimated Future
Maximum Daily Water Demands
(Average Day x 2.5)

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
<th>GPCD</th>
<th>Gallons/Day</th>
<th>GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>560</td>
<td>222</td>
<td>124,300</td>
<td>86</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>1,425</td>
<td>294</td>
<td>419,000</td>
<td>291</td>
</tr>
<tr>
<td>Outside Area</td>
<td>560</td>
<td>250</td>
<td>140,000</td>
<td>97</td>
</tr>
<tr>
<td>Total</td>
<td>2,545</td>
<td>-</td>
<td>617,700</td>
<td>474</td>
</tr>
</tbody>
</table>

Section 3.0 - Evaluation of Existing Water Supply

3.1 Crestview

The Crestview Improvement and Service District is currently served by a single well, the Crestview No. 1 Well, which is capable of a total long-term production of approximately 90 gpm. The original production was 200 gpm when the well was drilled. The pump was recently replaced, and a television survey was performed. During that survey, several leaks in the casing were discovered. These leaks could at least partially account for the drop in production if water from the original production horizon is being lost into the leaks. Because of the well is currently the sole source for the subdivision and would constitute the majority of the District's supply even in a combined system, it is recommended that a rehabilitation procedure be attempted on the well.

3.2 Antelope Valley

Antelope Valley is currently served by three production wells of varying depth and production. Historically, the District's No. 2 Well has been the primary supply due to its high water quality. However, in recent years the well has begun to produce sand and lose production raising questions about its integrity and causing problems with premature pump failures, especially in the summer months when the demand is high. Therefore, the District has had to rely more on its No. 3 Well and the recently completed No. 4 Well during high demand periods. The No. 1 Well developed large splits in its casing several years ago and is no longer used.

The No. 3 and No. 4 Wells are both highly productive, but they require higher horsepower pumps and are therefore significantly more costly to operate than the No. 2 Well. In addition, the No. 4 Well exceeds the primary EPA drinking water standard for fluoride and can only be used when blended with water from other wells. Therefore, the decision was made to construct the No. 5 Well as part of this Level II project to solidify the District's water supply.

3.3 Total Water Supply for a Combined Crestview/Antelope Valley System

Table 3-1 summarizes the available water supply for a combined Crestview/Antelope Valley system and compares that with the current and future estimated maximum day demand generated in Section 2.0. As this table illustrates, a combined system has adequate supply both currently and within the 30-year planning horizon for this study. In the table, a future Antelope Valley Well No. 6 was added. The District currently owns an 80-acre parcel of land which it is trying to sell for
development. In that parcel, the District has made arrangements to retain a tract of land for a possible future well and collection pipeline. Therefore, an estimated 150 gpm additional supply was added to the table. Although the current supply shown without Well No. 6 is adequate for the estimated future maximum day demand, the futures of Antelope Valley Well No. 2 and Crestview Well No. 1 are somewhat questionable, and Well No. 4 can only be used when blended with other wells to offset its high fluoride content. Therefore, the combined system may need an additional well in the future.

TABLE 3-1
Well Capacity Versus Estimated Maximum Day Demand

<table>
<thead>
<tr>
<th>System</th>
<th>Well</th>
<th>Capacity (gpm)</th>
<th>Existing Max. Day Demand (gpm)</th>
<th>Future Max. Day Demand (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crestview</td>
<td>Well No. 1</td>
<td>90</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>Antelope Valley</td>
<td>Well No. 1</td>
<td>0</td>
<td>245</td>
<td>291</td>
</tr>
<tr>
<td></td>
<td>Well No. 2</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. 3</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. 4</td>
<td>230</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. 5</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well No. 6 (future)</td>
<td>150 (estimate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Area</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>97</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>est. 940</strong></td>
<td><strong>331</strong></td>
<td><strong>474</strong></td>
</tr>
</tbody>
</table>

Section 4.0 - Distribution and Storage System Evaluation

The distribution and storage systems were evaluated to identify improvements required to enable the systems to function as intended, to improve operating efficiency, and to meet public water system standards adopted by the Wyoming DEQ. The evaluation consisted of discussions with water systems operators, visual inspection of system facilities including well sites, storage tanks, and the development of computer models to analyze the Crestview and Antelope Valley distribution systems. The evaluation did not include excavations of buried components or accessing the interior of the storage tanks.

