HOT SPRINGS RURAL – WORLAND REGIONAL WATER SUPPLY PROJECT

LEVEL II STUDY
EXECUTIVE SUMMARY

November 2004

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

The overall project area is located within a portion of the Big Horn River valley including portions of Hot Springs, Washakie, and Big Horn counties and the communities of Thermopolis, Worland, Manderson, Basin, and Greybull. The purpose of the project is to investigate a variety of components, which would expand and/or improve existing ground water supply; water rights; and transmission and storage capacity for domestic use. The project is sponsored by the Big Horn Regional Joint Powers Board.

The project goals include:

- The development of a regional water supply system which is protective of and compatible with the current domestic water supply and distribution systems and provides for a long term, secure ground water supply.

- Expansion of service area(s) where feasible to provide regional water supply to areas currently without domestic water supply.

- Development of a fair and equitable rate structure which provides for the repayment of capital improvement loans and the long term maintenance and operation of the system.

Specific areas of investigation in the study included:

- Determination of the feasibility of constructing a water supply transmission main from the existing Worland ground water well field, connecting to the South Big Horn system, Washakie Rural, and Worland.

- Determination of the feasibility of constructing a connection between the South Big Horn system and the Greybull system via a crossing of the Greybull River west of Greybull.

- Investigation of the feasibility of establishing a public water supply system in rural Hot Springs County in area

- Investigation into the siting and construction of a water supply well or wellfield in the southern portions of the Big Horn Basin.

- Evaluation of additional service areas within southern Big Horn County.

- Evaluation of the potential of developing a ground water supply source capable of replacing Thermopolis' current surface water supply/treatment system.
1.2 REGIONAL WATER SUPPLY CONCEPT

The Big Horn Regional Water Supply Project is a logical outgrowth of the various WWDC funded projects, which are underway. Specific projects include the South Big Horn Water Supply Project, the Washakie Rural Water Supply Project, and the Worland Pipeline Project.

The South Big Horn Water Supply Project has been constructed and now serves the southern portion of Big Horn County including the communities of Basin and Manderson, as well as the rural Big Horn County. The system presently includes a ground water wellfield located within the same geologic formation and structure as the Worland wellfield. However, well yields are substantially less than Worland's. The South Big Horn wellfield currently meets system demands, but does not allow for significant growth or expansion. With additional regional water supply the South Big Horn system will be utilized to expand water service to the north and can provide additional supply to Greybull.

The Washakie Rural system relies upon Worland’s wellfield and 20+ mile transmission supply pipeline for its service. The Washakie Rural system spans Washakie County from Big Horn to Hot Springs Counties and can be utilized to transport regional water supplies to Worland and the South Big Horn system.

1.3 REGIONAL SUPPLY / DEMAND

Currently available ground water supplies and regional system storage are summarized in Table I-1 below. Estimated regional water demands are summarized in Table I-2.

Current peak day demand of the combined Joint Powers entities is estimated to be approximately 12 MGD (including areas proposed to be served.) Of this total, approximately 3.1 MGD is related to the South Big Horn systems served by the Thermopolis water treatment plant. The North Big Horn system peak day demand is 8.9 MGD. The northern area is supplied wholly by groundwater sources. Assuming a nominal 1% growth rate, the regional peak day demand will increase to 16.2 MGD and 19.7 MGD for a 30-year and 50-year planning periods respectively.
TABLE I-1
Current Big Horn Regional Ground Water Supply & Storage

<table>
<thead>
<tr>
<th>Entity</th>
<th>Reported (gal/day)</th>
<th>Water Right (gal/day)</th>
<th>Est. Pipeline Capacity (gal/day)</th>
<th>Storage (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Northern Study Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basin / Manderson</td>
<td>1,152,000</td>
<td>604,800</td>
<td>604,800</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Greybull</td>
<td>1,706,000</td>
<td>2,160,000</td>
<td>1,728,000</td>
<td>1,600,000</td>
</tr>
<tr>
<td>Worland</td>
<td>27,360,000</td>
<td>11,995,200</td>
<td>6,200,000</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Washakie Rural</td>
<td></td>
<td></td>
<td>1,480,320</td>
<td>300,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>30,218,000</td>
<td>16,240,320</td>
<td>8,532,800</td>
<td>7,900,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Southern Study Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermopolis</td>
<td></td>
<td></td>
<td>Surface Water Supply</td>
<td>3,050,000</td>
</tr>
<tr>
<td>Lucerne</td>
<td></td>
<td></td>
<td>Wholesale from Thermopolis</td>
<td>200,000</td>
</tr>
<tr>
<td>Kirby</td>
<td></td>
<td></td>
<td>Wholesale from Thermopolis</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td>3,300,000</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>30,218,000</td>
<td>16,240,320</td>
<td>8,532,800</td>
<td>11,200,000</td>
</tr>
</tbody>
</table>

Existing ground water supplies are located exclusively in the northern portion of the project area. Ninety percent of the potential the wellhead capacity is represented by Worland’s existing wellfield. Useable water supply is largely limited by the delivery capacity and spatial distribution of the existing water supply transmission, storage, disinfection, and delivery systems. Current maximum transmission pipeline capacity in the northern system is estimated at 8.5 million gallons per day (from all ground water sources). This is marginally adequate to meet current peak day demand in the northern study area. Normal population growth will, in our opinion, require the development of additional water supply transmission and storage capacity. The regionalization of the area water system (and inclusion of areas not presently served) further underscores the need for additional supply, storage, and conveyance.

