Summary

Of Reports Prepared For The

Tri-State Water Resource Coalition

October 2009
PREFACE

Background:

The Missouri-American Water Company, which provides water to the City of Joplin and several neighboring cities, retained a consultant in 2002 to investigate the adequacy of the groundwater to meet the future needs of the Joplin metropolitan area. The consultant determined that more water was being withdrawn from the groundwater (wells) than was being replenished. The study concluded that the area might face a water shortage in 10 to 15 years during a drought period. Missouri-American Water Company held a public meeting to present the findings of the study. Many water suppliers attended the meeting and recognized that they too could face a water shortage in the days ahead. As a result of the widespread concern, the Tri-State Water Resource Coalition was formed. It is a not-for-profit, 501 c (3) corporation. The membership includes cities, water districts, businesses and individuals. The area served by the Coalition extends from Pittsburg, Kansas, and Miami, Oklahoma, on the west to Springfield, Missouri, on the east, Lamar on the north and the Arkansas state line on the south.

The Coalition entered into a contract with the Little Rock District, Corps of Engineers, to investigate potential new water sources for the area. The Corps’ study identified six potential sources:

1. Grand Lake
2. Table Rock Lake
3. Stockton Lake
4. Truman Lake
5. A combination of Grand Lake, Table Rock Lake and Stockton Lake
6. Construct one or more new reservoirs

The Coalition has met with officials of the State of Oklahoma to explore the possibility of acquiring water from Grand Lake. Apparently there is sufficient water in Grand Lake to meet the Coalition’s needs, but Oklahoma has a moratorium prohibiting transferring water out of state. Therefore, Grand Lake water is not available to the majority of the Coalition members.

Truman Lake was not found to be economically feasible. Stockton Lake does not have any non-committed discretionary water available. It will require congressional reallocation in order to provide water to the Coalition from Stockton Lake. While Table Rock Lake has discretionary water available, there is not enough to meet the total needs determined by the Coalition. While this source would not require congressional reallocation for the discretionary water available, it would require congressional reallocation in order to provide the total water needed by the coalition.

The Coalition has submitted a request to the Little Rock District, Corps of Engineers, for water from Table Rock Lake. In addition, the Coalition has submitted a request to the Kansas City District, Corps of Engineers, for water in Stockton Lake. Both Districts have said it would be 5 to 7 years before they can respond. This long response delay places the Coalition in a very difficult situation. If the response is positive, it gives the Coalition very little time to finance, design and construct the necessary facilities. If the response is that no water can be made available, then the Coalition must begin all over.
again and it will be impossible to develop additional supplies in time to meet the critical needs.

The Coalition concluded that it had no option other than to explore construction of one or more reservoirs. A consultant has been retained to make a site study to determine if suitable sites are available. The study is being financed by a $100,000 grant from the Missouri Department of Natural Resources and $100,000 of Coalition funds.

**Conclusion:**

The Coalition firmly believes there is more than adequate water available in each of Grand Lake, Stockton Lake and Table Rock Lake to meet the Coalition’s requirements. The Coalition strongly believes it would be in the best interests of the area to use these three reservoirs rather than build new reservoirs. It will be difficult and require considerable time and money to develop reservoirs. The Coalition would much prefer to use Grand Lake and the two Corps reservoirs, but since their availability will not be known for many years, the Coalition had no choice other than to investigate the development of one or more new reservoirs.

It will be difficult to justify the construction of one or more reservoirs since the water that will be caught is already being caught by existing reservoirs near by. Therefore, the Coalition believes it is essential to seek storage in Table Rock Lake and Stockton Lake. The Coalition will make every effort to secure supplies in existing reservoirs before moving forward on construction of reservoirs.

The Executive Summaries of the following reports are attached.

- Final Report – Source of Supply Investigation for Joplin, Missouri
- Water Supply Study
- Water Supply Screening Study
Final Report
Source of Supply Investigation
for Joplin, Missouri

Jack Wittman, Ph.D. CGWP  Vic Kelson, Ph.D. CGWP
Theresa Wilson

11th February 2003
Executive summary

Missouri–American Water Company (Missouri American) has hired Wittman Hydro Planning Associates of Bloomington, IN (WHPA) to conduct a regional groundwater study of Jasper and Newton counties in southwestern Missouri. The purpose of the study is to investigate a number of issues related to water supply, in particular the ability of the Ozark aquifer to sustain long-term population growth in the Joplin area and the potential for water-quality risks in the Ozark aquifer due to the contamination of the overlying Springfield Plateau aquifer.

Issues

As the population of southwestern Missouri has grown, the demand for water has increased. Between 1990 and 2000 the population of Jasper and Newton counties grew from 135,082 to 157,322 (16 percent increase) while personal income in the region increased from $1,969,000 to $3,272,500 between 1990 and 1999 (65 percent increase). Per capita personal income grew in the region more than 50 percent as a result of business development and expansion [MERIC, 2002]. As demand for water increases, the local drinking water suppliers need to add to their system capacity. Given the economics of drinking water development, the most common approach to increasing the capacity of any growing municipal system is to drill new deep wells into the Ozark aquifer as additional water is needed. The following problems have been identified:

Increasing reliance on the Ozark aquifer

As the demand for water increases in southwestern Missouri, more wells are being drilled into the Ozark aquifer, leading to problems with well field operation and production. All of the high capacity wells located in Jasper and Newton counties are drilled into the Ozark aquifer. Unfortunately, water enters the aquifer through a low-permeability confining layer that separates it from the overlying Springfield Plateau aquifer and locally increases drawdowns due to pumping. To further com-
plicate the situation, there have been well-reported episodes of high capacity well fields pumping from the Ozark aquifer that were unable to meet their production goals.

**Risk of contamination from the Springfield Plateau aquifer**

In Southwestern Missouri the Springfield Plateau aquifer is locally contaminated by high concentrations of lead and cadmium from mining that occurred over the past century. Other problems have been caused by more recent industrial activity where there have been unintended releases of solvents. These groundwater quality problems led to an effort by the state Department of Natural Resources to regulate well construction in areas where contamination was documented. The state requires that wells drilled into the deeper Ozark aquifer in areas where the Springfield Plateau aquifer is known to be contaminated must be cased and grouted through the confining layer. As more water is pumped from the deeper aquifer, the potential for migration of contaminated water into the drinking water supply increases.

**Well interference in the Ozark aquifer**

As wells continue to be drilled in the Ozark aquifer, it becomes increasingly likely that pumping at one well will lower water levels and pumping rates in neighboring wells. Because recharge (or leakage) into the deep aquifer is limited by the confining units and because there is no way to induce additional natural recharge or leakage into the system, local well interference could easily become a problem during peak demand periods.

**Investigation objectives**

The objectives of this investigation are to

1. characterize growth in demand and estimate future water use from the Ozark aquifer,
2. describe local and regional effects of groundwater withdrawal in the area,
3. evaluate the risk of contamination from the upper aquifer,
4. evaluate local yield under current and future conditions,
5. systematically evaluate water supply options, including groundwater, surface water, and springs.

Investigation approach

This investigation was conducted in six phases:

1. review the published literature and data for the area,
2. model groundwater flow using the hydrogeologic analysis presented in the Regional Aquifer System Analysis reports (Imes and Emmit, 1994),
3. conduct a site visit to interview water utility representatives in the area to collect data on water levels and pumping rates,
4. model groundwater flow to simulate flow patterns near the drinking water wells,
5. model aquifer yield to determine the long-term maximum production of the Ozark aquifer near Joplin,
6. evaluate stream and spring flows to consider their potential as sources of supply.

The final component of this project is a set of recommendations based on the findings of each of the phases of our work.

Summary of findings

A complete discussion of our findings and conclusions are provided within the report; however, a summary is provided below:
Additional data are required for reliable management of the groundwater resource

The pumping water levels of future drinking water wells are expected to decline (relative to current levels) as withdrawals from the aquifer increase. The information needed to manage the resource includes water levels in the aquifer at wells that have been shut down for a period of several weeks. Unfortunately, our experience in the area suggests that there are few communities that have the resources or personnel to collect data in a manner consistent with accurate predictions and resource management.