4.1 Distribution Systems

4.1.1 Crestview

The Crestview distribution system consists primarily of 6-inch and 8-inch PVC water main and is reported to be in good condition. The system has one pressure zone with static pressures from 36 to 68 psi. Pressures at residences with higher elevations would be considered low in most systems, and hydraulic modeling performed at maximum day demand indicates that the system drops below 30 psi during high demand periods or when the tank is at low levels. However, the District reports no complaints about pressure; therefore, no improvements are recommended.

Hydraulic modeling was also performed to determine the fire flow capabilities of the Crestview system. Based on information from the Insurance Services Office (ISO), fire flows were modeled...
at maximum day demand plus 1,000 gpm at individual nodes. It was found that the system was capable of delivering this flow to all areas while maintaining a residual pressure of 20 psi throughout with the exception of two of the modeled nodes. In each of these cases, the pressure dropped to approximately 18 psi, which was not considered to be significant.

4.1.2 Antelope Valley

The Antelope Valley system is also constructed of primarily 6-inch and 8-inch PVC pipe and is reported to be in good condition. The system functions with one pressure zone, but residences at lower elevations are required to reduce pressure at individual taps. The system has more than adequate pressure with static pressures ranging from approximately 52 to 118 psi in the system. Modeling at maximum day demand showed very little head loss throughout the system, indicating that the distribution lines are adequately sized.

Fire flow modeling yielded similar results. Again, fire flows were modeled at maximum day demand plus 1,000 gpm in residential areas based on ISO recommendations. Fire flows at the Conoco Kwik Shop and at the Antelope Valley Baptist Church were modeled at 1,500 gpm, respectively, also based on ISO guidelines. It was found that the system maintained adequate residual pressure during all modeled fire flow conditions.

4.2 Storage

4.2.1 Crestview

Crestview is serviced by one tank with a total storage capacity of 550,000 gallons, which is reported to be in good condition. The Wyoming Department of Environmental Quality requires public water supply systems to provide storage for one average day's demand plus fire flow (1,000 gpm for 2 hours). Using this criteria, Crestview is required to provide 170,000 gallons of storage. Therefore, the District has adequate storage both currently and within the planning horizon of this study.

4.2.2 Antelope Valley

Antelope Valley currently has three storage tanks with a combined capacity of 936,000 gallons including a 96,000 gallon standpipe (Tank No. 2), a 630,000 gallon tank constructed in 1997 (tank No. 3), and a 210,000 gallon tank which was the District's original storage (Tank No. 1). However, the Tank No. 1 is only 24 feet tall, while Tank No. 2 and Tank No. 3 are 48 feet tall. Tanks 2 and 3 are rarely drawn down to the point that Tank No. 1 contributes to the system. Therefore, the water in Tank No. 1 becomes stagnant and unusable. Because of this, the District no longer uses Tank No. 1.

The Wyoming Department of Environmental requires storage for one average day demand plus fire flow. Assuming a maximum fire flow of 3,500 gpm for 2 hours at the Antelope Valley Baptist Church and an average day demand of 120,000 gallons, the required storage capacity is 540,000 gallons. Therefore, the District has adequate storage using only Tanks 2 and 3. Because Tank No. 1 is not needed and is unused, it is recommended that it be abandoned.

Section 5.0 - Drilling and Testing of Antelope Valley Well No. 5

5.1 Drilling and Construction

The need for an additional well had been determined prior to the Level II project based on current demand and possible integrity problems with Crestview Well No. 1 and Antelope Valley Well No.
2. Therefore, an additional well in Antelope Valley was drilled and tested as part of this project. Antelope Valley operates at a higher hydraulic grade line than Crestview; therefore, the well was sited in Antelope Valley to allow for gravity flow from Antelope Valley to Crestview as opposed to avoid the need for boosting the water from Crestview to Antelope Valley.

The well was sited near Antelope Valley Well No. 2 and was drilled to a total depth of 2,060 feet below ground level (bgl). The design was telescopic, incorporating a 12%-inch diameter borehole and 9%-inch casing to 1,248 feet bgl and a 7%-inch diameter borehole through the production interval from 1,248 to 2,060 feet bgl. The production interval was completed with a 5%-inch liner to 2,001 feet with 150 feet of 5-inch pipe size stainless steel screen opposite the producing sands.

5.2 Testing

The well was then tested to determine the aquifer characteristics and to estimate long-term production once it is completed and used by the district. A step test was performed to estimate the well’s efficiency and to determine a discharge rate for a three-day constant rate test to follow. Following the step test, the well was allowed to recover was then pumped at a rate of 140 gpm for approximately three days. The wells’ recovery was then monitored for an additional 5 days.

