Contract No.: W912DQ-08-D-0048
Task Order 0014

# Final
# Stage 1 Pipeline
# Preliminary Engineering Report

## U.S. Army Corps of Engineers
## Kansas City District

**Northwest Missouri Regional Water Supply Study – Phase IV**

May 12, 2011

US Army Corps of Engineers
Kansas City District

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Missouri Department of Natural Resources

CDM

# Northwest Missouri Regional Water Supply
# Transmission System Study
# Phase IV

**Final**
**Stage 1 Pipeline Preliminary Engineering Report**

**May 2011**


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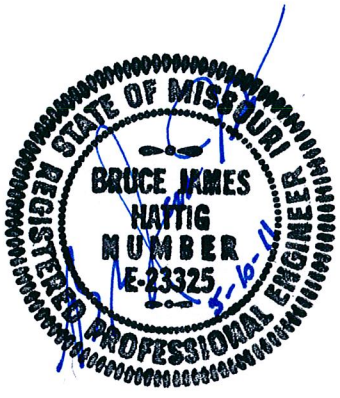


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# Acronyms/Abbreviations

| | |
|---|---|
| ACWWC | Atchison County Wholesale Water Commission |
| CDM | CDM Federal Programs Corporation |
| Commission | Great Northwest Wholesale Water Commission |
| GPCD | gallons per capita per day |
| HP | horsepower |
| kgal | 1,000 gallons |
| kwh | kilowatt-hours |
| M | million |
| MDNR | Missouri Department of Natural Resources |
| MGD | million gallons per day |
| O&M | operations and maintenance |
| OPC | opinion of probable cost |
| PAS | Planning Assistance to States |
| PER | Preliminary Engineering Report |
| psi | pounds per square inch |
| PWSD | Public Water Supply District |
| USACE | U.S. Army Corps of Engineers |
| WTP | water treatment plant |

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# Executive Summary

Under the July 15, 2010 Planning Assistance to States cost share agreement between the U.S. Army Corps of Engineers and the Missouri Department of Natural Resources Water Resources Center, CDM Federal Programs Corporation was requested to provide engineering and technical support services to the Kansas City District for Phase IV of the Northwest Missouri Regional Water Supply Study. The objective of Phase IV is to provide a Preliminary Engineering Report (PER) for the Stage 1 Pipeline and to provide an update to the 2009 *Phase II Feasibility Study* tailored for the current Great Northwest Wholesale Water Commission (Commission) membership. This report serves as the PER for the Stage 1 Pipeline. The Feasibility Study Update is a separate document, but relies heavily on the conclusions summarized herein.

The Stage 1 Pipeline PER was been completed as a follow-up to the Phase 1, 2 and 3 reports prepared for the Commission. In this study, three water suppliers, Missouri-American, the City of Savannah, and the Atchison Wholesale Water Commission, were compared to determine the most cost effective supplier to provide water to 12 of the current Commission members. These 12 members are Andrew County PWSD #1, Andrew County PWSD #4, City of Albany, City of Barnard, City of Bolckow, City of King City, City of Stanberry, Davies County PWSD #1, DeKalb County PWSD #1, Gentry County #1, Gentry County #2, and Nodaway County #1.

The pipeline lengths and diameters vary between the three options as summarized below in Table ES-1 and ES-2.

**Table ES-1**
**Alternative Comparison**

| Criteria | ACWWC | Savannah | Missouri-American |
|---|---|---|---|
| Pipeline Length | 127 miles | 108 miles | 113 miles |
| No. of Storage Tanks | 2 | 2 | 3 |
| Add'l Construction Requirements | None | Ammonia Facilities | Clearwell |
| OPC | $88,500,000 | $43,400,000 | $52,100,000 |
| | | | |
| Water Supply Capacity | 6 MGD | Up to 3.9 MGD | Existing 8.0 MGD |
| Cost of Water Per Year | $3,400,000 | $3,400,000 | $1,500,000 |
| Estimated Annual Cost | $8.8 Million | $6.1 Million | $4.7 Million |

While the Savannah alternative has the lowest estimated construction cost, the higher water purchase rate from Savannah and lower potential water treatment capacity do not recommend its selection. It was recommended to purchase water from Missouri-American to supply the Stage 1 pipeline. . The Commission may elect to purchase water from both Savannah and Missouri-American with little additional cost due to Savannah's proximity to the proposed wholesale water pipeline. The recommended waterline alignment and sizing information is shown in Figure 4-2.

The operation and maintenance, replacement, debt service and water purchase costs were combined to project an average cost per 1,000 gallons of water for a wholesale service rate for $8.83 per 1,000 gallons or an estimated customer monthly wholesale cost (purchasing 5,000 gallons) of $44.14 per 1,000 gallons. Grant money, should it be available, would reduce the cost significantly and should be pursued by the Commission. The debt services costs were based on 4.75-percent over 33 years.

This report also suggested a series of "Next Steps" for the Commission to proceed with in order to move forward with this project. Three of the most major of those items are identified below:

- The Commission needs to solicit actual water sales numbers from the member utilities to verify that they will be served by the Stage 1 Pipeline and to what extent. Several of the members may request only a portion of the flow choosing to continue either purchasing water from another source or treating their own water. The assumed water demands represent the single largest assumption in this PER. Should a significant number of the utilities choose to purchase a fraction of the total water sales, the OPCs will reduce greatly, as will the volume of water sales.
- Negotiate a water purchase contract with Missouri-American contingent on obtaining funding and receiving water sales agreements with the Commission membership.
- Obtain project funding through the Missouri Water and Wastewater Review Committee or through private lenders.

# Section 1
# Introduction

Under the July 15, 2010 Planning Assistance to States (PAS) cost share agreement between the U.S. Army Corps of Engineers (USACE) and the Missouri Department of Natural Resources (MDNR) Water Resources Center, CDM Federal Programs Corporation (CDM) was requested to provide engineering and technical support services to the Kansas City District for Phase IV of the Northwest Missouri Regional Water Supply Study. The objective of Phase IV is to provide a Preliminary Engineering Report (PER) for the Stage 1 Pipeline and to provide an update to the 2009 *Phase II Feasibility Study* tailored for the current Great Northwest Wholesale Water Commission (Commission) membership. This report serves as the PER for the Stage 1 Pipeline. The Feasibility Study Update is a separate document, but relies heavily on the conclusions summarized herein.

Funding for this study was provided through the USACE Planning Assistance to States (PAS) Program, Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251) as amended to assist the States in the preparation of comprehensive plans for the development, utilization and conservation of water and related land resources, and Section 319 of the Water Resources Development Act of 1990 (Public Law 101-640). The Missouri Department of Natural Resources (MDNR), as the non-Federal sponsor of the PAS agreement, utilized State general revenue funds for 50-percent of this study's cost. CDM and Bartlett & West completed the work on both documents under this agreement.

The PER and Feasibility Study Update also rely heavily on the data from previous studies and information provided by MDNR, the Commission and its membership and specific non-member water utilities that were identified as potential water supply options. Special recognition should also be given to the important role the Northwest Regional Council of Governments made by supporting communication with the Commission over the course of the project.