The Missouri DNR has one observation well in each of Jasper county. Because the predicted cone of depression is expected to develop in and around Joplin, it is important for the state and the local communities to establish a targeted data collection effort. The developing cone of depression near Joplin, along with the expanding cone of depression near Carthage, suggest that the limited groundwater supply will need to be closely monitored.

The data currently indicate that Ozark aquifer groundwater withdrawals are increasing rapidly, and that potentiometric heads are falling. This results in increasing “induced leakage” from the Springfield Plateau aquifer into the Ozark aquifer. Since the Springfield Plateau aquifer has large areas of known groundwater contamination, future risks may be present.

A cooperative effort will be needed to protect the Ozark aquifer from contamination

All of the water in the Ozark aquifer in the study region enters as leakage from the Springfield Plateau aquifer. Since the 1960s the state and the federal government have shown concern about the possibility of contaminated water from the Springfield Plateau aquifer reaching the Ozark aquifer. The first discussion of this risk was presented in the 1969 report, Water Resources of the Joplin Area, Missouri [Feder et al., 1969]. Feder reported that old mine works, chat piles, and mine waste that are distributed in the vicinity of Joplin are the primary source of groundwa-
ter contaminants in the area. Extensive mined areas exist along a line between Oronogo and Duenweg on the northeast side of Joplin. In addition, many mined areas are present between Carl Junction and Galena, Kansas on the west side of Joplin. Adding to the risk of these mined areas is breccia that acts as drains, introducing additional recharge in the previously mined areas. Recently, we have heard reports that metals contamination of the Ozark aquifer has been observed in northeastern Oklahoma; we are currently investigating these reports.

One possible source of support for data collection and analysis efforts related to the protection of the Ozark aquifer is the Center for Agricultural, Resource and Environmental Systems (CARES) at the University of Missouri–Columbia. This group has been primarily responsible for source water protection in the state for the past four years [Callison et al, 2002]. Their assistance in monitoring groundwater quality in the area, and their familiarity with the largest public databases, puts them in a position to effectively support this community effort. It may be beneficial for a cooperative water–supply organization in southwestern Missouri to partially fund a staff position at CARES to coordinate data management efforts.

**Only a cooperative regional response will create new water supply options**

Since the middle of the last century it has been understood that the aquifers near Joplin have limited capacity [Feder et al., 1969]. Creative pumping strategies and other mitigation techniques will not change the fact that the aquifer can produce only a limited supply of water. Without any state action, the best way for development to be coordinated and water levels restored in the Ozark aquifer is for all the involved parties to work together to manage the resource.

A cooperative effort will require more complete information about pumping rates and observed water levels. In addition, it might be desirable for a Regional Groundwater Consortium to be formed to help oversee the development of new supplies in the Newton-Jasper county area. The consortium might be responsible for analysis of all of the data that is collected by its members for distribution and consideration, and may become involved in advocacy for the development of
additional surface water supplies and surface storage facilities.

**The state DNR should collect additional data and encourage cooperation**

The role of the state in regional water supply planning is unclear. Between 1995 and 2000 the Missouri DNR Division of Geology and Land Survey produced a State Water Plan series that covered topics that include water use, water management and water quality protection. These documents, while representing the current status of water law and water resources at a state–wide scale, do not indicate how problems like regional water shortage problems should be addressed. Volume II of the Plan, *Groundwater Resources of Missouri* [Vandike, 1997] states:

> Missouri statutes and regulations generally provide for adequate protection of water quality. However, there are few if any laws that regulate the volume of water that is used for a particular purpose… If groundwater use exceeds recharge, water-level declines will occur, and disputes will likely arise. Currently these types of disputes, though uncommon, must be addressed in the courts through civil suits. As population and water use increases, there will be even greater demands placed on groundwater resources, and the incidence of conflict will probably increase. *Further legislation may be needed to prevent overuse of groundwater resources, or to define which uses should receive priority, especially during periods of drought or where groundwater demands greatly exceed resource capacity* (emphasis added).

Our investigation suggests that increasing demand for water, combined with the limited capacity of the aquifer, make it likely that these conflicts will occur in and around Joplin. It is apparent that drinking water is the most important use of groundwater in Missouri. While agriculture and industry (the other major players in water resource development) have well established strategies and voices to promote their rights to water, there is a far more diffuse voice for public water supply that should be heard.
US Army Corps of Engineers –
Little Rock District

Tri-state
water resource coalition

Water Supply Study

September 2006

Prepared by

BLACK & VEATCH

B&V Project No. 41395
Executive Summary

Purpose

The purpose of this study is to evaluate future water needs of the three-state region covering portions of Missouri, Kansas, and Oklahoma and to identify sources to meet those needs through the year 2050. The study culminates with this comprehensive report identifying the needs and the potential water sources available to best serve these needs, and identifies the infrastructure necessary for implementation. The U.S. Army Corps of Engineers (USACE) and the Tri-State Water Resource Coalition sponsored this study.

This Executive Summary highlights key information used in determining the water needs of the study area, available water supply sources to meet these needs, and an evaluation of alternative methods to provide treated water to the area.

Participating entities of the Tri-State Water Resource Coalition that funded this study and whose future needs are the primary purpose of this study, include the following:

- Carl Junction, Missouri
- Carthage, Missouri
- Cherokee County Rural Water Districts 2, 3, and 8, Kansas
- Lamar, Missouri
- Liberal, Missouri
- Miami, Oklahoma
- Missouri American Water Company (Joplin, Missouri)
- Monett, Missouri
- Neosho, Missouri
- Newton County Rural Water District, Missouri
- Noel Water Company (Noel, Missouri)
- Pittsburg, Kansas
- Tribal Members of Oklahoma
- Webb City, Missouri
- Empire District Electric Company Water Department (Missouri)

The initial "Kick-off" meeting was held January 19, 2005 to discuss concerns of the participants and to request relevant participant data. Three progress meetings were
held during the duration of the study with the study's sponsors and participating entities. Additional meetings were conducted with the Technical Committee of the Coalition to confirm the population and flow estimates that formed the basis of the water demands and to review and evaluate potential water supply alternatives developed for the study. A final draft of the report was presented to the Coalition's technical committee for review and comment. Comments from the technical committee were incorporated for presentation to the Coalition in June 2006.

The following paragraphs highlight key items from the study.

**Water Rights**

Water rights for the three states of the study area differ significantly. In Kansas, water supplies are regulated by the Division of Water Resources (DWR) that issues to the various individuals and entities water rights for an allotted quantity that cannot be exceeded. Prior to 1945, Kansas used a riparian doctrine which was defined as "relating to or living or located on the bank of a natural watercourse". Since June 29, 1945, Kansas has used a “prior appropriation” doctrine. The State of Kansas allows water right holders a period of time after approval to demonstrate how much of their approved amount of water is actually used. A certificate of appropriation is then issued for that amount, not to exceed the original approved quantity. Water rights granted prior to June 28, 1945 are considered vested rights, all subsequent rights are appropriation rights and their seniority based on their approval date.

In Missouri, all water supplies within the state are regulated by the Missouri Department of Natural Resources (MDNR). Missouri follows the "reasonable use" theory of water use by riparian landowners whose property borders a watercourse, stream, or lake. Landowners may beneficially use water as long as they do not cause unreasonable damage to fellow riparians. Groundwater is also subject to the reasonable use doctrine.

In Oklahoma, the state's designated water management agency is the Oklahoma Water Resources Board (OWRB), which appropriates stream and groundwater supplies to the various water users in the state. Permits are issued for the use of both surface water and groundwater (domestic uses are exempt), and all waters must be used beneficially without waste. Any person who intends to acquire a water right must file a permit application to be considered for approval by the nine-member Water Board. Stream water is considered to be public water subject to appropriation, while groundwater is private property that belongs to the owner of the overlying surface, subject to reasonable regulation by the OWRB. Surface supplies in the Grand River
Basin, which includes a major portion of northeast Oklahoma, are under the jurisdiction of the Grand River Dam Authority (GRDA). The State of Oklahoma currently has a moratorium on transporting water for use outside the state. Discussions with a representative of the Oklahoma Water Resources Board in June 2005 indicated that the OWRB does not regulate the Grand Lake and that the ability to transfer water from this lake across state lines would be solely at the discretion of the GRDA. However, discussions with the GRDA indicate that the moratorium is an issue that must be addressed before transfer water from the Grand Lake across state lines.