The No. 5 Well was originally designed to minimize interference between it and the nearby No. 2 Well. Based on information from the District, it appeared that the deepest production sand in the No. 2 Well was at approximately 1,160 feet bgl. Therefore, the No. 5 Well was designed to produce only from sands below 1,200 feet bgl. However, data collected during the constant rate test on the No. 5 Well showed significant drawdown in the No. 2 Well. Further investigation of State Engineer’s Office records revealed that the No. 2 Well was actually deeper than was originally thought, and that the wells shared two sands. Therefore, a second constant rate test was performed, this time pumping the No. 2 Well while monitoring the drawdown in both the No. 5 and No. 2 Wells.

5.3 Results and Conclusions

The constant rate and recovery tests performed on the No. 5 Well yielded transmissivities for the aquifer of 750 gallons per day per foot (gpd/ft) and 800 gpd/ft, respectively. Based on this number and an assumed storage coefficient of $1 \times 10^{-4}$, it was determined that the well is capable of approximately 150 to 170 gallons per minute long-term production.

Drawdown data taken in the No. 5 Well during pumping of the No. 2 Well provided definite evidence that the wells are hydraulically connected, and that interference between the wells is significant. While the amount of interference measured does not preclude simultaneous use of the wells, it is recommended that the District utilize the wells at different times of the year whenever possible.

The No. 2 Well experiences problems with sand production and pump failure during heavy demand periods in the summer. Therefore, it is recommended that the No. 5 Well be the primary supply for the District during the summer, and the No. 2 Well be used as the lead well during slack demand periods.

Section 6.0 - Improvement Alternatives

The evaluations performed concerning demand, the existing supply, storage and distribution systems and the results of the well testing led to the investigation of several improvement alternatives to be summarized in this section. The cost for each alternative is shown in Tables 6.1 and 6.2. The recommended alternatives are summarized in Section 7.0.
6.1 Crestview

6.1.1. Connection to the Antelope Valley Water Supply System - A vault was constructed in 1997 for the purpose of connecting the Crestview and Antelope Valley systems. Due to the decline in production and possible integrity problems associated with Crestview Well No. 1, a connection would ensure adequate supply and provide a redundant source if the well is ever out of service.

6.1.2. Rehabilitate Crestview Well No. 1 - As mentioned in Section 3.0, the production from Well No. 1 has declined, and a television survey performed on the well showed several leaks in the casing. Therefore, a rehabilitation procedure is recommended to attempt to plug the leaks and extend the life of the well.

6.1.3. Install Telemetry between the Tank and the Connection Vault - There are two basic methods for controlling the supply from the connection vault mentioned in 6.1.1. above. The on-off status of the valving in the vault can be controlled manually with a timer, allowing a pre-set rate of water to enter the system over a chosen time, or it could be controlled through telemetry that allows water to enter the system based on the level in the tank. A telemetry system would provide automatic operation, but because of its cost, it is not recommended at this time.

TABLE 6-1
Summary of Costs - Crestview Water System Improvements

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Initial Cost</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Connect to Antelope Valley Water System*</td>
<td>$22,400</td>
<td>$3,000</td>
</tr>
<tr>
<td>2. Rehabilitate Well No. 1*</td>
<td>$55,025</td>
<td>$1,200</td>
</tr>
<tr>
<td>3. Install a Telemetry System</td>
<td>$36,500</td>
<td>$2,300</td>
</tr>
</tbody>
</table>

* Recommended Improvement (See Section 7.0)

6.2 Antelope Valley

6.2.1. Sell Water to the Crestview System - The Antelope Valley No. 5 Well was drilled to provide additional supply for both Antelope Valley and Crestview. Because Antelope Valley is at a higher elevation, the well was sited in Antelope Valley to avoid the need for booster facilities to lift the water from Crestview to Antelope Valley. An agreement between the two Districts will define who pays for each improvement, but because the well is sited in Antelope Valley, they will likely pay for the well, and Crestview could then buy water from Antelope Valley.

6.2.2. Purchase Well No. 5 and Construct a Well House - The purchase of the newly constructed Antelope Valley Well No. 5 constitutes the majority of expenditures for Antelope Valley in the upcoming Level III construction project. The well will require a 60-75 horsepower pump, pitless adapter, building, an necessary valving and piping. It was assumed in this report that all costs associated with the well would be borne by Antelope Valley, and they would then sell water to Crestview.