## 1.1 Stage 1 Pipeline Project Description

The Commission membership included the 24 water utilities shown in Table 1-1at the time this project was initiated. The Commission Strategic Planning Sub-Committee, along with MDNR and USACE assistance, identified the initial Stage 1 Pipeline alignment shown in Figure 1-1. The transmission main from King City east to Daviess County PWSD No. 1 shown on the figure is an optional add-on alternative.

**Table 1-1**
**October 2010 GNWWWC Membership**

| |
|---|
| Andrew County Public Water Supply District (PWSD) #1 |
| Andrew County PWSD #2 |
| Andrew County PWSD #4 |
| Buchannan County PWSD #1 |
| City of Albany |
| City of Barnard |
| City of Bolckow |
| City of Cameron |
| City of Gallatin |
| City of Grant City |
| City of King City |
| City of Maitland |
| City of Maysville |
| City of Plattsburg |
| City of Ravenwood |
| City of Savannah |
| City of Stanberry |
| City of Stewarstville |
| Clinton County PWSD #1 |
| Davies County PWSD #1 |
| DeKalb County PWSD #1 |
| Gentry County #1 |
| Gentry County #2 |
| Nodaway County #1 |

Three nearby potential water suppliers were identified as alternatives to serve the Stage 1 Pipeline: Missouri-American (located in St. Joseph, Missouri), City of Savannah, and the Atchison County Wholesale Water Commission (ACWWC).

The intent of this report is to determine the potential water demand for the Stage 1 Pipeline, evaluate the three water supply options, provide a recommendation as to the lowest cost source, and provide construction cost information to the Commission to pursue funding.

# 1.2 Project Background

A group of interested parties and stakeholders from Northwest Missouri established a Water Partnership planning group consisting of representatives from each of the 12 counties Northwest Missouri. The 12 counties included Andrew, Atchison, Buchanan, Caldwell, Clinton, Davies, DeKalb, Gentry, Harrison, Holt, Nodaway, and Worth. The goal of the Water Partnership was to explore options for a regional plan to provide a long-term, affordable, high-quality water supply.

During the 2007 Phase I study, 83 public water systems in the 12 county area were evaluated with regards to their water supply capacity (including source capacity and treatment capacity), ability to withstand drought, and adequacy of water treatment facilities (including excess capacity, age of treatment facilities, and compliance with drinking water standards). Only 40 of the 83 systems had their own water supply sources. Other potential water supply sources for the 12 county area were identified and evaluated. These sources included aquifers, potential reservoir sites, off stream diversions, and other suppliers (City of Kansas City, Missouri, Rathburn Reservoir in Iowa, and Missouri-American Water Company of St. Joseph). The water supply demands were identified, including the existing unserved population, anticipated population growth, and other needs including commercial and industrial projections. The initial studies identified seven of the current water systems that could serve as hubs in a more comprehensive, long-range plan. These systems have the capacity to continue meeting the needs of their current service area while providing additional water to a regional system. The Water Partnership and an appointed engineering/technical subcommittee were assigned responsibility for identifying and evaluating alternative solutions to address the water supply needs for the 12 county area. The subcommittee identified and evaluated several alternatives, and provided the Water Partnership with a recommended water supply transmission system plan. The recommendation was adopted by the Water Partnership as the best alternative to evaluate for implementation in Phase II of the study.

The Phase II study, completed March 6, 2009, provided the preliminary planning report with cost estimates for the regional water supply transmission system and a framework for implementing the regional water supply system outlined in Phase 1.

The Water Partnership eventually formed the Commission that has 24 member utilities as of the beginning of 2011. The Phase III study completed in 2010 provided a methodology for water supply facilities to compare cost, a discussion of how current and future regulatory issues may impact groundwater and surface water supplies, and an analysis of the availability, reliability, and quality of current groundwater and surface water supplies.

As the follow on to the previous work, CDM and Bartlett & West were retained to complete that Phase IV work described above.

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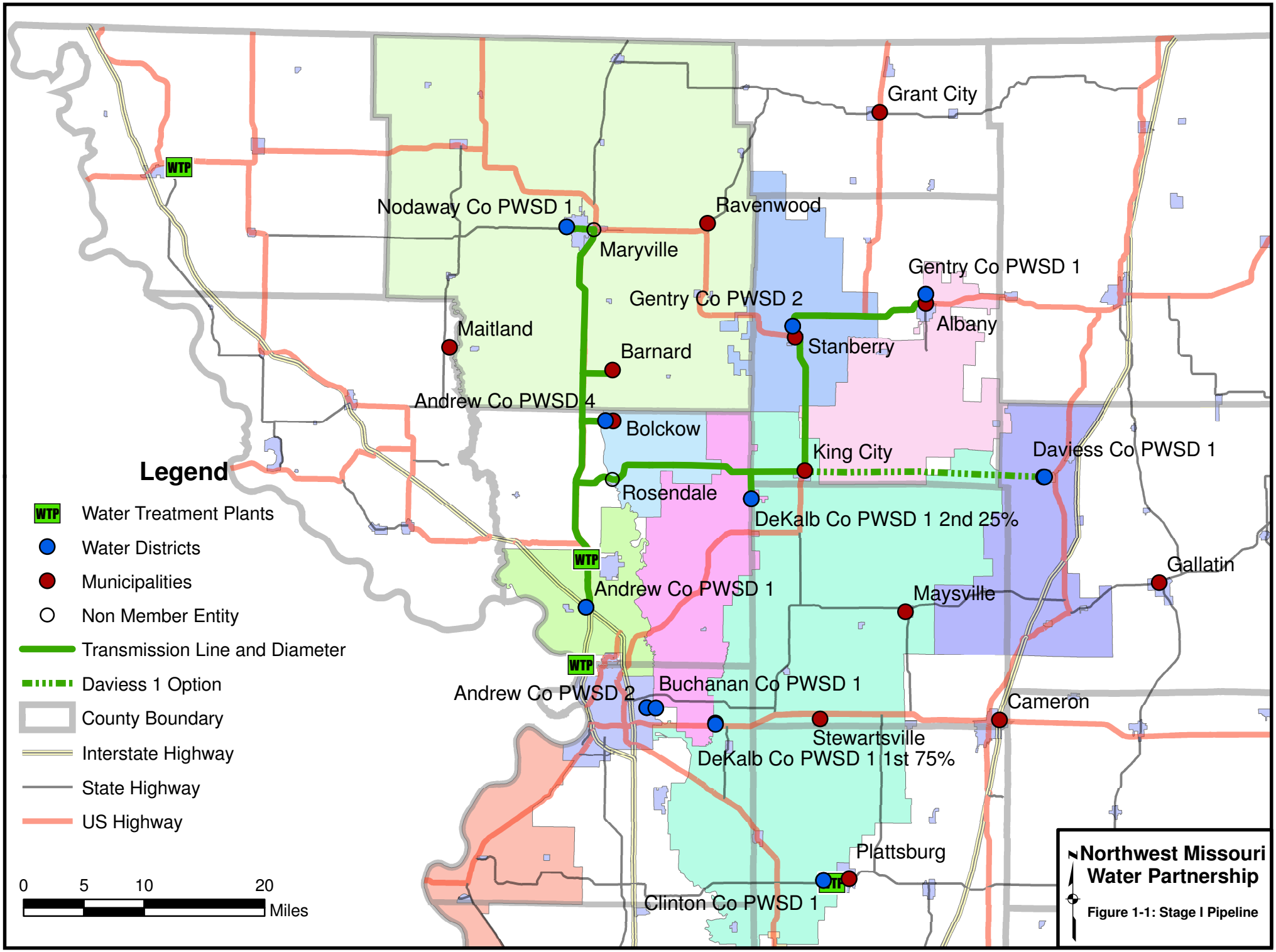