It should also be noted that the existing lengthy transmission pipeline(s) lack redundancy, thus leaving water users vulnerable to service interruption in the event of a water break. This is particularly true of the Worland transmission line which provides roughly 2/3 of the northern region’s water supply. This fact was punctuated by the catastrophic and costly break of the Worland pipeline on December 27, 1996, which left Worland without adequate water service for several days.
TABLE I-2
Estimated Current Regional Water Demands

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NORTH STUDY AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Worland</td>
<td>6,000</td>
<td>2,815</td>
<td>1,710,000</td>
<td>1,188</td>
<td>1,710,000</td>
<td>1,188</td>
<td>5,160,000</td>
<td>3,583</td>
</tr>
<tr>
<td>Washakie Rural&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>1,000</td>
<td>500</td>
<td>285,000</td>
<td>198</td>
<td>250,000</td>
<td>174</td>
<td>690,000</td>
<td>479</td>
</tr>
<tr>
<td>Basin</td>
<td>1240</td>
<td>814</td>
<td>353,400</td>
<td>245</td>
<td>205,000</td>
<td>143</td>
<td>615,000</td>
<td>427</td>
</tr>
<tr>
<td>South Big Horn/ Manderson</td>
<td>880</td>
<td>352</td>
<td>250,800</td>
<td>174</td>
<td>140,000</td>
<td>97</td>
<td>420,000</td>
<td>292</td>
</tr>
<tr>
<td>Town of Greybull</td>
<td>1815</td>
<td>1,202</td>
<td>517,275</td>
<td>360</td>
<td>835,200</td>
<td>580</td>
<td>1,700,000</td>
<td>1,180</td>
</tr>
<tr>
<td>Burlington / Otto</td>
<td>315</td>
<td>140</td>
<td>89,775</td>
<td>62</td>
<td>102,200</td>
<td>71</td>
<td>275,000</td>
<td>191</td>
</tr>
<tr>
<td>Basin Gardens</td>
<td>25</td>
<td>10</td>
<td>7,125</td>
<td>5</td>
<td>7,100</td>
<td>5</td>
<td>21,400</td>
<td>15</td>
</tr>
<tr>
<td><strong>North Area Subtotal</strong></td>
<td>11,275</td>
<td>5833</td>
<td>3,213,375</td>
<td>2,232</td>
<td>3,249,500</td>
<td>2,258</td>
<td>8,881,400</td>
<td>6,167</td>
</tr>
</tbody>
</table>

| **SOUTH STUDY AREA**          |                |                             |                                 |               |                       |                       |                        |               |
| Thermopolis                   | 3,172          | 1,880                       | 904,020                         | 628           | 1,100,000             | 764                   | 2,900,000              | 2,014         |
| East Thermopolis<sup>(2)</sup> | 270            | 123                         | 77,000                          | 54            | 25,600                | 18                    | 44,200                 | 31            |
| Red Lane<sup>(2)</sup>        | 120            | 48                          | 34,200                          | 24            | 10,600                | 8                     | 20,200                 | 14            |
| Lucerne<sup>(2)</sup>         | 300            | 117                         | 85,500                          | 60            | 26,000                | 18                    | 49,600                 | 35            |
| Kirby<sup>(2)</sup>           | 100            | 37                          | 28,500                          | 18            | 5,000                 | 4                     | 12,000                 | 9             |
| Rural Areas East of Big Horn  | 130            | 50                          | 37,100                          | 26            | 20,800                | 15                    | 52,000                 | 36            |
| River (including Black Willow)|                |                             |                                 |               |                       |                       |                        |               |
| - not presently served<sup>(3)</sup> | 130          | 50                          | 37,100                          | 26            | 20,800                | 15                    | 52,000                 | 36            |
| **South Area Subtotal**       | 4,092          | 2,255                       | 1,166,500                       | 810           | 1,188,000             | 827                   | 3,078,000              | 2,139         |

Notes:
1. Washakie Rural system is presently under construction with 52 reported current EDUs.
2. These southern entities currently purchase wholesale water from Thermopolis.
3. Per capita water use for rural area east of the river is realistically estimated at 160 gpcpd.
4. EDU's taken from data provided by Joint Powers Water Board – 8/12/04. Actual system demands based on metered or reported data.
2.0 NORTHERN REGIONAL WATER SUPPLY SYSTEM

At the time of this final report, the final design of the northern supply pipeline is already underway. Final design schematics and criteria are documented in the HKM Level III design report. The proposed northern pipeline is shown schematically in Figures I-2 and I-3. Project elements and estimated costs from that report total $38,593,940. These costs are inclusive of engineering, rights-of-way, legal fees, permitting, and construction and also include common portions of the Washakie Rural system improvements.