**Population Projections**

Population projections were used to predict future water supply needs for this study. At the June 2005 meeting of the Tri-State Water Resource Coalition, Coalition members decided that water supply needs should include all population within the study area and not just the population served by the participating Coalition entities. Population data provided by Coalition entities were used when available. For areas where such data were not available or provided, data from state and county agencies were used. To facilitate assessment of water supply infrastructure, population projections were determined by County and are presented in Table ES-1. These projections were used to establish future water demand for the service area.

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Barry</td>
<td>10,977</td>
<td>11,903</td>
<td>14,747</td>
<td>16,618</td>
<td>18,623</td>
<td>20,681</td>
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<tr>
<td>Barton</td>
<td>12,123</td>
<td>13,013</td>
<td>13,893</td>
<td>14,800</td>
<td>15,700</td>
<td>16,500</td>
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<td>Jasper</td>
<td>101,207</td>
<td>111,390</td>
<td>120,623</td>
<td>129,200</td>
<td>138,500</td>
<td>147,900</td>
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<td>Lawrence</td>
<td>27,263</td>
<td>30,245</td>
<td>33,116</td>
<td>35,800</td>
<td>38,600</td>
<td>41,400</td>
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<td>McDonald</td>
<td>20,373</td>
<td>26,485</td>
<td>34,430</td>
<td>44,760</td>
<td>58,188</td>
<td>75,644</td>
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<td>Newton</td>
<td>49,596</td>
<td>54,451</td>
<td>59,153</td>
<td>63,600</td>
<td>68,200</td>
<td>72,800</td>
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<td>Kansas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Crawford</td>
<td>29,336</td>
<td>32,698</td>
<td>36,294</td>
<td>40,888</td>
<td>46,659</td>
<td>53,400</td>
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<td>Cherokee</td>
<td>16,207</td>
<td>17,742</td>
<td>18,771</td>
<td>19,801</td>
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<td>21,859</td>
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<td>Ottawa</td>
<td>33,194</td>
<td>39,400</td>
<td>37,300</td>
<td>39,600</td>
<td>41,800</td>
<td>43,900</td>
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<tr>
<td>Total</td>
<td>303,286</td>
<td>336,622</td>
<td>371,405</td>
<td>408,446</td>
<td>450,772</td>
<td>498,044</td>
</tr>
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</table>
As indicated above, the participating entities currently serve most of the population within the study area, and are anticipated to serve approximately 275,000 by the year 2050, which is approximately 55 percent of the total projected population in the study area.

Projected Water Needs

Each entity participating in this study was requested to provide historical water use data which were used to develop annual average day per capita water use and peak day water use for each entity. The participating entities also provided input as to any future water needs they wanted to include for industrial, commercial, or other use beyond what was predicted from historical data.

These data were used to calculate an overall annual average day and peak day use for all entities, which were in turn used to develop anticipated future water needs (unless the entity supplied specific data about their anticipated future water demands). These data, projected Year 2050 population and average day demand for each entity are listed in Table ES-2 (next page).

Table ES-2 indicates a total average day flow of 71 mgd, which represents only the needs of the participating entities. The total average per capita flow value of 189 gpd is reflective of the relatively high industrial flow component for several communities. The 126 gallons per capita day value for residential use represents higher end of the average day flow values but is reasonable to use for this study.

To determine the water use for the entire study area, daily and peak usage must be predicted for the remaining population in the study area. By multiplying the population estimates of those not served by the participating entities by the residential per capita flow value of 126 gallons per capita day, the study area water demand presented in Tables ES-2 and ES-3 was determined.

The average day demand of 102 mgd will be used in determining water supply needs. The peak day demand will be used to size intake, pumping, piping, and treatment needs. Data provided by participating entities showed peak day to average day ratios between 1.5 and 2. For this study, a peaking factor of 2.0 is used.
<table>
<thead>
<tr>
<th>Entity</th>
<th>Population</th>
<th>Total Average Day Flow, mgd</th>
<th>Residential, mgd</th>
<th>Commercial/Industrial/Government</th>
<th>Total Flow per Capita</th>
<th>Residential Flow per Capita</th>
<th>Comm/Ind/Gov. Total Flow per Capita</th>
<th>Projected Year 2050 Population</th>
<th>Projected Year 2050 Ave Flow, mgd</th>
<th>Comments</th>
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<tr>
<td>Carthage Water and Electric Plant</td>
<td>12,802</td>
<td>2.84</td>
<td>0.83</td>
<td>2.01</td>
<td>222</td>
<td>65</td>
<td>157</td>
<td>17,026</td>
<td>5.0</td>
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<td>5,400</td>
<td>0.81</td>
<td>0.61</td>
<td>0.20</td>
<td>150</td>
<td>113</td>
<td>37</td>
<td>10,105</td>
<td>1.5</td>
<td>2000 Data. Year 2050 based on historical per capita rate</td>
</tr>
<tr>
<td>City of Joplin Missouri</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>See Mo-American Data</td>
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<td>City of Lamar Missouri</td>
<td>4,600</td>
<td>0.59</td>
<td>0.49</td>
<td>0.10</td>
<td>128</td>
<td>107</td>
<td>22</td>
<td>6,000</td>
<td>0.8</td>
<td>2004 Data. Year 2050 based on historical per capita rate</td>
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<td>0.08</td>
<td>0.01</td>
<td>109</td>
<td>96</td>
<td>13</td>
<td>1,060</td>
<td>0.1</td>
<td>2004 Data. Year 2050 based on historical per capita rate</td>
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<td>City of Miami Oklahoma</td>
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<td>1.84</td>
<td>1.22</td>
<td>0.59</td>
<td>131</td>
<td>87</td>
<td>42</td>
<td>18,692</td>
<td>2.4</td>
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<td>City of Monett Missouri</td>
<td>7,629</td>
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<td>0.55</td>
<td>2.07</td>
<td>271</td>
<td>72</td>
<td>343</td>
<td>13,221</td>
<td>7.1</td>
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<td>2.59</td>
<td>3.37</td>
<td>155</td>
<td>119</td>
<td>155</td>
<td>25,600</td>
<td>4.0</td>
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<td>1.87</td>
<td>0.37</td>
<td>120</td>
<td>100</td>
<td>20</td>
<td>39,306</td>
<td>5.9</td>
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<td>1.20</td>
<td>0.00</td>
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<td>112</td>
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<td>18,482</td>
<td>2.3</td>
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<td>8.66</td>
<td>1.54</td>
<td>264</td>
<td>184</td>
<td>33</td>
<td>97,000</td>
<td>33.0</td>
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<td>No Data</td>
</tr>
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<td>Noel Water Company</td>
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<td>0.56</td>
<td>0.00</td>
<td>341</td>
<td>341</td>
<td>0</td>
<td>5,570</td>
<td>1.9</td>
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<td>0.10</td>
<td>0.00</td>
<td>83</td>
<td>83</td>
<td>0</td>
<td>1,584</td>
<td>0.1</td>
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<tr>
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<td>0.22</td>
<td>0.01</td>
<td>142</td>
<td>137</td>
<td>5</td>
<td>2,145</td>
<td>0.3</td>
<td>2004 Data. Year 2050 based on historical per capita rate</td>
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<tr>
<td>Rural Water District No. 8 of Cherokee County, Kansas</td>
<td>1,300</td>
<td>0.09</td>
<td>0.08</td>
<td>0.01</td>
<td>69</td>
<td>63</td>
<td>6</td>
<td>1,716</td>
<td>0.1</td>
<td>2004 Data. Year 2050 based on historical per capita rate</td>
</tr>
<tr>
<td>Baxter Springs, Kansas</td>
<td>4,400</td>
<td>0.86</td>
<td>0.66</td>
<td>0.20</td>
<td>194</td>
<td>150</td>
<td>44</td>
<td>6,046</td>
<td>1.2</td>
<td>2004 Data. Residential use assume to be 150 good.</td>
</tr>
<tr>
<td>Empire Electric</td>
<td>10,088</td>
<td>1.01</td>
<td>0.81</td>
<td>0.20</td>
<td>100</td>
<td>80</td>
<td>20</td>
<td>11,490</td>
<td>5.3</td>
<td>Requested additional water for 4 mgd for coal fired power plant.</td>
</tr>
<tr>
<td>Total</td>
<td>163,616</td>
<td>30.85</td>
<td>20.53</td>
<td>10.67</td>
<td>189</td>
<td>126</td>
<td>65</td>
<td>2,752,243</td>
<td>71.0</td>
<td>Notes: (1) Per Capita are calculated by dividing total flow by population. Provides a basic measure of historical water use in the study area. (2) No data provided from Newton County Water District. Values and needs will be included through the population in study area not currently served by Participating Entities. (3) Projections in population not provided by entity. Values presented based on matching growth rate for the county which is approximately 50% increase by 2050. (4) Year 2050 Demand is only for participating entities. Does not include demand for rest of study area. See text for discussion of how this is used.</td>
</tr>
<tr>
<td>Participating Entities</td>
<td>Population</td>
<td>Average Flow, nearest mgd</td>
<td>Peak Day nearest mgd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<tr>
<td></td>
<td>275,243</td>
<td>71</td>
<td>142</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remainder of Study Area</td>
<td>222,800</td>
<td>31</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>498,043</td>
<td>102</td>
<td>204</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