Grant City
WTP
Nodaway Co PWSD 1
Ravenwood
Maryville
Gentry Co PWSD 1
Gentry Co PWSD 2
Albany
Maitland
Stanberry
Barnard
Andrew Co PWSD 4
Bolckow
King City
Daviess Co PWSD 1
Legend
Rosendale
DeKalb Co PWSD 1 2nd 25%
Water Treatment Plants
Water Districts
Municipalities
Non Member Entity
Transmission Line and Diameter
Daviess 1 Option
County Boundary
Interstate Highway
State Highway
US Highway
WTP
Andrew Co PWSD 1
Gallatin
Maysville
WTP
Andrew Co PWSD 2
Buchanan Co PWSD 1
Cameron
Stewartsville
DeKalb Co PWSD 1 1st 75%
Plattsburg
WTP
Clinton Co PWSD 1
0
5
10
20
Miles
Northwest Missouri Water Partnership
Figure 1-1: Stage I Pipeline

# Section 2
# Future Water Need Projections

## 2.1 Description of Need

Water has long been identified as a key driver in the success and stability of population trends. In northwest Missouri, many communities depend on access to the Missouri River and its alluvial aquifers or reservoirs for water supply. Those without access to these sources purchase water from a wholesale supplier. The *Northwest Missouri Regional Water Supply Transmission System Study Phase III Report* dated May 2010 provides a summary of water supply issues in the northwest region of Missouri. The *Phase III Report* discussed four primary topics: formation of the Commission, cost of water, current and future regulatory issues and drinking water sources within the region and on a county-by-county basis.

This report provides water system sizing and cost information specific to the 24 current Commission members individually, rather than analyzing the entire 12 county area as done in the 2007 *Phase I Report*. The methodology, assumptions, and projected demands are summarized below.

## 2.2 Future Water Need Projections

Historical growth trends and water usage surveys for the 24 Commission members were compiled and studied and from that, projections extending to year 2030 were completed. Water demands are projected to the year 2030, which is anticipated to be the first year that all phases of the conceptual system would be built and in operation. This work was performed under the 2007 *Phase 1 Report* and modified in the 2009 *Phase II Report*, but have been updated as part of this work. The objective was to determine the overall amount of water demand required by the Commission members when all phases of the project would be constructed and in operation.

The 1950 through 2000 city and county population data was provided by the Missouri Census Data Center. The 2006 population data was also used if available from the 2007 *Phase I Report*. The historic population trend and population projections through 2030 are shown in Appendix A. Six utilities have a negative population growth since 1950. For those utilities, it was assumed that the current water demands would remain as is without any decline in the future.

Historical water demand data was requested from each Commission member. If data was not available, data from the 2007 *Phase I Report* was used. In certain cases, the water demand and sales numbers were modified due to one Commission member selling water to a second member. These changes were made to provide a more realistic view of the water demands for the membership and not to double count water needs.

Similar to the methodology used in the 2007 *Phase 1 Report* and in the modified 2009 *Phase II Report*, the entire water usage for selected communities has been included in the wholesale supply system. This acknowledges that most of these supplies are aging beyond their expected service life, or suffer from water quality or quantity issues. An important trend identified in the Phase I effort is that of the 83 systems in the region, 43 purchase water from a neighboring community. At one time, 24 of those 43 systems had their own source supply. Since many aging and degrading supplies remain, regionalization and consolidation of water suppliers will likely continue, even in absence of a regional comprehensive system. The assumption that a majority of communities will have abandoned their water supplies within the next 20 years is validated by the trends seen in the area.

### 2.2.1 Calculation Methodology

The calculations are presented in Appendix A of this report. The 2009 water demand data were divided by the 2009 utility population projections to determine a gallon per capita per day (GPCD). The GPCD was then multiplied by the 2030 projected population to determine the annual water demand and average day water demand. Consistent with the 2009 *Phase II Report*, a peaking factor of 2.0 was multiplied by the average day water demand to estimate the maximum day demands.

One important note was that the population data for water districts was projected from the population data included in the 2007 *Phase I Report*, which used the district reported population and calculated a percentage of the total county population served in 2006. That percentage was assumed to remain constant and multiplied by the individual County growth projections to determine the District population growth.

Table 2-1 summarizes the water demand results of the Commission.

**Table 2-1**
**Summary of Commission Demands**

| District/City | Water Demands (MGD) | |
|---|---|---|
| | Current Max. Day | 2030 Max. Day |
| Andrew County PWSD #1 | 1.02 | 1.17 |
| Andrew County PWSD #2 | 0.73 | 0.84 |
| Andrew County PWSD #4 | 0.07 | 0.09 |
| Buchannan County PWSD #1 | 0.35 | 0.35 |
| City of Albany | 0.44 | 0.50 |
| City of Barnard | 0.04 | 0.05 |
| City of Bolckow | 0.10 | 0.10 |
| City of Cameron | 2.68 | 3.33 |
| City of Gallatin | 0.75 | 0.78 |
| City of Grant City | 0.25 | 0.25 |
| City of King City | 0.20 | 0.20 |
| City of Maitland | 0.05 | 0.05 |
| City of Maysville | 0.17 | 0.19 |
| City of Ravenwood | 0.06 | 0.07 |
| City of Stanberry | 0.23 | 0.23 |
| City of Stewarstville | 0.10 | 0.13 |

**Table 2-1 (Continued)**

| District/City | Water Demands (MGD) | |
|---|---|---|
| | Current Max. Day | 2030 Max. Day |
| Clinton County PWSD #1 | 0.12 | 0.16 |
| Davies County PWSD #1 | 0.31 | 0.32 |
| DeKalb County PWSD #1 | 1.41 | 1.62 |
| Gentry County #1 | 0.25 | 0.25 |
| Gentry County #2 | 0.10 | 0.10 |
| Nodaway County #1 (1) | 0.60 | 0.60 |
| City of Plattsburg | 1.85 | 2.07 |
| City of Savannah | 0.92 | 1.13 |
| Total (Excluding Plattsburg & Savannah) | 10.03 | 11.38 |
| Total w/ 15% Additional Growth Included | 11.53 | 13.09 |

Note 1: Assumes only another 0.3MGD average day and 0.6 MGD maximum day purchased not full system demand
MGD = million gallons per day

The resulting total annual percentage change was 0.61-percent per decade as opposed to 0.26-percent per decade presented in the 2007 *Phase I Report*. However, the 2007 *Phase I Report* analyzed 80 utilities over 12 counties and was a much broader assessment of the area. These projections are tailored specifically to the utilities shown.