### TABLE I-3
NORTHERN SUPPLY PIPELINE COST ESTIMATE SUMMARY

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Description</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Worland wells to county line</td>
<td>$10,991,200</td>
</tr>
<tr>
<td>2</td>
<td>Big Horn River X-ing at county line</td>
<td>903,300</td>
</tr>
<tr>
<td>3</td>
<td>West River road from county line to Worland</td>
<td>2,550,315</td>
</tr>
<tr>
<td>4A</td>
<td>Washakie Rural distribution to South Flats</td>
<td>799,335</td>
</tr>
<tr>
<td>4B1</td>
<td>Highway 20 south of Boys School to Highway 432</td>
<td>1,935,010</td>
</tr>
<tr>
<td>4B2</td>
<td>Highway 20 south from Highway 432 to Winchester</td>
<td>2,902,730</td>
</tr>
<tr>
<td>5A</td>
<td>Washakie Rural north and east of Worland</td>
<td>1,081,630</td>
</tr>
<tr>
<td>5B</td>
<td>Common distribution and transmission from county line to Lane 4, east of Big Horn River</td>
<td>1,772,300</td>
</tr>
<tr>
<td>5C</td>
<td>Washakie Rural distribution between county line and Lane 5</td>
<td>554,335</td>
</tr>
<tr>
<td>6</td>
<td>Common distribution and transmission from Lane 4 to Lane 6, piping to and from regional tank (including tank)</td>
<td>4,184,100</td>
</tr>
<tr>
<td>7A</td>
<td>Common distribution and transmission and Washakie Rural distribution from Lane 10 to Highway 16</td>
<td>956,675</td>
</tr>
<tr>
<td>7B</td>
<td>Common distribution and transmission from Lane 6 to Lane 10</td>
<td>1,646,170</td>
</tr>
<tr>
<td>7C</td>
<td>Washakie Rural distribution between Lane 5 and Lane 8</td>
<td>911,620</td>
</tr>
<tr>
<td>8</td>
<td>Washakie Rural distribution in areas south of Worland</td>
<td>1,265,020</td>
</tr>
<tr>
<td>Interim 9</td>
<td>Upsize Basin gardens</td>
<td>427,219</td>
</tr>
<tr>
<td>9</td>
<td>Regional transmission to Greybull</td>
<td>6,140,200</td>
</tr>
<tr>
<td><strong>Total - Elements 1 thru Interim 9</strong></td>
<td></td>
<td><strong>$32,880,959</strong></td>
</tr>
<tr>
<td><strong>Total - Elements 1 thru 9</strong></td>
<td></td>
<td><strong>$38,593,940</strong></td>
</tr>
</tbody>
</table>
Figure I-2: Big Horn Regional Water Project – Proposed Northern Supply Pipeline, South of Manderson
Figure I-3: Big Horn Regional Water Project – Proposed Northern Supply Pipeline, North of Manderson
(Source: HKM Level III Design Report)
3.0 SOUTHERN BIG HORN WATER SUPPLY NEEDS

3.1 SOUTHERN SYSTEM PRESENT AND FUTURE DEMANDS

Existing and projected future water needs specific to each southern Big Horn community are summarized in Table I-4 below. For the purposes of pipeline sizing and water supply planning, per-capita water demands for Lucerne/Kirby and the rural areas east of the river have been “adjusted” upwards to 160 gpcpd. This figure is less than the Wyoming average of 285 gpcpd for rural communities, but is comparable to the actual water consumption of the rural South Big Horn Joint Powers Board service area to the north.

**TABLE I-4**
South Big Horn Service Area
Projected System Demands

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Thermopolis</th>
<th>East Thermopolis</th>
<th>Red Lane</th>
<th>Lucerne</th>
<th>Kirby</th>
<th>Rural Areas East of River</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est. Population</td>
<td>3,172</td>
<td>270</td>
<td>120</td>
<td>300</td>
<td>100</td>
<td>130</td>
<td>4,092</td>
</tr>
<tr>
<td>EDU’s</td>
<td>1,880</td>
<td>123</td>
<td>48</td>
<td>117</td>
<td>37</td>
<td>50</td>
<td>2,255</td>
</tr>
<tr>
<td><strong>Immediate / Current Demands</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Day (Gallons/day)</td>
<td>1,100,000</td>
<td>25,600</td>
<td>10,600</td>
<td>26,000</td>
<td>5,000</td>
<td>N/A</td>
<td>1,167,200 (811 gpm)</td>
</tr>
<tr>
<td>Peak Day (Gallons/day)</td>
<td>2,900,000</td>
<td>44,200</td>
<td>20,200</td>
<td>49,600</td>
<td>12,000</td>
<td>N/A</td>
<td>3,026,000 (2,101 gpm)</td>
</tr>
<tr>
<td><strong>“Adjusted” Current Demands</strong>&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Day (Gallons/day)</td>
<td>1,100,000</td>
<td>43,200</td>
<td>19,200</td>
<td>48,000</td>
<td>16,000</td>
<td>20,800</td>
<td>1,247,200 (866 gpm)</td>
</tr>
<tr>
<td>Peak Day (Gallons/day)</td>
<td>2,900,000</td>
<td>86,400</td>
<td>38,400</td>
<td>96,000</td>
<td>32,000</td>
<td>41,600</td>
<td>3,194,400 (2,218 gpm)</td>
</tr>
<tr>
<td><strong>30-year Future Demands</strong>&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Day (Gallons/day)</td>
<td>1,482,600</td>
<td>58,300</td>
<td>25,900</td>
<td>116,600</td>
<td>38,900</td>
<td>50,500</td>
<td>1,772,800 (1,231 gpm)</td>
</tr>
<tr>
<td>Peak Day (Gallons/day)</td>
<td>3,908,800</td>
<td>116,600</td>
<td>51,800</td>
<td>233,200</td>
<td>77,800</td>
<td>101,000</td>
<td>4,489,200 (3,118 gpm)</td>
</tr>
<tr>
<td><strong>50-year Future Demands</strong>&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Day (Gallons/day)</td>
<td>1,809,100</td>
<td>70,800</td>
<td>31,500</td>
<td>210,200</td>
<td>70,100</td>
<td>91,100</td>
<td>2,282,800 (1,585 gpm)</td>
</tr>
<tr>
<td>Peak Day (Gallons/day)</td>
<td>4,769,800</td>
<td>141,700</td>
<td>63,000</td>
<td>420,500</td>
<td>140,200</td>
<td>182,200</td>
<td>5,717,400 (3,970 gpm)</td>
</tr>
</tbody>
</table>
Population projections are based on a 1% annual growth rate in the town of Thermopolis, consistent with historical regional growth patterns. A 3% annual growth rate was assumed for Kirby, Lucerne, and the rural area east of the river due to the increased potential for developmental growth.