1. Participating entities' data from Table 3-3.
2. Population from Table 3-2. The remaining population is difference between the total and the participating entities' population.
3. Flow for remainder of study area is equal to population multiplied by average day per capita value of 126 gpd from Table 3-3 plus additional flow to account for the needs of Ottawa County, Oklahoma as predicted by the Oklahoma Water Resources Board in their July 11, 2006 letter to Jeff Kaiser, Black & Veatch.

**Water Supply Sources**

The water supplies for the study area consist of both groundwater and surface water, and both were considered for meeting future water needs. Based on discussions with the Tri-State Coalition technical committee and consideration of potential groundwater quantity and quality issues facing the area, it has been estimated that all of the current surface water supply and half of the current groundwater supply will be considered available to meet future needs. Water supplies for participating entities are based on their input. Water supplies for residents of the study area region who are currently not served by one of the participating entities are assumed to all be from groundwater and were calculated based on groundwater meeting an average day demand of 126 gallons per capita day. Year 2050 projected average day demand for the entire study area is 102 mgd. To meet this need, new water supply must be sufficient to provide an average day production of 66 mgd.

Groundwater as a future long term source was considered. The area is underlain by two aquifers: the Springfield Plateau aquifer, located in southwest Missouri and southeast Kansas area and the deeper Ozark Aquifer which covers nearly all of southern Missouri south of the Missouri River. Chapter 4 provides a summary of the groundwater information for the area. Members of the Coalition's technical committee expressed concerns about relying on groundwater as a long term solution to meet future needs. Further, the committee was concerned that groundwater levels continue to be lowered by
existing use, not all of the current groundwater supply could be relied upon for future use, and the coalition decided to include only half of the current groundwater supply as being available for meeting long term needs.

Existing surface water supplies include Shoal Creek for Missouri American Water and Neosho; Spring River for Baxter Springs, Kansas; and Lamar Lake for Lamar, Missouri. The Coalition indicated that these supplies should be considered available for meeting future needs.

The following potential future surface water supplies were considered in this study:

- Grand Lake o’ the Cherokees which is operated by the Grand River Dam Authority
- Table Rock Lake (USACE Lake)
- Stockton Lake (USACE Lake)
- Truman Lake (USACE Lake)
- Prosperity Lake or Lake Slyvania (not constructed)
- Lamar Lake
- Spring River
- Shoal Creek
- Elk River
- Center Creek

It is estimated that none of the rivers or creeks within the study area has sufficient flow to have a firm yield adequate for meeting the area’s water supply needs without constructing an impoundment. In the 1970’s, the USACE conducted studies to determine if in-stream impoundments, Prosperity Lake (on Center Creek) or Lake Slyvania (on Shoal Creek) were viable alternatives for the region in and around Jasper County. Those studies concluded that these proposed lakes were not justified economically at that time.

Of the potential future water supply sources discussed by the Coalition, the existing major lakes (Truman, Stockton, Table Rock, and Grand Lake o’ the Cherokees) appear to offer the best opportunity for meeting the region’s needs; however, none of them has sufficient “discretionary” storage to serve as a single source to meet the region’s entire needs. The Chief of Engineers for the USACE has the discretionary authority to reallocate up to 15 percent or 50,000 ac-ft, whichever is less, of the total storage capacity allocated to all purposes, provided the reallocation has no severe effect on other authorized purposes. This storage is commonly referred to as discretionary storage. Storage beyond the discretionary storage could be reallocated to the Coalition for water
supply provided Congress approves such a reallocation. During one of the Tri-State Coalition technical committee meetings, representatives of the USACE indicated that they would support pursuing congressional approval for reallocation of water from any of their lakes so that a single source for future water is possible.

**Water Treatment Facilities**

Water treatment needs will be based on providing sufficient treatment capacity to meet maximum (peak) day demand for 2050. Approximately 132 mgd of additional water is projected as being required to serve the population in the region during the 2050 maximum day use. It is anticipated that peak hour demands will be met by providing sufficient storage of treated water. Existing plant capacities were reviewed to identify the plants that may be available for future needs through 2050. No detailed engineering study was conducted of any of the plants. There are six treatment plants currently operated by Coalition entities which have a combined treatment capacity of 34 mgd. Current water treatment capacity in the region is 34 mgd, most of which treats groundwater. Disinfection treatment varies at the treatment plants between chloramines and free chlorine.

Additional treatment facilities and upgrades to existing facilities must meet Safe Drinking Water Act requirements and the requirements of the state in which the facilities are located. Existing treatment plants that will be blending their treated water with water from new surface water treatment facilities are the Missouri American Joplin WTP and the Carthage, Lamar, Pittsburg, Neosho, and Baxter Springs treatment facilities. The blending of these waters, if not done properly, may present some challenges as differences in the water quality may be conducive to corrosion or to the release of deposits of scales and films in the distribution piping. Before any new treatment facility is placed on line, a detailed plan of how each community intends to use the various water sources should be prepared and the quality of the combined waters should be evaluated. Issues regarding blending are not public health issues, but aesthetic concerns about color, tastes and odors, and corrosion control are.

A detailed preliminary design study should be conducted after selection of the appropriate water source to determine the most economical treatment process to satisfy all current, pending, and future drinking water regulations. Conventional treatment consisting of coagulation, flocculation, sedimentation, granular media filtration, and disinfection should be adequate to treat the water from these surface sources. However, it may be more feasible to use a high-rate process such as ballasted flocculation or an
advanced treatment process such as membranes, depending on the quality and composition of the selected source water.

Initial disinfection of the source water is expected to be with free chlorine, followed by chloramines before it enters the distribution system. This assumption needs to be confirmed by bench-scale testing during preliminary design. Using chloramines as secondary disinfectant is a departure from current disinfection practice at several of the treatment facilities. Since the travel time from new treatment facilities to individual users will be lengthy for several utilities, it appears that chloramines will be the most cost-effective means of meeting the new regulations. The decision to utilize chloramines for secondary disinfection is based on current best engineering judgment and should be re-evaluated by simulated testing of DBP on the selected water source.