6.2.3. Abandon Tank No. 1 - Tank No. 1 is approximately 24 feet shorter than Tanks 2 and 3 and is therefore no longer used due to stagnant water and icing problems.
Therefore, this tank should be abandoned and removed. Currently, the District is in ongoing negotiations with a nearby coalbed methane (CBM) producer to use produced water from methane wells as a potable supply and for aquifer storage and retrieval. If this occurs, the tank will be used for disinfection and aeration purposes.

6.2.4. **Install equipment for Use of CBM-produced water** - If the ongoing negotiations lead to the actual use of CBM-produced water, it is recommended that the District install disinfection and various other facilities to use this water. A very cursory preliminary design for these facilities was performed for this report, and a cost estimate was prepared. Further analysis will need to be performed prior to CBM water use.

6.2.5 **Install a Chlorine Feed System at the Tank Site** - Currently, the District is able to feed chlorine into the influent from the No. 2 and No. 3 Wells, but not into the No. 4 Well or a possible No. 6 Well mentioned previously. Therefore, the chlorination facilities should be moved to the tank site where the water from all of the wells can be disinfected.

6.2.6 **Plug and Abandon Well No. 1** - Antelope Valley Well No. 1 has serious integrity problems with its casing and has not been used for several years. Therefore, it should be properly abandoned in accordance with State Engineer’s Office guidelines.

6.2.7 **Construct Booster Facilities to service new 80-acre Parcel** - The District purchased 80 acres surrounding Well No. 4 when that well was converted for potable use. The District is currently trying to sell the land to a developer. Due to the elevation in the majority of this parcel, the current level of the tanks would not provide adequate pressure. Therefore, booster facilities will need to be constructed to service this area from Antelope Valley. The improvement is not recommended at this time because the District will probably require the developer to bear the cost of water service to this area.

### Table 6-2
Summary of Costs - Antelope Valley Water System Improvements

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Initial Cost</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Furnish Water to Crestview*</td>
<td>$0</td>
<td>($2,000)</td>
</tr>
<tr>
<td>2. Purchase and Complete Well No. 5*</td>
<td>$247,000</td>
<td>$18,200</td>
</tr>
<tr>
<td>3. Abandon Tank No. 1**</td>
<td>$20,500</td>
<td>$900</td>
</tr>
<tr>
<td>4. Install Equipment for Use of CBM-produced Water</td>
<td>$110,500</td>
<td>$7,100</td>
</tr>
<tr>
<td>5. Install Chlorine Feed System at the Tank Site*</td>
<td>$25,900</td>
<td>$2,100</td>
</tr>
<tr>
<td>6. Plug and Abandon Well No. 1*</td>
<td>$8,000</td>
<td>$400</td>
</tr>
<tr>
<td>7. Construct Booster Facilities for New 80-acre Parcel</td>
<td>$48,000</td>
<td>$4,700</td>
</tr>
</tbody>
</table>

* Recommended Improvement

** Tank No. 1 will not be abandoned if the use of CBM-produced water is found to be a feasible supply option for Antelope Valley.
Section 7.0 - Water Supply Plan

This section details the water system plan for the Crestview/Antelope Valley water systems and identifies the selected improvement alternatives to enable Crestview and Antelope Valley to continue to provide its citizens with an abundant supply of water in a cost effective manner. Economic analyses were performed on each of the proposed improvements to determine the cost per tap associated with constructing, operating, and maintaining the improvements. These costs are presented in three forms; Total Improvement Cost, Total Annual Cost per Improvement and Monthly Cost per Equivalent Dwelling Unit (EDU).

7.1 Operating Plan

7.1.1 General Operational Recommendations

This section includes operational recommendations that should be implemented to improve the overall system efficiency. In general the suggested changes relate to inspections and the development of records. Suggested operational recommendations are:

1. Calibration of existing flow meters in order to develop an accurate and reliable record of production;
2. Develop and maintain a formal record of all inspections, maintenance, and repairs made within the distribution systems;
3. Inspect the interior of the storage tanks every three years; and
4. Maintain the present staffing levels which appear to be adequate to effectively operate the water system.

7.1.2 Specific Operational Recommendations

7.1.2.1 Crestview Water System

The recommended improvements for Crestview at this time include a connection to the Antelope Valley water system to provide an alternate source and the rehabilitation of Crestview Well No. 1. Because the No. 1 Well will be out of service during rehabilitation, the connection to Antelope Valley should be made first.