3.2 **EXISTING WATER SUPPLY (Thermopolis Water Treatment Plant)**

The Town of Thermopolis operates the southern area’s only municipal water supply system. Treated drinking water is delivered to Thermopolis residents and sold wholesale to other entities in the southern Big Horn study area.

Although the plant is relatively old, it is very well maintained. We are not aware of any serious or on-going water quality issues associated with the plant. The treatment plant capacity is reportedly as high as 4.3 MGD. Available meter records (1995) indicate an historical maximum daily output closer to 3.5 MGD. The more restrictive regulatory requirements mandated by EPA almost certainly has and will impact plant capacity.

3.2.1 **Thermopolis Treatment Plant Operational Cost**

Annual operating costs for the Thermopolis treatment plant are broken out in the town’s 2003/2004 budget worksheet. These budgeted costs total $354,300 annually.

Based on an estimated 2205 existing EDU’s served, the budgeted operational cost of the Thermopolis treatment plant is approximately $13.39/EDU/month. Based on historical average day demands of 1.167 MGD, this equates to an operating cost of $0.83 per 1000 gallons of treated water. These numbers are helpful when considering the economic feasibility and desirability of developing alternate water resources in the southern Big Horn study area.

3.2.2 **Thermopolis Treatment Plant Replacement Cost**

The existing treatment plant capacity is adequate to meet peak day demands for the existing service area now and in the short-term future. As growth occurs, the regulatory environment becomes more restrictive, and the plant continues to age, it is likely that the treatment plant will need to be upgraded, enlarged, or replaced. The (2005) replacement cost for a new 5 MGD water treatment plant is estimated to be approximately $8 million. Based on a typical funding scenario of 50% grant and 50% loan (4.5% interest over 30 years), the annual loan payment would be $245,566. Assuming a remaining plant life of 20 years, with interest being 2% greater than inflation, the present worth cost of replacing the treatment plant in the future is calculated to be $5.38 million. Assuming that a new treatment plant could be 50% grant funded with the remaining 50% being borrowed at 4.5% over 30 years, this would result in an annual loan payment of $165,143 or $6.24 per EDU per month.
4.0 SOUTHERN BIG HORN
GROUND WATER AVAILABILITY

Within the Big Horn Basin, the need for high yield and high quality municipal water supplies has been growing for several years due to the EPA's increasingly stringent drinking water standards and more costly water treatment requirements.

One purpose of this Wyoming Water Development Commission (WWDC) project was to investigate the ground water development potential for a municipal supply well or well field for the Big Horn Regional Joint Powers Board (JPB) in the southern Big Horn Basin. Single test wells were drilled at two of the preferred locations.

4.1 HYDROGEOLOGIC RECONNAISSANCE

During the course of this project, more than 10 potential well sites that could yield abundant (>500 gpm), good quality water (< 500 mg/L TDS) were identified within the southern Big Horn Basin. These sites were selected and ranked on the basis of geologic structure, potential permeability, drilling depths, geothermal gradient, distance from known geothermal activity, accessibility, and potential ground water quality. These sites are shown on Figure I-4 and listed in Table I-5.

An extensive review of ground water data within the southern Big Horn Basin revealed that the most likely aquifer to yield abundant, good quality water is the Madison Aquifer, which consists of saturated parts of the Darwin Sandstone, the Madison Limestone, and Bighorn Dolomite.

<table>
<thead>
<tr>
<th>Map Designation</th>
<th>Geologic Structure or Prospect Name</th>
<th>Site Location</th>
<th>Elevation</th>
<th>Target Aquifer(s)</th>
<th>Depth to Madison Aquifer (ft)</th>
<th>Depth to Flathead Aquifer (ft)</th>
<th>Distance to Thermopolis (mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yankee Dome</td>
<td>T42N, R96W, 12</td>
<td>5,220</td>
<td>Tensleep Sandstone, Madison Limestone</td>
<td>1,863</td>
<td>3,613</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>Buffalo Creek Monocline</td>
<td>T42N, R94W, 21</td>
<td>4,575</td>
<td>Madison Limestone, Flathead Sandstone</td>
<td>850</td>
<td>2,600</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>Wildhorse Butte Anticline</td>
<td>T42N, R92W, 18</td>
<td>5,375</td>
<td>Tensleep Sandstone, Madison Limestone</td>
<td>1,100</td>
<td>2,850</td>
<td>13</td>
</tr>
<tr>
<td>D</td>
<td>Lake Creek Anticline</td>
<td>T42N, R91W, 2</td>
<td>5,110</td>
<td>Madison Limestone</td>
<td>3,800</td>
<td>5,550</td>
<td>24</td>
</tr>
<tr>
<td>E</td>
<td>Lysite Mountain Anticline</td>
<td>T42N, R90W, 8</td>
<td>5,450</td>
<td>Madison Limestone</td>
<td>3,900</td>
<td>5,650</td>
<td>26</td>
</tr>
<tr>
<td>F</td>
<td>Black Mountain</td>
<td>T42N,</td>
<td>5,060</td>
<td>Madison Limestone</td>
<td>4,260</td>
<td>6,010</td>
<td>26</td>
</tr>
</tbody>
</table>
Of the sites listed in Table I-5, four were selected for further field investigation and two of these four sites were drilled to evaluate their hydrogeologic and water yielding properties. Wildhorse Butte Anticline, Buffalo Creek Monocline, Lysite Mountain Anticline, and Big Spring Anticline were considered the most appealing sites from the standpoint of geologic structure, drilling depths, potential aquifer yields, water quality, and accessibility. Single test wells were drilled at both the Wildhorse Butte Anticline and Buffalo Creek Monocline structures.