This methodology does not account for any future water demands in excess of the current customer base. The overall water demand was increased by 15-percent to allow for some future water sales or supply to water utilities near the transmission mains that are not current Commission members.

### 2.2.2 Stage 1 Pipeline Water Demands

Table 2-2 provides a summary of the Stage 1 water system demands used for the Stage 1 Pipeline.

**Table 2-2**
**Summary of Stage 1 Water System Demands**

| District/City | Water Demands (MGD) | |
|---|---|---|
| | Current Max. Day | 2030 Max. Day |
| Andrew County PWSD #1 | 1.02 | 1.17 |
| Andrew County PWSD #4 | 0.07 | 0.09 |
| City of Albany | 0.44 | 0.50 |
| City of Barnard | 0.04 | 0.05 |
| City of Bolckow | 0.10 | 0.10 |
| City of King City | 0.20 | 0.20 |
| City of Stanberry | 0.23 | 0.23 |
| Davies County PWSD #1 | 0.31 | 0.32 |

**Table 2-2 (Continued)**

| District/City | Water Demands (MGD) | |
|---|---|---|
| | Current Max. Day | 2030 Max. Day |
| DeKalb County PWSD #1 (1) | 0.35 | 0.40 |
| Gentry County #1 | 0.25 | 0.25 |
| Gentry County #2 | 0.10 | 0.10 |
| Nodaway County #1 (2) | 0.60 | 0.60 |
| Total | 3.71 | 4.01 |
| Total w/ 15% Additional Growth Included | 4.27 | 4.61 |

Note 1: Listed demand for DeKalb County PWSD #1 includes 25 percent of overall utility demand for Stage 1

Note 2: Assumes only another 0.3 MGD average day and 0.6 MGD maximum day purchased not full system demand

It is important to note that Nodaway County PWSD No. 1 currently purchases all of its water from the City of Maryville and has a long term water purchase contract with that supply. The 0.6 MGD maximum day demand is an estimate of the demands for the unserved areas within Nodaway County that could be served by the Commission supply rather than the Maryville Supply.

Several Commission members on the Stage 1 Pipeline already purchase water from Missouri-American. To maintain an equal comparison between the Savannah, ACWWC, and Missouri-American supply alternatives it is assumed that these water demands are part of the water purchased from any of the three system suppliers.

# Section 3
# Conceptual Design Criteria

The goal of this conceptual design was to evaluate an overall transmission system for the existing 24 Commission members. For the overall system design, each member has a transmission line connecting their current master meter locations to the overall system. EPANET 2.0 modeling software was used to evaluate the overall system.

The input parameters used to create the EPANET model and the output data can be found in Appendix B. The piping, pumping, and storage facilities for the conceptual plan are shown in Figure 3-1.

To create the overall system model, points were assigned for each utility which represents where they would receive water from the Commission. The actual connection points were selected by referencing the water distribution and transmission system maps provided by the individual utility and referencing the knowledge of wholesale water suppliers to the current membership.

Further, DeKalb County PWSD #1 has two connection points in the system. It was assumed based on pipe diameter that the northern connection point would receive 25 percent of the demand, and the southern connection point would receive 75 percent of the demand.

## 3.1 Model Criteria and Pipeline Sizing

The hydraulic criteria used in the model are indicated in Table 3-1. These criteria were chosen to minimize energy costs while optimizing storage and pumping facilities. A maximum pressure was selected to minimize the need for energy dissipation at delivery points. Most Commission members should be able to accept incoming water at this selected pressure without the need for throttling or higher pressure class pipelines. Some individual utilities may need to install booster pump stations to meet their individual pressure requirements.

**Table 3-1**
**Model Development Criteria**

| Model Constraint | Value |
|---|---|
| Allowable Friction Headloss Range | 5 to 16 feet per mile |
| Target Pressure Range | 40 - 150 PSI |
| Allowable Pressure Range | 20 - 200 PSI |
| Maximum Transmission Velocity | 3.5 feet per second |
| Storage Tank Volume | 10% transmission flow |
| Maximum Horsepower (HP) per Pump | 300 HP |
| Hazen-Williams Roughness Coefficient | 140 |

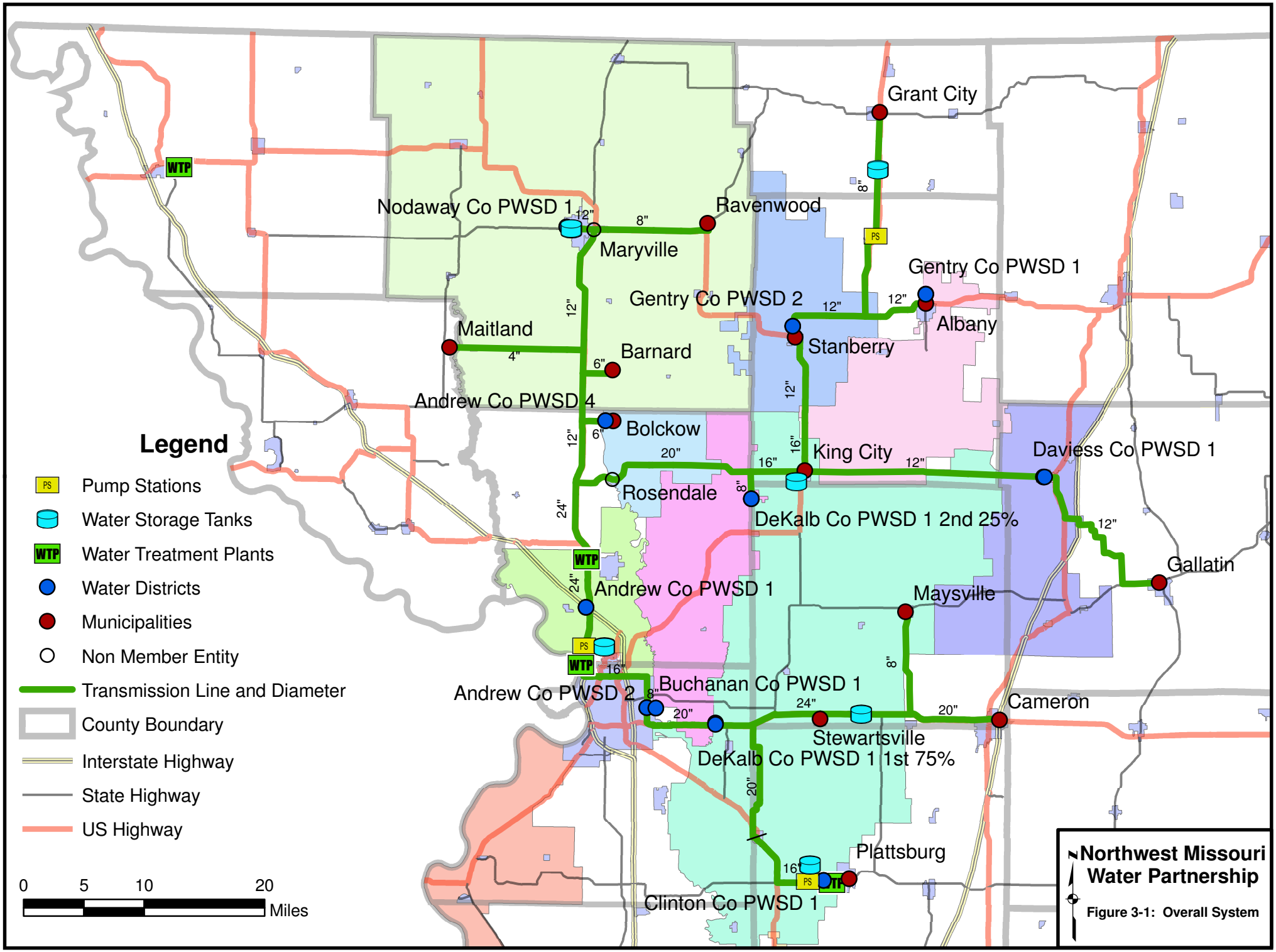
PSI = pounds per square inch
HP = horsepower