Table 7-1 is an itemized listing of the recommended improvements for the Crestview water system. A more detailed cost breakdown for each item in this table can be found in Appendix G of the Final Report for this project.

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>EDU's</th>
<th>Total Project Cost</th>
<th>Total Annual Cost</th>
<th>Monthly Cost per EDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connect to Antelope Valley Water System</td>
<td>159</td>
<td>$22,400.00</td>
<td>$3,000.00</td>
<td>$1.57</td>
</tr>
<tr>
<td>2</td>
<td>Rehabilitate Crestview Well No. 1</td>
<td>159</td>
<td>$55,025.00</td>
<td>$1,200.00</td>
<td>$0.63</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>$22,400.00</td>
<td>$3,400.00</td>
<td>$2.20</td>
</tr>
</tbody>
</table>
7.1.2.2 Antelope Valley Water System

Previous operational practices have worked quite well for the District, and, other than the record keeping recommendations listed previously in Section 7.1.1, the District should continue operating as they have in the past.

Recommendations that are felt will improve the quality of the water and the efficiency of the system are:

1. Sell water to Crestview as a means of generating revenue and to help provide Crestview with a back-up water supply.
2. Well No. 5 should be completed with a pump and well house.
3. Tank No. 1 should be abandoned. However, in the event that ongoing negotiations lead to the use of coal bed methane produced water, Tank No. 1 should be retained and used for contact time once the CBM water has been chlorinated.
4. A chlorine feed system should be installed at the tank site to chlorinate water from Antelope Valley Well No. 4 and future wells from the south.
5. Existing Antelope Valley Well No. 1 should be plugged and abandoned to conform with Wyoming State Engineer’s Office Regulations.
6. The No. 2 Well should operate as the lead well in the low demand winter months with the No. 3 Well as primary backup. Using the No. 2 Well only during low demand periods should minimize pump problems and extend the well's useful life. The No. 5 Well should be operated as the lead well during the high demand summer months with the No. 3 Well operating as primary backup and the No. 4 Well being used as auxiliary backup only when needed due to its high fluorides.

Table 7-2 lists the recommended improvements for the Antelope Valley system. A more detailed cost breakdown for these items can be found in Appendix G of the Final Report for this project.

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>EDU's</th>
<th>Total Project Cost</th>
<th>Total Annual Cost</th>
<th>Monthly Cost per EDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Furnish Water to Crestview</td>
<td>327</td>
<td>$0.00</td>
<td>($2,000)</td>
<td>$(0.51)</td>
</tr>
<tr>
<td>2</td>
<td>Purchase and Complete Well No. 5</td>
<td>327</td>
<td>$247,000</td>
<td>$18,200</td>
<td>$ 4.38</td>
</tr>
<tr>
<td>3</td>
<td>Abandon Tank No. 1</td>
<td>327</td>
<td>$20,500</td>
<td>$900</td>
<td>$ 0.23</td>
</tr>
<tr>
<td>4</td>
<td>Install Chlorine Feed System at the Tank Site</td>
<td>327</td>
<td>$25,900</td>
<td>$2,100</td>
<td>$ 0.54</td>
</tr>
<tr>
<td>5</td>
<td>Plug and Abandon Well No. 1</td>
<td>327</td>
<td>$8,000</td>
<td>$300</td>
<td>$ 0.10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>$272,200</td>
<td>$18,500</td>
<td>$ 4.74</td>
</tr>
</tbody>
</table>
7.2 Permitting Requirements

The primary permitting requirement for the improvements identified in this water master plan is the Permit To Construct issued by Campbell County for any modifications to existing systems. The application process for this permit involves submitting the plans and specifications for the improvement, along with a brief descriptive report for the review and approval of the Campbell County Public Works Department.

Permits from the State Engineer's Office will also be required for the Antelope Valley wells if or when the connection to Crestview is made. Applications for enlargements will need to be filed for all wells to reflect the additional service area to include the Crestview system. In addition, a Statement of Completion and Description of Well form (Form U.W. 6) will need to be filed for Antelope Valley Well No. 5. If the applications for enlargements are approved, Proofs of Appropriation and Beneficial Use will then need to be filed along with all necessary plats.

The abandonment of Antelope Valley Well No. 1 will require approval from the State Engineer's Office as well. The SEO has specific requirements related to the abandonment of wells, and proof of compliance with these procedures needs to be submitted to the State Engineer.

In summary, permits and approvals required for the improvements proposed for the Crestview and Antelope Valley water systems are not extensive and are not expected to require major time commitments that could impact project schedules.