### 4.2 BUFFALO CREEK WELL #2 EXPLORATORY WELL

To test the hydrogeologic characteristics and water yielding potential, a well was drilled and completed in Buffalo Creek Monocline.

Barnhart Drilling drilled a 16 inch diameter borehole for the production casing to a total depth of 866 feet. After setting 866 feet of 10 3/4 inch-diameter casing with centralizers in this borehole, the casing was cemented in place with approximately 750 sacks of Class G cement. Barnhart then drilled an 8 3/4 inch diameter borehole to a depth of 1,068 feet.

The drilling and completion of Buffalo Creek No. 2 was hindered due to lost drilling fluid circulation conditions and problems associated with the installation of the production casing.

#### 4.2.1 Hydrogeologic Evaluation of Buffalo Creek No. 2

Stepped and constant-rate aquifer tests of Buffalo Creek No. 2 were conducted between April 16 and 25, 2004, to estimate the maximum sustainable yield of the well, to evaluate the hydraulic properties of the aquifer, to assess any boundary conditions near the well, and to determine the quality of ground water discharged from the well.
To monitor any impact of the test pumping on nearby wells and springs were also monitored to ascertain any in accordance with the access agreement with the landowner, Dennis Jones, LA regularly collected water level and spring discharge data from a variety of water sources on his property. These monitoring points included Ellen Baird’s domestic well and Sulphur Spring. While these two sources were considered the most vulnerable to well interference, several other wells and springs were also monitored.

Comparison of the data collected during the stepped-rate tests revealed the well continued to develop, and indicated the well will likely sustain a higher discharge of water than the test pump could produce. The relative differences in the drawdown for similar discharge rates between the tests highlights the ongoing development of the well, as shown on Figure I-6. The most likely reason the overall well efficiency improved is due to ongoing removal of lost circulation materials from either the well, the pump, or both. Regardless of the reason, the test revealed the well will yield in excess of 750 gpm with a drawdown of approximately 23 feet after 100 minutes. The pump that was placed in the well was insufficient to fully stress the aquifer under short term testing conditions, and left approximately 646 feet of water over the pump during the test at the highest discharge rate. LA estimates the sustainable yield from this well may be as much as 1,000 gpm based on the data available, but additional testing would be required to verify that figure.

To assess the sustainability of prolonged pumpage from Buffalo Creek No. 2, LA conducted several constant-rate tests of the well. Based on an analysis of stepped-rate test data and given the limitations of the pumping equipment, a target discharge rate of 600 gpm was selected for the test. Summaries of the constant-rate tests are graphically summarized on Figures I-7 and I-8.

Additional aquifer testing of the Buffalo Creek No. 2 well is recommended to assess the yield characteristics of the well and to further evaluate potential impacts on regional water sources, in particular Hot Springs State Park. Aquifer testing to date has not sufficiently stressed this aquifer to determine its sustainable yield point, nor has it determined the maximum well yield. LA has estimated based on this testing that the sustainable yield of this well may be 1,000 gpm, but given the uncertainty with respect to the overall development of this well, additional testing must be performed to verify the accuracy of that estimate.
4.2.2 Water Quality of Buffalo Creek No. 2

Water Quality for Buffalo Creek No. 2 Well is summarized in Table I-6 below.

**TABLE I-6**
**Buffalo Creek No. 2**
**Water Quality Summary and Comparison, April 2004**

<table>
<thead>
<tr>
<th>Analyte</th>
<th>EPA Water Quality Stds.</th>
<th>Buffalo Creek No. 2 T42N, R94W Sec. 21</th>
<th>Hot Springs No. 1 T42N, R92W Sec. 18, SWSW</th>
<th>Husky No. 1 T49N, R91W Sec. 12, NWSE</th>
<th>Shell No. 3 T53N, R90W Sec. 19, NENE</th>
<th>Ten Sleep No. 2 T47N, R88W Sec. 17, NESE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Madison Limestone</td>
<td>Madison Limestone &amp; Bighorn Dolomite</td>
<td>Madison Limestone</td>
<td>Madison Limestone &amp; Bighorn Dolomite</td>
<td>Madison Limestone</td>
</tr>
<tr>
<td>Water Source</td>
<td>--</td>
<td>Calcium 89</td>
<td>70.5</td>
<td>38.1</td>
<td>50</td>
<td>49.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magnesium 37</td>
<td>33</td>
<td>21.7</td>
<td>29</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sodium 16</td>
<td>12.6</td>
<td>2.7</td>
<td>3</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potassium 4.6</td>
<td>3.4</td>
<td>&lt;1.0</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chloride 250</td>
<td>9.4</td>
<td>8.2</td>
<td>5</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fluoride 4</td>
<td>1.1</td>
<td>0.6</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nitrate 10</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sulfate 250</td>
<td>136</td>
<td>144</td>
<td>12.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bicarbonate 291</td>
<td>245</td>
<td>209</td>
<td>241</td>
<td>244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iron 0.3</td>
<td>0.32(T); &lt;0.03(D)</td>
<td>4.46(T)</td>
<td>&lt;0.03</td>
<td>0.03(T)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lead 0.015</td>
<td>0.014(T); &lt;0.001(D)</td>
<td>0.006(T)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sulfide &lt;1.0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hardness 376</td>
<td>311</td>
<td>184</td>
<td>244</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH 6.5-8.5</td>
<td>7.3</td>
<td>8.3</td>
<td>8.0</td>
<td>8.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TDS 500</td>
<td>449</td>
<td>441</td>
<td>189</td>
<td>242</td>
</tr>
</tbody>
</table>

Notes: Results listed in mg/l unless noted otherwise.