**Long-Term Water Supply Alternatives**

With input from the Coalition’s technical committee, six alternatives were developed to meet the water supply and treatment demand for Year 2050. Five of the six alternatives involve the use of the existing lakes; the sixth considers a new reservoir as the water supply. There are no streams or rivers in the study area with sufficient year round flow to allow continuous direct withdrawal; thus an off-stream or in-stream impoundment (reservoir) will be required. The six alternatives developed are:

- Alternative 1 – Grand Lake o’ the Cherokees
- Alternative 2 – Stockton Lake
- Alternative 3 – Truman Lake
- Alternative 4 – Table Rock Lake
- Alternative 5 – Multiple Lakes (Grand Lake, Table Rock, Stockton)
- Alternative 6 – A new reservoir on a stream or river (by constructing a new reservoir). For costing purposes the new reservoir has been located in the general vicinity of Jasper County, Missouri.

Two water demand conditions were considered for each alternative: (1) the Year 2050 average and peak day demands for the population projected to be served by the current members of the Tri-State Coalition, and (2) the water demand of the projected Year 2050 population for the entire study area. Intakes, pumping, piping, and treatment facilities have been sized on peak day demand values. The facilities sizing described for each alternative is based on the demand for the entire study area population.
**Alternative 1**

Alternative 1 involves using the Grand Lake o’ the Cherokees to provide an annual average day capacity of 66 mgd to the study area. Use of this alternative would require Grand River Dam Authority approval for re-allocating storage to this demand. Implementing this alternative would likely involve addressing Oklahoma’s current moratorium on transferring in-state waters out of Oklahoma. Grand Lake is located in the same watershed as the service area and is the closest major water supply. Improvements considered for costing purposes include an intake pumping station and a new raw water main from the Grand Lake routed to three new water treatment plants: a 100 mgd plant near Carthage and Joplin, a 14 mgd water treatment plant to serve the Ottawa County, Oklahoma, area and an 18 mgd water treatment plant to serve the McDonald County, Missouri, area. New treated water transmission lines would extend from the 100 mgd regional plant to counties in the Missouri and Kansas portion of the study area.

**Alternative 2**

Alternative 2 involves using Stockton Lake to meet the 66 mgd annual average day capacity. Re-allocating storage to meet this demand will require Congressional approval. Although currently discretionary storage is available in Stockton Lake, it is recognized that some of this discretionary storage has already been re-allocated to the City of Springfield and that this could also be the case with the remaining storage. Improvements considered for costing purposes included a new intake pump station, transmission line, a 105 mgd plant in the Carthage/Joplin area with a branch transmission line to a 27 mgd plant in the Monett area. New treated water transmission lines would from the 100 mgd plant would distribute treated water to all county areas except the Barry/Lawrence area that will be served by the 27 mgd plant.

**Alternative 3**

Alternative 3 involves using Truman Lake. Congressional approval is required to re-allocate storage to meet the 66 mgd demand. Truman Lake is the most distant from the water demand center of the water supply sources considered. Improvements proposed for this alternative are similar to that for Stockton and include a new intake pumping station, a raw water force main to a 105 mgd treatment plant near the Carthage/Joplin area with a branch line to a 27 mgd plant in the Monett area to serve the Barry/Lawrence County area. New treated water transmission lines would from the 105
mgd plant would distribute treated water to all county areas except the Barry/Lawrence area that will be served by the 27 mgd plant.

Alternative 4

Table Rock Lake is the sole water source considered for Alternative 4. Reallocation of storage would be required to meet the full 66 mgd demand. Improvements proposed include a new intake pumping station, an 18 mgd treatment in McDonald County, a 27 mgd plant near Monett, an 87 mgd regional plant in the Carthage/Joplin area of Jasper County, a raw water force main from Table Rock to the treatment plants, a treated water pumping station and force mains to distribute water throughout the study area.

Alternative 5

Under Alternative 5, water would be drawn from three lakes to supply water to the area. This alternative was developed on the premise of supplying water to sub-regions in the study area from the lake nearest each sub-region. Stockton Lake is near the Barton County area; Table Rock Lake is near Barry/Lawrence County area; and Grand Lake o' the Cherokees is closest to the remaining county areas. Improvements include: new intake pumping stations at Grand Lake, Stockton, and Table Rock Lakes; a new raw water main from Table Rock Lake to a new 62 mgd plant located in the Carthage/Joplin area to serve the Jasper and Newton Counties in Missouri and Cherokee County in Kansas; a new branch raw water main to supply the new 27 mgd treatment plant to serve the Barry/Lawrence County area; a new branch raw water main branching off the line leading from Table Rock Lake to the 62 mgd plant to feed a new 18 mgd plant serving McDonald County; a new raw water force main from Stockton Lake to a new 2.2 mgd plant to be located near Lamar to serve the Barton County area; a new 9 mgd treatment plant in the Crawford County, Kansas, area; and a treated water pumping station and treated water force mains to convey water from the 62 mgd regional water treatment plant to the three county areas it serves. A new raw water force main would be routed from Grand Lake to a new 14 mgd treatment plant located in Miami, Oklahoma area.

Alternative 6

Under Alternative 6, a new reservoir would be constructed in the study area nearer to the water demand centers. This alternative would involve impounding existing streams or rivers for municipal use. The concept of building a reservoir is not new to the Jasper, Newton, Barry, and Lawrence County area. As previously mentioned, the Corps
of Engineers conducted studies in the 1970s to determine the economic feasibility of constructing instream reservoirs on Center Creek or Shoal Creek, identified tentatively as Prosperity Lake and Lake Sylvania. Either of these lakes would be located in southern Jasper County. For comparison purposes, a new reservoir has been placed in the Carthage/Joplin area, which is near the area with the greatest future water demand. Improvements would include: a new reservoir equipped with an intake pumping station and a new raw water force main from the reservoir to a new 106 mgd water treatment plant to be located near the reservoir to serve county areas in Missouri, a new treated water pumping station and treated water transmission mains to convey water from the 61 mgd regional water treatment plant to all county areas in Missouri, a new raw water main from the reservoir to a new 12 mgd treatment plant in Cherokee County, Kansas, to serve Cherokee and Crawford County areas in Kansas, a new treated water pumping station and transmission mains to convey water from the 12 mgd regional water treatment plant to the two county areas in Kansas, and a new raw water main from the reservoir to a new 14 mgd treatment plant in Ottawa County, Oklahoma, to serve Ottawa County. While this analysis has been based on three treatment plants, one plant could be constructed or the number of plants could be expanded if found advisable by further study.

**Groundwater as Long-Term Solution**

Obtaining sufficient water from the Ozark Aquifer to meet the Coalition’s long-term demands without compromising the aquifer’s quality is not considered feasible based on the results of previous studies, modeling, and discussions with members of the Tri-State Coalition. Portions of the Springfield Aquifer which overlies the Ozark Aquifer are known to be contaminated with metals, posing a risk to Ozark Aquifer’s water quality. Other concerns about the use of groundwater as a long-term solution include:

- Impact of other groundwater users on the availability of high-quality water from Ozark Aquifer. Missouri is a riparian state and has limited control on the amount of groundwater that can be taken from the Ozark Aquifer for other uses, such as for agriculture, irrigation, and industrial processes. Assuring adequate groundwater for domestic use will be difficult.
- To obtain groundwater in Missouri involves acquisition of land for construction of wells and pipeline easements to convey the water to users.
- Kansas currently has a moratorium on water rights to groundwater.
- No comprehensive groundwater study on the feasibility of using groundwater as a regional supply source was made available for this study.
If the use of groundwater is to be pursued further, the feasibility of its use should be confirmed through further study.

For these reasons, the Tri-State Coalition decided not to consider groundwater any further as a long-term regional water supply.

**Evaluation**

An evaluation consisting of a comparison of costs and intangibles was conducted for each alternative. The cost evaluation included development of opinions for capital cost, present worth, and equivalent annual costs for each alternative. The present worth and equivalent annual costs, which are used to determine which alternative is the most cost-effective, are based on a 50-year planning period as stated in the scope of services for this project. Costs are in July 2006 dollars. The intangible factors include environmental constraints, public acceptance, and security considerations.