## 3.2 Pumping Facilities

Pump stations are located in areas where free-flowing pressures from elevated storage or other pump stations would drop below 20 psi. The pump stations are sized to provide flow for peak daily demands in a 24-hour delivery period. Individual pumps were limited to 300 HP to allow low voltage (480 volt or less) equipment while keeping conductor sizes within a reasonable and economical range.

## 3.3 Water Storage Facilities

Storage facilities are located where the combination of elevation and pipeline friction losses cause pipeline pressure upstream of the pump station to exceed 200 psi. Storage facilities were sized in the transmission system for pump station equalization only. Each member of the Commission will be responsible for their own internal storage needs. Some storage capacity is available on the transmission system, but it is assumed that emergency storage will be provided by each member of the Commission. Recirculation systems will be needed to maintain disinfectant residuals.


Legend
Pump Stations
Water Storage Tanks
Water Treatment Plants
Water Districts
Municipalities
Non Member Entity
Transmission Line and Diameter
County Boundary
Interstate Highway
State Highway
US Highway
0 5 10 20
Miles
Grant City
Nodaway Co PWSD 1
Ravenwood
Maryville
Gentry Co PWSD 1
Gentry Co PWSD 2
Albany
Maitland
Stanberry
Barnard
Andrew Co PWSD 4
Bolckow
King City
Daviess Co PWSD 1
Rosendale
DeKalb Co PWSD 1 2nd 25%
Gallatin
Andrew Co PWSD 1
Maysville
Buchanan Co PWSD 1
Andrew Co PWSD 2
Cameron
Stewartsville
DeKalb Co PWSD 1 1st 75%
Plattsburg
Clinton Co PWSD 1
Northwest Missouri Water Partnership
Figure 3-1: Overall System

# Section 4
# Stage 1 Pipeline Alternatives

Three wholesale water suppliers were considered to serve the Stage 1 Pipeline. These suppliers include the emerging ACWWC, Missouri-American Water Company in St. Joseph, and the City of Savannah. There are additional supply hubs in the area, Middlefork Water Company being one example, that do have the capability of providing minor quantities of potable water as compared to the three major suppliers named above. These additional local contributors may be considered in the preparation of a final design, but are not further evaluated as part of the preparation of this PER. Water quality from these smaller sources should also be investigated and confirmed to be compatible with the primary source. All sources should have chloramines as the residual disinfectant and be of similar water hardness and pH.

A survey of the three suppliers was completed as an initial task of the Phase II Feasibility Report and was updated again as a portion of this PER. In the survey, the suppliers were asked to define their current capacity and describe any expansion plans. They were also asked to report their current wholesale water rates. Copies of the correspondence with the suppliers are provided in Appendix C. This data was incorporated into the report and provided for the Commission's reference.

## 4.1 Atchison County Wholesale Water Commission

The ACWWC is currently under design and is scheduled to go online in mid 2013. The initial construction will include a 2.5 MGD groundwater treatment facility and well field. This facility will not have excess treatment or transmission capacity, but the site was selected to allow for future expansions up to 10 MGD. The ACWWC has not set a wholesale water rate, but the 2008 facility plan indicates that it will be approximately $4.00 per 1,000 gallons. Assuming an inflation rate of 5 percent per year for 5 years, the 2013 rate will be $5.11 per 1,000 gallons. The ACWWC will provide chloramines as the residual disinfectant and could provide up to 6 MGD to the Commission.

The ACWWC Stage 1 alignment used the new ACWWC Water Treatment Plant (WTP) as its source for the transmission system. The alignment of the ACWWC alternative is shown in Figure 4-1. The transmission system consists of approximately 127 miles of pipeline ranging between 6 and 30 inches in diameter. The system also includes one pump station and two water storage tanks, one near King City and the other near Maryville. The pump station is located at the ACWWC WTP and was designed to pump 6.0 MGD with a head of 376 feet. To keep the pumps at 300 HP or under, there are four pumps in the system, with three operating and one standby. The King City elevated storage tank operating water levels are between 140 and 160 feet above ground and the tank stores up to 400,000 gallons of water. The Maryville standpipe is 200,000 gallons and has a high water level at 63 feet above ground. The storage tanks are not intended to replace any of the Commission members' own storage tanks and were not designed to provide fire protection or emergency storage.

# 4.2 Missouri-American Water Company

Missouri-American Water Company owns and operates the 30 MGD groundwater treatment municipal water system in St. Joseph, Missouri. The WTP currently has a minimum of additional 8 MGD available capacity to serve the Commission. Missouri-American also uses chloramines as the residual disinfectant. The 2010 wholesale water rate structure includes a minimum charge and a water charge per 1,000 gallons as outlined in Table 4-1 below. The projected 2013 rates were inflated at 5 percent per year for 3 years.

**Table 4-1**
**Missouri-American Rate Schedule**

| Rate Class | 2010 Rate ($/kgal) | 2013 Projected Rate ($/kgal) |
|---|---|---|
| Monthly Minimum Charge (12-inch meter) | $1,124.62 | $1,301.89 |
| For the first 100,000 gallons | $4.2794 | $4.95 |
| For the next 1.9 million (M) gallons | $3.3234 | $3.85 |
| For the next 3.0M gallons | $2.7691 | $3.21 |
| For all over 5.0M gallons | $1.8886 | $2.19 |

Several of the existing Commission members currently purchase water from Missouri-American with varying time frames to their existing contracts. It is assumed that when these contracts expire the individual Commission members would then purchase water from the Commission. Further, for this comparison it is assumed that Missouri-American has one meter location that serves the entire Commission and that the declining rate structure is applied to the entire purchase volume as one location.

The Missouri-American Stage 1 alignment used the existing Missouri-American WTP that serves some current Commission members. The alignment of the Missouri-American alternative is shown in Figure 4-2. The transmission system consists of approximately 113 miles of pipeline ranging between 6 and 24 inches in diameter. The system also includes one pump station, one flow control structure, and two storage tanks. The two storage tanks included in this alternative are identical to those sized for the ACWWC Stage 1 Pipeline Alternative. The pump station is located at the Missouri-American site and sized to provide 6.0 MGD firm capacity with a total dynamic head of 255 feet.