-- Indicates not applicable or no analytical data available.

<Symbol indicates analyte concentration was below laboratory method detection limit shown.

1 Iron and lead data are presented for both total (T) and dissolved (D) components. Presence of iron and lead is most likely due to particular materials from the submersible pump and/or well casing.

2 Water sample was collected near the end of drilling. Sample likely tainted by foam based drilling fluids. High iron content may not accurately reflect dissolved iron concentration.

Review of the data indicates ground water from Buffalo Creek No. 2 generally meets EPA Primary Drinking Water Standards for the analyzed compounds. However, these data also revealed that the iron and lead concentrations were at or approaching EPA standards. It is speculated that the source of these elements is particulate material derived from either the submersible pump and/or well casing.
5.0 SOUTHERN BIG HORN BASIN WATER SUPPLY ALTERNATIVES

The Southern Big Horn service area is currently supplied wholly by the Town of Thermopolis treatment plant. That plant is able to meet current peak day demands of approximately 3.2 MGD. The following are provided for discussion of water supply alternatives.

5.1 DO-NOTHING

“Do-nothing” is a viable option for the short-term future assuming the implementation of planned improvements by Thermopolis to their raw water well field. The current treatment plant will not, however, be able to meet peak demands throughout the planning period of this study as growth occurs and water quality rules become more restrictive. Of course, this option would not benefit rural residents not currently served by a municipal water system. It is also assumed that the treatment plant will need to under-go complete renovation or replacement at some point during that time frame. The desirability of this option is, in our opinion, largely an issue of economic cost vs. benefits received as discussed hereafter.

5.2 BUFFALO CREEK No. 2 WELL AS SUPPLEMENTAL SOURCE

Under this alternative, Thermopolis with JPB approval could purchase the Buffalo Creek No. 2 well and deliver water produced from this well to its east tank for distribution to the system without the addition of any other wells in the area. The anticipated 1000 gpm +/- capacity of this well is more than adequate to meet the projected long-term (50-year) domestic water needs of East Thermopolis, Kirby, Lucerne, and other rural areas north of Thermopolis. This single well is not, however, to meet the future or current peak day needs of the Town of Thermopolis. Development of this resource could, however, provide Thermopolis with a valuable emergency and/or secondary supply. It should be noted that this well water is relatively hard (hardness = 346), thus requiring blending or softening at the wellhead or by endpoint users.

Required infrastructure for this concept, assuming Thermopolis retains its role as the primary area-wide water wholesaler, is shown in Figure I-5.

Alternatively, this option could involve the development and completion of the Buffalo Creek No. 2 well to be used as a primary water supply source to feed East Thermopolis, Lucerne, Kirby, other rural residents to the north, as well as a potential backup to the Town of Thermopolis. This concept is shown schematically in Figure I-6.
HOT SPRINGS RURAL–WORLAND PIPELINE
REGIONAL WATER SUPPLY PROJECT

RECOMMENDED SYSTEM W/
BUFFALO CREEK WELL #2 ONLY

LEGEND
- 14" (LINE FROM BUFFALO WELL#2 TO TREATMENT PLANT)
- EXISTING LINE
- EXISTING TANK(S)
- WELL EXISTING/FUTURE
- PROPOSED 250,000 GAL.TANK

FIGURE 1-5
RECOMMENDED SYSTEM W/ BUFFALO CREEK WELL #2 SERVING NORTH RURAL AREAS

LEGEND
- 14" (LINE FROM BUFFALO WELL#2 TO T.P.)
- 14" (TREATMENT PLANT TO STATE PARK TANK)
- 12" (RURAL AREA EAST OF RIVER TO LUCERNE)
- EXISTING LINE
- EXISTING TANK(S)
- WELL EXISTING/FUTURE
- PROPOSED 250,000 GAL. TANK
- EXISTING HOUSES EAST OF RIVER

Other information:
- HOT SPRINGS STATE PARK
- STATE PARK TANK ELEV. 64462, 200,000 GAL.
- THERMOPOLIS
- EAST THERMOPOLIS
- WATER TREATMENT FACILITY
- BUFFALO CREEK WELL #2
- LOCATION ELEV. 4584
- PROPOSED 250,000 GAL. STORAGE TANK

FIGURE I-6

Page 1 - 18
5.3 DEVELOPMENT OF SOUTHERN BIG HORN WELL FIELD

This option is based on the assumption that additional groundwater supplies totaling between 3,000 gpm and 4000 gpm can be successfully developed. For the purposes of economic understanding, it is assumed that two additional high-yield (1000 gpm+) wells would be developed in the Buffalo Creek anticline and at Wildhorse as shown in Figure 1-7. Under this scenario, the Town of Thermopolis could replace their surface water treatment plant with groundwater provided by the JPWB system.

5.4 OTHER SYSTEM NEEDS

5.4.1 Rural Distribution System (East of River)

Service to the 50 rural residents east of the Big Horn River will require the construction of approximately 5 miles of distribution piping and services. Based on discussions with Lucerne board members, it is believed that the Lucerne District would be willing to support their neighbors east of the river though annexation or other cooperative agreement provided that their current rate payers are not adversely impacted. It is presumed, therefore, that these rural users would be required to bear the unfunded cost of constructing their own distribution system. The estimated cost for this work is $1,067,000.