Table ES-4 presents a summary of the opinion of the probable initial year capital cost, present worth, equivalent annual cost and a unit cost per 1,000 gallons for each alternative. All capital costs have been shown as initial year costs for comparison purposes. Staging of the improvements would be recommended. However, for the purposes of comparing alternatives it is reasonable to expect that such staging would have little or no change in the overall cost ranking as all options would have similar staging as water needs increase over the planning period. Note that the costs developed do not include costs to connect to individual participant's distribution systems, the cost of water from the USACE lakes, nor any institutional costs that may be required, as these costs are considered to be essentially equal for all alternatives and would not have an impact on the cost ranking. These costs can be better defined as part of a program to determine the most appropriate institutional arrangement for the participants pursuing additional water supply.
<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Alternative 4</th>
<th>Alternative 5</th>
<th>Alternative 6</th>
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<tbody>
<tr>
<td>Initial Year Capital Costs (2006$)</td>
<td>$1,181,200,000</td>
<td>$1,389,000,000</td>
<td>$1,681,600,000</td>
<td>$1,396,000,000</td>
<td>$1,397,600,000</td>
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<td>Present Worth (PW) 50 Year period</td>
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<td></td>
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<tr>
<td>PW for Capital Costs (Note 1)</td>
<td>$1,487,000,000</td>
<td>$1,727,000,000</td>
<td>$2,054,000,000</td>
<td>$1,944,000,000</td>
<td>$1,754,000,000</td>
<td>$1,518,000,000</td>
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<td>PW for O&amp;M Costs</td>
<td>$108,000,000</td>
<td>$116,000,000</td>
<td>$132,000,000</td>
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<td>$120,000,000</td>
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<td>PW Cost of water from Corps Lakes (Note 2)</td>
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<tr>
<td>PW for Cost of Lost Power (Note 3)</td>
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<tr>
<td>PW for Cost of Storage</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
</tr>
<tr>
<td>PW for Cost of Storm Storage</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
</tr>
<tr>
<td>PW for Cost of Flood Storage</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
</tr>
<tr>
<td>PW of Greater of Costs for Corps Lake Water</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total Present Worth (Nearest $1M)</td>
<td>$1,595,000,000</td>
<td>$1,843,000,000</td>
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<td>$2,063,000,000</td>
<td>$1,874,000,000</td>
<td>$1,525,000,000</td>
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<tr>
<td>Lowest PW or % &gt; Lowest PW</td>
<td>4.6%</td>
<td>20.9%</td>
<td>43.3%</td>
<td>35.3%</td>
<td>22.9%</td>
<td>Lowest PW</td>
</tr>
<tr>
<td>Rank based on Present Worth</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>1</td>
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<tr>
<td>Equivalent Annual Cost (EAC)</td>
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<tr>
<td>EAC Capital Costs (includes land costs)</td>
<td>$83,000,000</td>
<td>$96,400,000</td>
<td>$114,700,000</td>
<td>$108,600,000</td>
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<td>EAC O&amp;M Costs (avg. for 50 yr planning period)</td>
<td>$6,000,000</td>
<td>$6,500,000</td>
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<td>$6,700,000</td>
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<td>EAC for use of water from Corps Lakes (note 2)</td>
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<tr>
<td>EAC for Cost of Lost Power (Note 3)</td>
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<td></td>
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<tr>
<td>EAC for Cost of Storage</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
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<td>Note 2</td>
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<tr>
<td>EAC for Flood Storm</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
<td>Note 2</td>
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<td>Note 2</td>
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<tr>
<td>EAC of Greater of Costs for Corps Lake Water</td>
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<td></td>
</tr>
<tr>
<td>Total EAC (Nearest $1M)</td>
<td>$89,000,000</td>
<td>$103,000,000</td>
<td>$122,000,000</td>
<td>$115,000,000</td>
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<tr>
<td>Cost per 1,000 gallons</td>
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<tr>
<td>Equivalent Annual Cost</td>
<td>$89,000,000</td>
<td>$103,000,000</td>
<td>$122,000,000</td>
<td>$115,000,000</td>
<td>$105,000,000</td>
<td>$90,000,000</td>
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<tr>
<td>Flow Peak Day, mgd (based on new trmnt)</td>
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<td>133.2</td>
<td>133.2</td>
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<tr>
<td>Cost per 1,000 gallons (Note 6)</td>
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<td>$2.10</td>
<td>$2.50</td>
<td>$2.40</td>
<td>$2.20</td>
<td>$1.90</td>
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<tr>
<td>New Water Supply, mgd</td>
<td>66.6</td>
<td>66.6</td>
<td>66.6</td>
<td>66.6</td>
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<td>Cost per 1,000 gallons (Note 6)</td>
<td>$3.70</td>
<td>$4.20</td>
<td>$5.00</td>
<td>$4.70</td>
<td>$4.30</td>
<td>$3.70</td>
</tr>
</tbody>
</table>

Notes:
1. PW cost includes estimated land costs and 3 years of interest during construction.
2. Reallocation from Corps lakes will require an annual payment to the Corps based on one of three costs: lost power benefit cost; cost for lost flood storage or annual O&M cost for storage. Actual value must be determined by US Army Corps of Engineers in allocation study. For purposes of this study, Corps advises that the for recent reallocations for lakes in jurisdiction of the USACE Little Rock office, reallocation has been from flood storage as it has typically resulted in the lowest cost. To cover the budget level costs for this study, USACE recommends taking the larger of the estimated values for lost power benefit cost and annual O&M cost for storage.
3. If water taken from downstream of dam, there would be no power cost.
4. Institutional costs are not included and may vary between alternatives based on institutional arrangement(s) agreed to by participants.
5. Interest Rate Used = 5.125%
Observations

Based on the cost opinions and intangible factors related to each alternative the following observations were presented to the Coalition’s technical committee in April 2006:

- The budget level opinions of costs developed for this study indicate that Alternative 1, Grand Lake, has the lowest capital cost.
- Alternatives 1 and 6 (new reservoir) can be considered essentially equal from the present worth and capital cost standpoints, as their costs are within 10 percent of each other (6 percent difference in costs when based on Total Area Population). However, the actual cost of a new reservoir depends largely on its location and size. If this alternative is pursued, its costs should be re-evaluated and revised based on the most likely location and size of the reservoir and compared again with the costs of the other alternatives.
- The costs of Alternatives 2, 4, and 5 are between 16 and 19 percent higher than those of Alternative 1.
- The capital cost and total present worth cost of Alternative 3, Truman Lake, are considerably higher than the costs of the other alternatives. This is reasonable, since Truman is located the farthest from the study area and its use would involve substantially more conveyance infrastructure.
- For all six alternatives, the cost of conveying raw or treated water ranges from 50 to 65 percent of the total project cost. This reflects the significant distance that water must be transported to meet the demand of the area.
- GRDA has expressed an interest in supplying water from Grand Lake to the Coalition. The most daunting issue to be addressed appears to be the current moratorium Oklahoma has on transferring water to entities outside of the state. The Oklahoma Water Resources Board advised Black & Veatch in 2005 that the State of Oklahoma does not govern over Grand Lake and that the ability to transfer water from this lake across state lines would be solely at the discretion of the GRDA.
- Use of Stockton Lake would require reallocation by Congress to obtain sufficient water to meet Year 2050 demand. There are concerns about the impact to Stockton residents, should the Coalition pursue this option.
- Table Rock Lake appears to be the most readily accessible source of water for the Coalition. An amount equal to approximately half of the projected
demand is in discretionary storage, and the use of some or all of it could be pursued immediately. If needed in the future, the Coalition could request Congressional reallocation of storage to increase the supply.

- The multiple lakes alternative was considered in an attempt to keep conveyance costs down by supplying portions of the study area with water from the nearest lake; however, this approach does not appear to offer a substantial economic advantage over a single-lake option. In addition, the intangible factors associated with the use of each individual lake would all apply to the multiple-lakes option, making it less desirable.

- Before a new reservoir can be constructed, significant study, planning, and approval must be completed. The cost opinions prepared for this study are generic only. No specific river or stream has been recommended as the preferred source of water supply and no preferred location has been identified for a reservoir. It is recommended that once the selection is made, the costs of this option be updated to reflect the choice of the water supply and the reservoir location. If a reservoir can be located near the areas of highest water demand, the cost of conveyance can be significantly lower than the costs of conveyance from any of the existing lakes.