In addition, the Commission would need to construct on-site water storage for the new booster pump station at the Missouri-American plant site. The cost for this additional storage is approximately $1.8 million.

# 4.3 City of Savannah

The City of Savannah currently operates a 2.0 MGD municipal groundwater treatment plant constructed in 2008. The 2010 *Drinking Water Facilities Plan* addressed possible plant expansions and provided some projected water rates based on different purchasing scenarios.

The Savannah WTP has free chlorine as its residual disinfectant. All of the other major sources of water are providing chloramines as the residual disinfectant in the system. Purchasing water from the City of Savannah would require the Commission to invest in an ammonia feed facility to convert the residual disinfectant to chloramines to match the other suppliers. This cost is estimated at $70,000 for the initial construction cost and will add an additional operation and maintenance expense to the Commission that is not incurred with the other alternatives. The cost for the ammonia feed facility is included in the Commission's capital cost.

Based on the Facilities Plan assumptions, the plant could be expanded to 5.0 MGD and make available up to 3.9 MGD for Commission use. It is assumed that Andrew County PWSD No. 1 is part of the general Commission demand and not an individual purchaser for this capacity. The Facilities Plan does note that it may be feasible to expand the plant capacity beyond this amount, but further information is needed regarding the well field yield and evaluation of the plant site and lime sludge lagoon layout to make that determination.

Further, an estimated production cost was provided in the report indicating the cost of water would be $3.77 per 1,000 gallons, but this did not include city administration and billing costs. For this PER, these improvements were assumed to add 20 percent to the cost of water rate to account for costs not covered in the *Drinking Water Facilities Plan*. The rates were then inflated at 5 percent per year to a projected 2013 rate of $5.24 per 1,000 gallons.

The Savannah alternative for Stage 1 is similar to the Missouri-American Stage 1 alternative. Savannah's WTP is north of the Missouri-American and the alternative includes a transmission main from the Savannah WTP to the Missouri-American connection. The Savannah alignment is shown in Figure 4-3. The Savannah transmission system is approximately 108 miles of pipeline ranging between 6 and 24 inches in diameter. The storage and pumping facilities sized for the Missouri-American alternative are the same for the Savannah alternative, which is described above.