5.4.2 Operation and Disinfection of North Rural Area Transmission Lines and Lucerne Storage Tank:

Water delivered from Thermopolis typically maintains a residual chlorine content of about 0.1 mg/l at the first point of use located approximately 3 ½ miles north of Thermopolis (or 1 mile South of the Stark Subdivision). The Lucerne Water District presently has no disinfection or treatment facilities. The system operator reports that the residual chlorine is virtually undetectable by the time it reaches the north end of the system. Inadequate residual chlorine levels, in our opinion, represent a significant threat to public health and safety.

In considering an extension of the north rural water system, it is felt that the issues associated with disinfection and tank stagnation must be reliably addressed. Recommendations for solving this problem include:

- **Actuated Valve Stations**: It is recommended that automated valves be installed in the existing 6-inch and proposed 12-inch transmission pipelines south of the primary area(s) of use.

- **Disinfection Facility**: A hypochlorite system is recommended based on the simplistic operation, low system demands, and relatively low capital costs involved.
6.0 PROJECT ALTERNATIVES COSTS
AND RATE PAYER IMPACTS

6.1 PROJECT FINANCING ASSUMPTIONS

Given the Joint Powers Board’s experience with the north pipeline, it is anticipated that the South Big Horn system would be eligible for funding assistance through both the WWDC and USDA Rural Development. Of course, funding assistance is subject to an application process, eligibility, and approval of those agencies.

6.1.1 WWDC Funding

An assumption of 67% grant assistance from WWDC is used in this financial analysis based on discussions with WWDC staff and the experience of the north Big Horn system. It should be noted that the well purchase costs reflected in the cost estimates reflect 50% of the actual cost of the drillers contract exclusive of aquifer testing, data logging and engineering. The well purchase(s) are not eligible for additional grant funding from WWDC.

6.1.2 USDA Rural Development

The USDA rural development program favors rural low-to-moderate income communities. Anticipated project grant funding is assumed to be 30% of the eligible project costs not granted by WWDC. The remaining project costs would be borrowed in the form of a bond through the Rural Development program. A 4.5% interest rate over 30 years has been assumed for the purposes of this study.

6.1.3 Wyoming State Loan and Investment (SLIB)

It is proposed that non-WWDC eligible expenses, such as the rural distribution system, be funded though the SLIB program. Typically, they would grant 50% of the project cost. It is assumed that the remaining 50% could be funded through the Rural Development program using the same grant loan mix discussed in paragraph 6.1.2 above.

6.2 PROJECT COSTS AND RATE PAYER IMPACTS

Total costs and rate payer impacts for each of the scenarios presented in Section 5 are summarized in Table I-7 on the following page. Project loan payments are broken down by monthly cost per EDU for the purposes of economic comparison. This is consistent with Joint Powers Board practice. A cost per 1000 gallons (based on current average day demand) is also presented in Table I-7. It is anticipated that actual user rates will be balanced between EDU base charges plus a cost per 1000 gallons. This billing approach better insures fairness and encourages water conservation. Currently, the BHJPWB charges 45 cents per 1000 gallons in addition to the base EDU charge in the north service area.
### TABLE I-7
Projected Rate Payer Impacts
South Big Horn Regional Water Supply

<table>
<thead>
<tr>
<th>OPTION</th>
<th>EDU’S in Benefiting Service Area</th>
<th>Estimated Project Costs</th>
<th>Estimated Project Loan Amount</th>
<th>Annual Loan Payment (30-year, 4.5%)</th>
<th>Depreciation / Sinking Fund (10% of Loan Payment)</th>
<th>Loan Payment Monthly Cost per EDU</th>
<th>O&amp;M Cost per EDU</th>
<th>TOTAL Monthly Cost per EDU</th>
<th>Equivalent Cost per 1,000 Gallons</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 – Complete Buffalo Creek Well as Secondary Supply for Thermopolis System.</td>
<td>2,205</td>
<td>$4,002,050</td>
<td>$1,011,684</td>
<td>$62,109</td>
<td>$6,211</td>
<td>$2.58</td>
<td>$1.70 (includes JPWB admin, water sampling, &amp; well pump maint.)</td>
<td>$4</td>
<td>4.28</td>
<td>Loan amount based on 67% WWDC grant funding of total (exclusive of well purchase) – 30% USDA grant funding of remainder. EDU’s reflect current service area.</td>
</tr>
<tr>
<td>Option #2 – Complete Buffalo Creek Well as Primary Supply for North Rural Service Areas</td>
<td>327</td>
<td>$9,487,350</td>
<td>$2,278,788</td>
<td>$139,898</td>
<td>$13,990</td>
<td>$39.22</td>
<td>$4.87 (includes JPWB admin, water sampling, &amp; well pump maint. and pumping costs based on ave. day use.)</td>
<td>$44.09</td>
<td>$3.70 per 1000 gallons</td>
<td>Loan amount based on 67% WWDC grant funding of total (exclusive of well purchase) – 30% USDA grant funding of remainder. EDU’s reflect East Thermopolis, Lucerne, Kirby, &amp; Rural area East of River.</td>
</tr>
<tr>
<td>Option #3 – Develop Additional Ground Water Supplies as needed for Primary Supply to South Big Horn Basin.</td>
<td>2255</td>
<td>$15,776,950</td>
<td>$3,972,518</td>
<td>$243,879</td>
<td>$24,388</td>
<td>$9.91</td>
<td>$3.72 (includes JPWB admin, water sampling, &amp; well pump main. and pumping costs based on ave. day use.)</td>
<td>$13.63</td>
<td>$0.81 per 1000 gallons</td>
<td>Loan amount based on 67% WWDC grant funding of total (exclusive of well purchases) – 30% USDA grant funding of remainder.</td>
</tr>
<tr>
<td>North-South Regional Connection Between Lucerne and Winchester (including pump station)</td>
<td>8088</td>
<td>$2,198,500</td>
<td>$507,854</td>
<td>$31,178</td>
<td>$3,118</td>
<td>$0.35</td>
<td>$0.02 (JPWB admin, water sampling, &amp; well pump maint. and pumping costs based on ave. day use.)</td>
<td>$0.37</td>
<td>N/A</td>
<td>Loan amount based on 67% WWDC grant funding of total – 30% USDA grant funding of remainder. EDU’s reflect entire north and south Big Horn service areas.</td>
</tr>
<tr>
<td>Distribution System for Rural Users East of River</td>
<td>50</td>
<td>$974,200</td>
<td>$340,970</td>
<td>$20,933</td>
<td>$2,093</td>
<td>$38.38</td>
<td>N/A</td>
<td>$38.38 (in addition to JPWB costs)</td>
<td>$3.03 per 1000 gallons (in addition to JPWB costs)</td>
<td>Loan amount based on 50% SLOB grant funding of total – 30% USDA grant funding of remainder.</td>
</tr>
</tbody>
</table>