- The cost of a new reservoir may be lower or higher than predicted in this study. A reservoir sized strictly for water supply can be smaller than a lake that serves other purposes such as flood control, recreation, and power generation. If the option that includes a new reservoir is pursued, the Coalition should consider this aspect.

Assessment by Tri-State Coalition Technical Committee

The Tri-State Coalition technical committee considered cost, intangible factors, and the observations presented above, and have determined the most effective pursuit of a water supply for the region as follows:

- Pursue Alternatives 1, 4, and 6 concurrently as possible solutions to the regions supply needs. These alternatives represent the three lowest capital cost and two of the three lowest present worth solutions. (Table Rock Lake has a considerably higher present worth cost than the other two alternatives.) Each alternative includes issues that should be investigated more thoroughly before the alternative is eliminated from further consideration.
• Table Rock Lake is the most readily available source for water to meet the Coalition’s needs. It does not require interstate negotiations nor is it subject to regulatory restriction. This alternative would require an inter-basin transfer of water.

• Use of Grand Lake will likely involve inter-state negotiations to allow water to be transferred across the Oklahoma state line. The level of complexity of this option is unclear, but it is expected to involve significant time if success is to be achieved. The potential cost savings compared with other alternatives justify pursuing this alternative further.

• A new reservoir has potential cost benefits that merit further consideration. Implementing this alternative will involve the greatest effort which includes assessment of environmental impacts and selecting the most suitable location.

**Proposed Next Steps**

Working with the USACE and Black & Veatch, the Tri-State Water Resource Coalition has identified Alternatives 1, 4, and 6 as the most favorable options for meeting the long-term needs of the region. While these three have been selected for further study, this does not necessarily mean that the other alternatives have been removed from consideration. The following steps are recommended to assist the Coalition in determining which alternative or combination of alternatives can be implemented to best meets the long term water supply needs:

1. **Review and Revise the Projected Water Demands for the Coalition.** It is not unusual that once the projected costs of these long-term solutions are presented, some of the study participants will choose not to continue their involvement in a regional pursuit for a water supply. Other members of the Coalition may wish to revise their water demands based on the potential cost implications or which alternative is pursued. It is also likely that entities in the surrounding area who did not participate in this study may now wish to become involved in the pursuit of a regional water supply with the Coalition. Such a change in participants could change the amount of water required as well as the staging of construction of the facilities to convey and treat the water for the region. Updating the water demands would be appropriate at this time, and at regular intervals as the
Coalition continues to develop and implement the final water supply alternative.

2. **Request Reallocation of Discretionary Storage from Table Rock Lake.** The Coalition should pursue with the USACE, the steps and procedures for requesting reallocation of discretionary storage from Table Rock Lake. Approximately 35 mgd of capacity is available from the remaining discretionary storage. The USACE has suggested that the Coalition consider determining how much water is needed for the next 20 to 25 years instead of requesting the entire 35 mgd. The Coalition will also likely be required to take steps to be recognized as a legal entity that can request reallocation from the USACE, sign contracts, etc.. Legal consultation is recommended to determine what steps are required to form this legal entity.

3. **Pursue the Grand Lake Option.** From the information provided by the GRDA, it appears that the GRDA is open the possibility of working with the Coalition and the Coalition should pursue the viability of this option with the State of Oklahoma. The Coalition should enlist representatives from the City of Miami, Oklahoma, as well as state officials from Missouri and Kansas to pursue this matter with the Oklahoma legislators. The current moratorium on transporting water outside of the state of Oklahoma is an important issue that must be addressed for this Alternative to be viable.

4. **Pursue the New Reservoir Alternative.** To determine the viability of this option, more knowledge will be required about the size, location, cost, and other aspects of a new reservoir. The USACE has performed reservoir studies in the past and could be approached by the Coalition regarding performing a study for this area. MDNR might also provide another resource for study and construction of a new reservoir, and the Coalition should pursue MDNR and the legislators from the area regarding funding of such as study.

5. **Assess the impact of combining treated water from new plants with water from existing treatment plants.** Treatment plants that will likely be blending their treated water with water from new surface water treatment facilities are the Missouri American Joplin WTP and the Carthage, Lamar, Pittsburg, Neosho, and Baxter Springs facilities. The Baxter Springs and Lamar facilities treat surface water, the Joplin and Neosho facilities treat a
combination of groundwater and surface water, and the Carthage and Pittsburg plants treat groundwater only. The blending of these waters, if not done properly, may present some challenges as differences in the water quality may be conducive to corrosion or to release of deposits of scales and films in the distribution piping. Before any new treatment facility is placed on line, a detailed plan of how each community intends to use the various water sources should be prepared and the quality of the combined waters should be evaluated. Issues regarding blending are not public health issues, but aesthetic concerns about color, tastes and odors, and corrosion control are.

One expected modification to four of the treatment facilities would be switching disinfection methods from using free chlorine to chloramines. With the Stage 2 DBP regulations in effect, it is unlikely that the new surface water treatment plant could supply disinfected water into an extended distribution system using only free chlorine. Some bench-scale testing could be done to confirm this assumption. If chloramines are needed, as anticipated, the four systems currently using free chlorine would need to add ammonia for conversion to chloramines. Trying to blend treated waters with free chlorine with chloraminated water is not advised.

6. **Address Short-Term Needs.** Identifying interim steps to meet the near-term water demands for some members of the Coalition will be critical in sustaining a reliable water supply while a long term solution is implemented. The stated purpose of the USACE study is to identify solutions to meet “long-term” (Year 2050) needs. However, it is likely that due to the significant scope of the potential long term solutions, it will require several years to plan, design, and construct the selected alternative. It is anticipated that some of the Coalition members will continue to experience increased water demands in the near term prior to the long term plans being implemented. For these water suppliers, the need for new water supplies will occur sooner than the needs of others, and interim solutions to meet those needs will be required.
As part of Step 1 above, a closer look at the more immediate water demands is recommended. Once those near term needs are identified, interim solutions can be identified and implemented. Potential solutions to the near term water supply needs may include scaled down or intermediate versions of the proposed long term supply alternatives. However, more localized solutions may be necessary to augment existing supplies in specific areas. These localized solutions may include the use of additional smaller surface supplies to augment existing supplies, the installation of new wells (intended only as short term solutions), or the creation of smaller in-stream or off-stream impoundments to store water for high demand periods. It is recommended that whatever near term solutions are planned and implemented, as much as possible these interim solutions be coordinated with and augment the proposed long-term solution for the region.

7. **Determine the future role of the Tri-State Coalition and what legal steps are required to serve in that role.** Future steps may require that the Coalition obtain a different legal status than it currently holds in order to pursue some of the options for securing water.
Figure 6-4
Figure 6-5
The locations of intakes, pump stations, pipe lines, and treatment plants have been selected only for developing costs for comparison with other alternatives. Siting studies and preliminary engineering reports of selected alternatives to optimize design features and costs are recommended.
WATER SUPPLY RESERVOIR SCREENING STUDY

CITY OF MONETT AND MISSOURI DEPARTMENT OF NATURAL RESOURCES
In Conjunction with Tri-State Coalition

July 2009

Prepared by

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Suite 200
Fort Worth, Texas 76109
817-735-7300
EXECUTIVE SUMMARY

In May of 2008, Freese and Nichols (FNI) was retained by the City of Monett, Missouri on behalf of the Tri-State Coalition and the Missouri Department of Natural Resources (DNR) to perform a screening study of potential reservoir sites in southwest Missouri. The member cities and water supply entities of the Coalition, have determined that the area will have various shortages of water supply at various times in the future. Previous studies have developed projected supply shortfalls and reviewed potential supply sources, primarily obtaining water from the existing large reservoirs in the area. Each has been determined to be either very difficult to implement or non-viable under current regulatory circumstances. As a result, the Coalition, with funding assistance from the DNR, requested an additional study to identify and determine the viability of potential reservoir sites in the area that could meet the estimated future needs.