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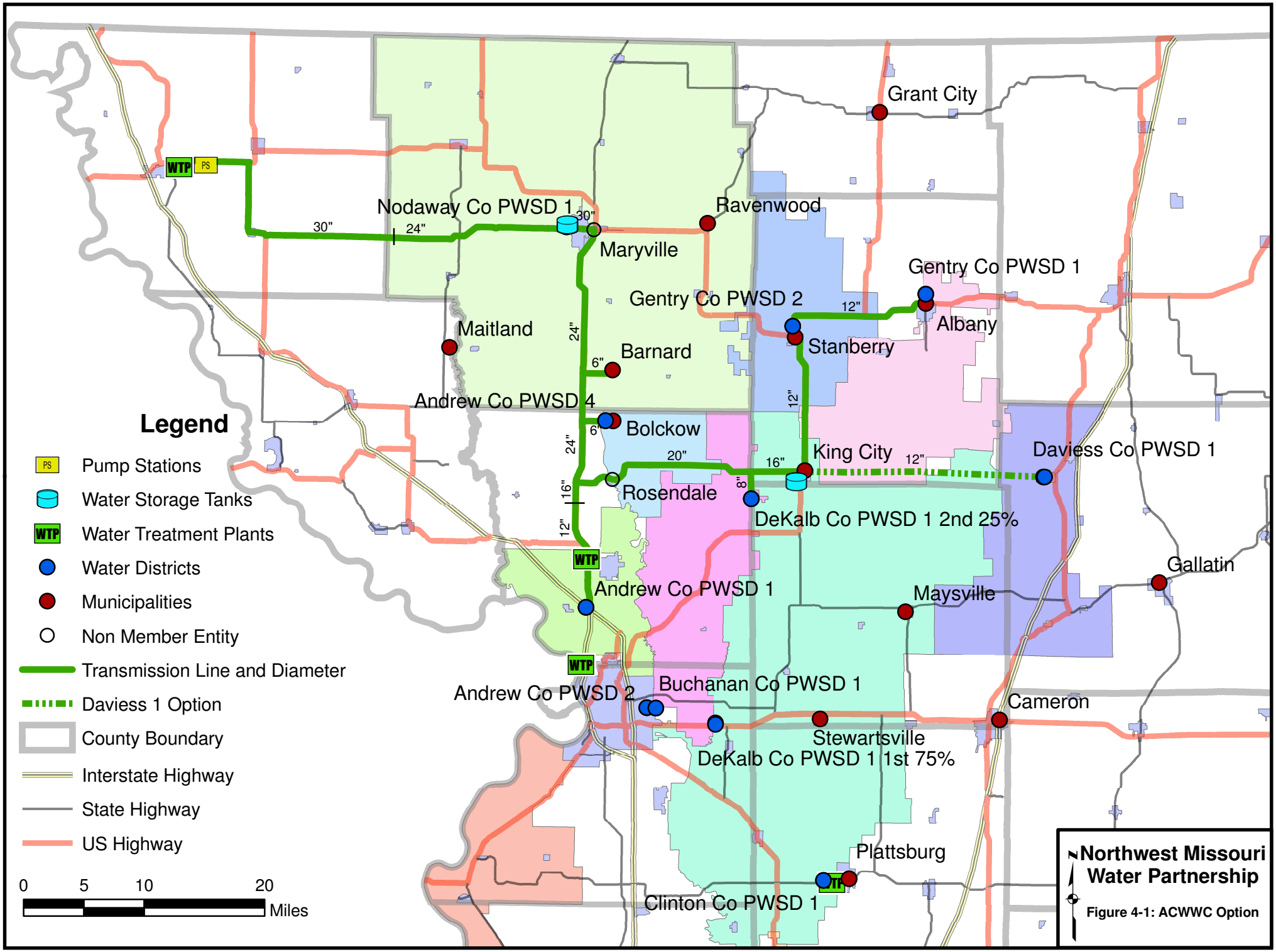
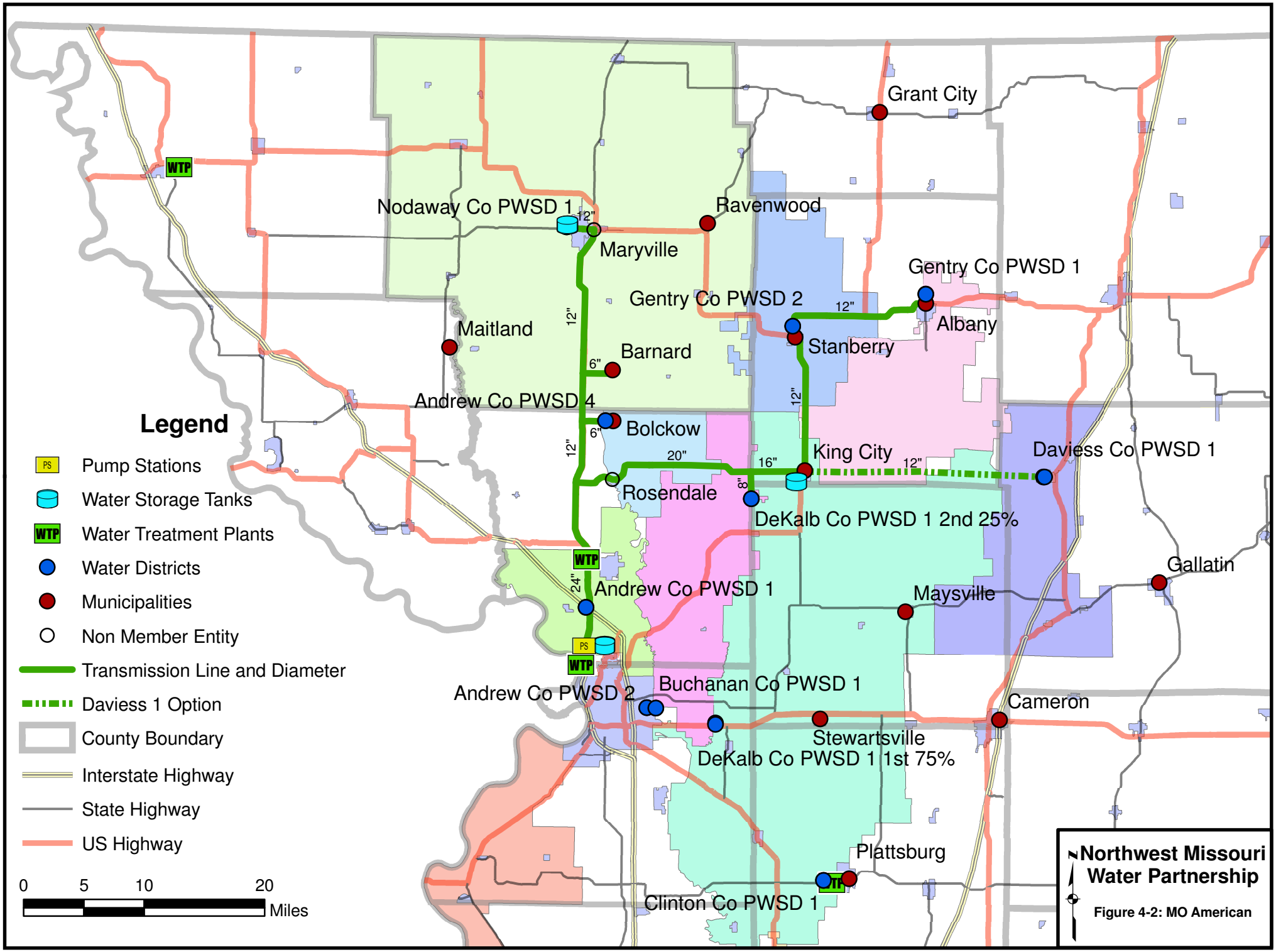
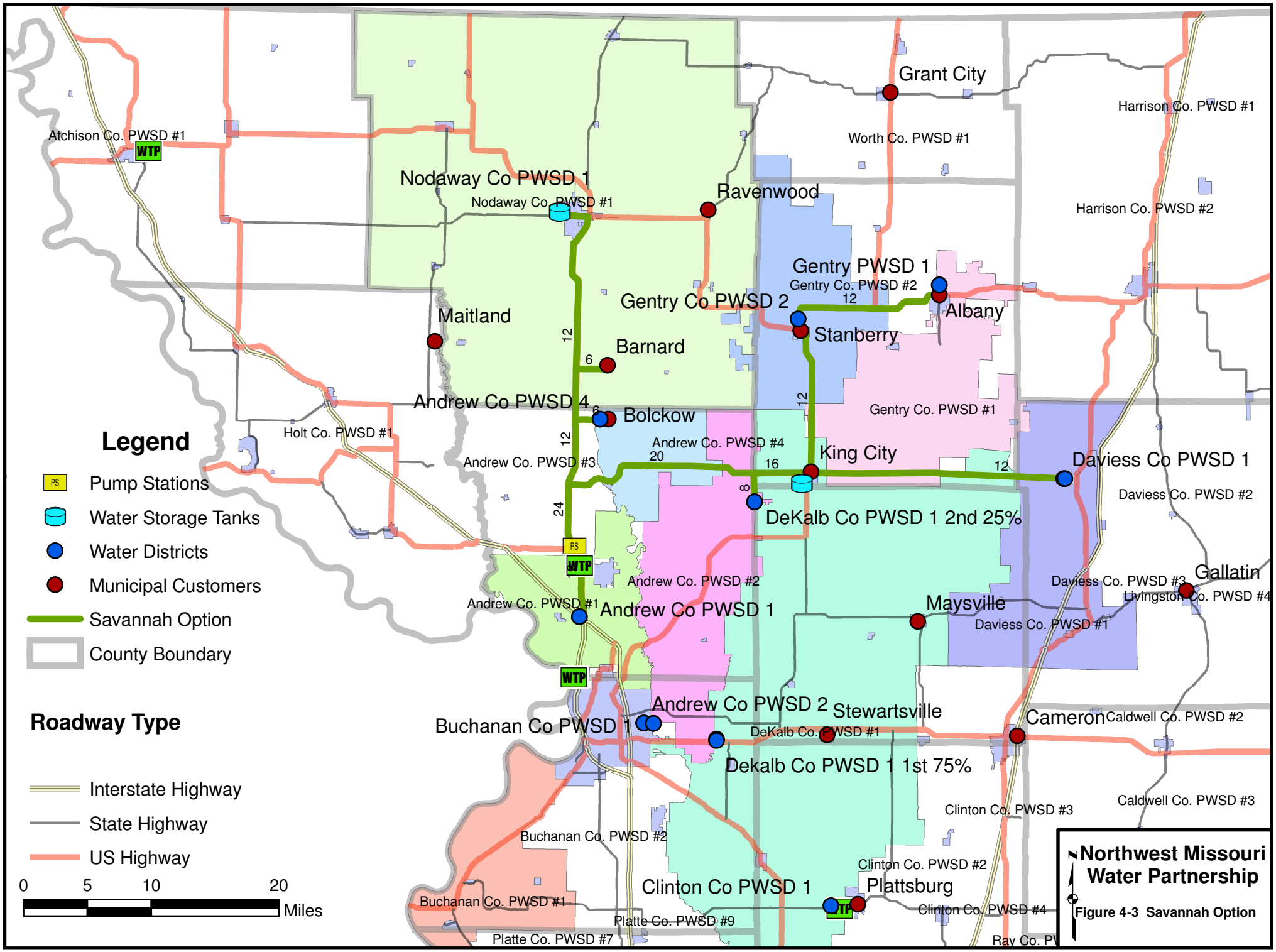