**Notes:**
1. O&M Costs reflect JPWB staffing and operation. Operational costs associated with individual entities for distribution, system maintenance, billing, etc. are not reflected herein.
2. Total cost per 1000 gallons is based on current average day demands.

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7.0 CONCLUSIONS AND RECOMMENDATIONS

The successful drilling of the Buffalo Creek Well has presented the water users in the South Big Horn study area with several options (and questions) for using groundwater to supplement or replace their current treated surface water supply. Clearly, there are still too many unknowns to determine the preferred approach to regional water supplies in the South Big Horn area. The biggest uncertainty, of course, is the feasibility of finding and developing additional groundwater sources in the southern basin. There are, however, several excellent possibilities for exploration. With this in mind, we offer the following recommendations and conclusions:

7.1 CONCLUSIONS

a) The Buffalo Creek Well No. 2 is a valuable water supply resource. It is economically viable to connect this well to the area water supply with or without additional groundwater supplies.

b) The Buffalo Creek well water meets EPA safe drinking water standards but is relatively hard. Prior to using this water, it must be decided whether a water softening system is used at the source, or the water is delivered to the consumer "as-is".

c) The Thermopolis treatment plant is able to meet current peak system demands. However, it is felt that each of the entities in the basin believe it is important to find and develop additional affordable domestic water supply source(s) for the long-term future.

7.2 RECOMMENDATIONS (Where do we go from here?)

Project sponsor(s) must first determine their interest for exploring and developing additional groundwater sources. With that in mind, two alternatives are recommended herein for consideration by the BHJPWB as discussed below.

7.2.1 Alternative Recommendation #1 – Reinitiate the WWDC Level II Study Process

This alternative would involve one or more of the following tasks to be incorporated into a new Level II study.

a) **Further development and testing of Buffalo Creek Well No. 2:** This effort would include further development and testing of the Buffalo Creek Well No.2. The cost of that additional work is estimated to be $307,862.
b) **Additional Ground Water Exploration:** This alternative would also involve drilling and testing other groundwater targets including one or more of the following identified sites:

- **Second well in Buffalo Creek Anticline**  
  (Madison target - $713,000)  
  (Flathead target - $1,072,000)

- **Wildhorse Butte Anticline**  
  (Madison target - $701,000)  
  (Flathead target - $901,000)

- **Lysite Mountain Anticline**  
  (Madison target - $1,226,000)

Of course, the location of the Lysite Mountain well makes it less attractive than the other two targets due to the high cost of transmission pipeline and other infrastructure that would be needed to utilize that well.

c) **Secondary Irrigation Opportunities:** It is recommended that this level II study, if pursued by the BHJPWB, include the investigation and a feasibility analysis of secondary irrigation opportunities within the Thermopolis service area. The ability to decrease irrigation demands on the culinary water system has the same net effect as developing new domestic supply sources. The ability to decrease summer peak day demands on the system, therefore, could become an important feasibility issue.

7.2.2 **Alternative Recommendation #2 – Advance Project to Level III Construction – Complete Buffalo Creek Well No. 2.**

Under this scenario, the Buffalo Creek No. 2 Well would be completed, tested and developed as part of the level III construction process. This project could also include the design and construction of the transmission pipelines (and storage tank) to tie this well into Thermopolis water system as previously shown in Figure I-5.

7.2.3 **Service to Rural Areas east of the Big Horn River**

There is currently no legal entity to fund a project or serve water to rural residents located east of the Big Horn River. It is recommended that residents of that area should form a district, petition to be annexed into the Lucerne District, or enter into individual user agreements with the Lucerne District to allow their portion of the project to move forward along with any regional project.
7.2.4 **Regional Supply Availability between North and South Basin Areas**

The ability to share water between entities and service areas is considered a fundamental principal behind the formation and goals of the BHJPWB. The need for this type of system redundancy was clearly evident when the City of Worland suffered their transmission line breakage.

It is recommended that the north and south systems be connected with an 8-inch minimum pipeline extending from the Lucerne tank to the proposed Winchester tank(s) as schematically shown in Figure I-7. The cost of that line could, in our opinion, reasonably be shared among basin-wide water users based on the benefits received. The timing and construction of that transmission line, of course, presumes the construction of the I-7.