The methodology of the study was to initially identify alternative project locations for reservoirs that would supply sufficient raw water supply to meet the projected shortfalls, including both on-channel and adjacent off-channel storage reservoirs. For each of the identified potential sites, available hydrologic, geologic, environmental, and soils information was reviewed in order to approximate the viability of the sites for dam construction. Then, a conceptual level estimate of the construction and total project costs for each of the alternate reservoir locations, including transmission costs, was developed. Based on these costs and other factors, a priority ranking of recommended sites was developed that considered various potential future demand levels and appropriate geographical areas consistent with that level of demand. Chapters 2 through 8 describe in
more detail the information determined and the results of the analysis that support the priority rankings.

The primary intention of this screening process was to compare multiple sites using consistent assumptions in order to rank the viability of the sites and to determine a priority listing of the sites that would be worthy of additional, more detailed study, as appropriate for the various potential demand levels. It should be emphasized that this initial screening is intended as a priority ranking for future analysis and comparison to other viable water supply options for the area. It is not the selection of a reservoir site or a water supply alternative.

Based on the results of previous analyses, a maximum reservoir size was identified as that which would provide up to 124 MGD for the entire region. In addition, smaller reservoirs were reviewed that might develop the needed supplies for either the eastern or western portions of the area. The Eastern portion was defined, for planning purposes, as Greene, Barry, and Lawrence Counties, with a total estimated 2050 demand of up to 70 MGD. The western portion consisted of the remaining counties, with a total estimated demand of up to 54 MGD in 2050. The eastern demands are dominated by the City of Springfield and its customers. The western half has its largest demands in the Joplin and Carthage area with the rest being more widely dispersed.

In all, 14 different potential reservoir sites were identified, four of which are off-channel reservoir sites. These were located on smaller tributaries with varying levels of pumping assumed from an adjacent major river channel. The sites are described more fully in
Chapter 3 and shown in Figure 3-1. Eleven sites were developed sufficiently for a conceptual development cost. The estimated costs included:

- Dam construction
- Land acquisition
- Conflicts and relocations, including homes, roads, and utilities
- Environmental mitigation lands
- Water Transmission costs for raw water moved to the Joplin and/or Springfield areas.

Treatment and distribution costs were not included. The costs are approximate due to the cursory level of review and do include an appropriate level of contingencies. They should be considered primarily for comparison and ranking as significant changes or errors are likely to affect all the estimates in a similar manner.

Table ES.1 is a summary of the conceptual costs in 2009 dollars for the construction of the dams, land acquisition, and pipeline costs, including estimated total annual costs. Details of the particular elements that support the costs estimates are described in the main report. The table lists the results for the total area, west region, and east region respectively, ranked in order by the unit cost of water in dollars per 1,000 gallons.

The costs of a single reservoir site for the entire region tend to be prohibitively high due to the high transmission costs. Site 10 would be the most economical site at $637 million. It has a very cost effective site for dam construction, but the land and transmission costs are very high. This also does not address the issue of balancing the timing of payment and needs among the various participants as well as possible permitting issues related to interbasin transfers.
Table ES.1  
Total Development Costs

<table>
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<tr>
<th>Reservoir Site</th>
<th>Service Region</th>
<th>Yield (MGD)</th>
<th>Dam Cost ($Mil)</th>
<th>Land Acquisition Cost ($Mil)</th>
<th>Transmission Cost ($Mil)</th>
<th>Total Cost ($Mil)</th>
<th>Capital Unit Cost ($Mil/MGD)</th>
<th>Total Annual Cost ($Mil/Yr)</th>
<th>Unit Cost of Water ($/1000 gal)</th>
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<td>3.3</td>
<td>20</td>
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<td></td>
<td></td>
</tr>
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<td>$179</td>
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<td>20</td>
<td>0.94</td>
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</table>

* Option A includes the cost for a pipeline from the reservoir directly to the water treatment plant. Option B includes costs for releasing water into Shoal Creek and re-diverting it near the existing Joplin Water Treatment Plant.
It would be much more cost effective to build two reservoirs sized for each particular region. For comparison, the two sites with the lowest unit costs of water, Site 10a for the east and Site 11 for the west, combined provide 114 MGD for a total of $381 million, a savings of more than $250 million. Two dams would also provide more flexibility in the timing of development and the possible permitting constraints involved with interbasin transfers.

Therefore, it is recommended that the concept of a single reservoir for the entire region not be considered further. For the Eastern portion, Site 10 is the most cost effective site that supplies the full potential demand. However, Site 10a could be developed at a significantly lower unit cost and also would likely have significantly less political and public resistance. In addition, because it is an off-channel reservoir, it will likely have less environmental permitting resistance as well. However, the most water supply that Site 10a could produce was estimated to be 59 MGD, due to the limitations on storage caused by the existence of the town of Hurley. If Site 10a is to be developed, either the City of Springfield would have to accept slightly less than their estimated deficit or Barry and Lawrence Counties would have to look to the development of the reservoir in the western region. Therefore, we recommend that Site 10a be considered for further review, with Site 10 considered a backup.

For the western region, two sites, 8 and 11, generate sufficient water supply and are the most cost effective by a significant margin. They were estimated to cost $197 and $202 million for 59 and 55 MGD, respectively. Both use the assumption that water can be transported down Shoal Creek to the current intake of the Joplin water treatment plant. This dramatically reduces the cost of transmission and is the primary reason for the lower
cost of development. However, even if the water had to be piped all the way to the assumed treatment area, the two sites would still be the two most cost effective sites in the west. Though Site 8 has a lower unit capital cost for development, Site 11 has a lower unit cost of water due to lower pumping costs. Therefore, we recommend that both Sites 8 and 11 be considered for further review, with each site given equal priority.

The recommended combination of reservoirs for further study included Sites 8 or 11 in the west and Site 10a in the east. Combined, these reservoirs can provide up to 118 MGD for a total estimated capital cost, in 2009 dollars, of $376 million (Site 8) to $381 million (Site 11) for raw water delivered to the assumed treatment locations in the Springfield and Joplin areas.

For comparison purposes, cost estimates have been prepared for transmitting water from three existing reservoirs to the eastern and western service areas in a manner similar to that studied in previous reports. Table ES. 2 is a summary of the conceptual costs for water transmission facilities from Table Rock Lake, Stockton Lake, and Grand Lake O’ the Cherokees to Joplin and Springfield. These costs, however, do not include any purchase cost of the raw water itself from the current dam owner.

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Service Region</th>
<th>Average Supply(MGD)</th>
<th>Transmission Cost ($Mil)</th>
<th>Total Annual Cost ($Mil)</th>
<th>Unit Capital Cost ($/Mil/MGD)</th>
<th>Unit Cost of Water ($/1000 gal)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>54</td>
<td>$306</td>
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<tr>
<td>Grand Lake</td>
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<td>54</td>
<td>$200</td>
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<td>54</td>
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<td>Grand Lake</td>
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<td>$194</td>
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As can be seen in Table ES.2, these costs are competitive with the reviewed alternatives of developing surface water supply from new reservoirs.

In the development of new surface water supply in the region of the Tri-State Coalition, two primary potential supply sources have been identified, new reservoirs and pipelines transmitting water from the one or more of the existing reservoirs. Obtaining water from the existing reservoirs faces significant political and regulatory obstacles and may or may not be feasible. Likewise, developing new reservoirs of the size considered in this report also face considerable political and regulatory challenges and should be expected to take roughly 15 to 20 years to develop, including planning, permitting, design, and construction. Currently, there is not sufficient information known about either option to rule one out at this time. Both avenues should be pursued until one is determined to be not viable. The following steps should be taken to continue the review:

Develop a more detailed analysis of the needed water supply, timing of that need, and comparison of local supply alternatives with the proposed regional options.

Continue discussion with appropriate federal authorities, as well as the Grand River Dam Authority to determine viable options for water supply, either for the Coalition or for individual entities.

Perform a more detailed review of each recommended site, including a geotechnical analysis of the foundations and a design flood analysis. This should be done for at least Sites 8, 11, and 10a, and possibly for Site 10, if funding is available.