Grant City
Nodaway Co PWSD 1
Ravenwood
Maryville
Gentry Co PWSD 1
Gentry Co PWSD 2
Albany
Maitland
Stanberry
Barnard
Andrew Co PWSD 4
Bolckow
King City
Daviess Co PWSD 1
Rosendale
DeKalb Co PWSD 1 2nd 25%
Gallatin
Andrew Co PWSD 1
Maysville
Buchanan Co PWSD 1
Andrew Co PWSD 2
Cameron
Stewartsville
DeKalb Co PWSD 1 1st 75%
Plattsburg
Clinton Co PWSD 1
30"
24"
12"
6"
20"
16"
8"
Legend
Pump Stations
Water Storage Tanks
Water Treatment Plants
Water Districts
Municipalities
Non Member Entity
Transmission Line and Diameter
Daviess 1 Option
County Boundary
Interstate Highway
State Highway
US Highway
0 5 10 20
Miles
Northwest Missouri Water Partnership
Figure 4-1: ACWWC Option


Grant City
WTP
Nodaway Co PWSD 1
12"
Ravenwood
Maryville
Gentry Co PWSD 1
Gentry Co PWSD 2
12"
Albany
Maitland
12"
Stanberry
Barnard
6"
Andrew Co PWSD 4
12"
Bolckow
6"
King City
20"
16"
12"
Daviess Co PWSD 1
Rosendale
8"
DeKalb Co PWSD 1 2nd 25%
WTP
Gallatin
24"
Andrew Co PWSD 1
Maysville
PS
WTP
Andrew Co PWSD 2
Buchanan Co PWSD 1
Cameron
Stewartsville
DeKalb Co PWSD 1 1st 75%
Plattsburg
WTP
Clinton Co PWSD 1
Legend
PS
Pump Stations
Water Storage Tanks
WTP
Water Treatment Plants
Water Districts
Municipalities
Non Member Entity
Transmission Line and Diameter
Daviess 1 Option
County Boundary
Interstate Highway
State Highway
US Highway
0
5
10
20
Miles
Northwest Missouri Water Partnership
Figure 4-2: MO American


Grant City
Harrison Co. PWSD #1
Atchison Co. PWSD #1
WTP
Worth Co. PWSD #1
Nodaway Co PWSD 1
Nodaway Co. PWSD #1
Ravenwood
Harrison Co. PWSD #2
Gentry PWSD 1
Gentry Co. PWSD #2
Gentry Co PWSD 2
12
Albany
Maitland
Stanberry
12
Barnard
6
Andrew Co PWSD 4
6
Bolckow
12
Gentry Co. PWSD #1
Holt Co. PWSD #1
Andrew Co. PWSD #4
Andrew Co. PWSD #3
20
16
King City
12
Daviess Co PWSD 1
8
Daviess Co. PWSD #2
DeKalb Co PWSD 1 2nd 25%
24
PS
WTP
Andrew Co. PWSD #2
Daviess Co. PWSD #3
Gallatin
Livingston Co. PWSD #4
Andrew Co. PWSD #1
Andrew Co PWSD 1
Maysville
Daviess Co. PWSD #1
WTP
Andrew Co PWSD 2
Stewartsville
Buchanan Co PWSD 1
Cameron
Caldwell Co. PWSD #2
DeKalb Co. PWSD #1
Dekalb Co PWSD 1 1st 75%
Caldwell Co. PWSD #3
Clinton Co. PWSD #3
Buchanan Co. PWSD #2
Clinton Co. PWSD #2
Clinton Co PWSD 1
Plattsburg
WTP
Buchanan Co. PWSD #1
Clinton Co. PWSD #4
Platte Co. PWSD #9
Platte Co. PWSD #7
Ray Co. PW
Legend
PS
Pump Stations
Water Storage Tanks
Water Districts
Municipal Customers
Savannah Option
County Boundary
Roadway Type
Interstate Highway
State Highway
US Highway
0
5
10
20
Miles
Northwest Missouri Water Partnership
Figure 4-3 Savannah Option

# Section 5
# Alternative Comparison and Recommended Source

## 5.1 Opinion of Probable Cost

Opinions of Probable Cost (OPC) for the initial construction cost of the conceptual system were developed using an approach that incorporates actual prices from recent similar rural water projects. Facilities are divided into three classes: pipeline, pump stations, and water storage.

Individual cost opinions were developed for each Stage I Alternative. Pipeline costs were estimated by assuming a unit price per foot for each size of pipe. These prices ranged from $27.00 per linear foot for a 6-inch diameter pipe up to $150.00 per linear foot for a 30-inch diameter pipe. Pipeline unit prices include design, material, installation, and easement acquisition.

Pump station costs were estimated by assuming a fixed cost for a pump station, which includes design, land, structure, power, and instrumentation. Additional cost is then added per pump and per HP for additional building footprint, power, and equipment costs. Estimated pump station costs range from $1.25 million for a 450 HP station with 3 pumps to $1.73 million for a 650 HP station with four pumps.

Water storage tank costs have been estimated assuming a fixed cost for a basic installation, which includes cost for land acquisition, design, and basic structure. Additional cost is then added per foot of height and per 1,000 gallons of volume. Estimated storage tank costs range from $550,000 for the Maryville standpipe to $970,000 for the 400,000 gallon King City elevated storage tank.

In addition, legal and financial costs (5 percent) and contingency and inflation (20-percent) were added to arrive at the total cost.

As shown in Table 5-1, Alternative 3 (Savannah) has the lowest OPC for initial construction. The OPC for constructing Alternative 2 (Missouri-American) is 17-percent higher than Alternative 3 and Alternative 1 (ACWWC) is double the cost of Alternative 3. A more detailed cost summary that includes specific OPC tables can be found in the Appendix D.

**Table 5-1**
**OPC for Supply Alternatives**

| | Alternative 1 ACWWC | Alternative 2 Missouri-American | Alternative 3 Savannah |
|---|---|---|---|
| Construction, Land, and Engineering | $70,800,000 | $41,700,000 | $34,700,000 |
| Legal and Financial (5%) | $3,500,000 | $2,100,000 | $1,750,000 |
| Contingency and Inflation (20%) | $14,200,000 | $8,300,000 | $6,950,000 |
| Total | $88,500,000 | $52,100,000 | $43,400,000 |

# 5.2 Water Rate and Capacity Comparison

Each of the water supply alternatives was contacted for information on current and/or projected rates and system source capacity. Table 5-2 provides a comparison of the available capacity and projected water rates for the three supplies.

**Table 5-2**
**Water Rate and Capacity Data**

| | Savannah | Missouri-American | ACWWC |
|---|---|---|---|
| Annual Est. Water Purchase Volume (kgal) ([1]) | 654,000 | 654,000 | 654,000 |
| Cost to Purchase Water ($/kgal) | $5.24 | $2.19 to $4.95 | $5.11 |
| Cost of Water Per Year ([2]) | $3,400,000 | $1,500,000 | $3,400,000 |
| Water Supply Capacity | Up to 3.9 MGD | Existing 8.0 MGD | 6 MGD |

(1) Current Avg. Day for Stage 1 Pipeline Customers x 1.05 to account for system water loss x 365 days/year.
(2) Cost to Purchase Water ($/kgal) x Annual Est. Water Purchase Volume (kgal). Assumes single point of purchase.

The water rate calculation assumptions and capacity descriptions are included in Section 4 of this report. Based on the annual estimated water purchase volume, the cost to purchase water from Missouri-American is approximately half that of any other source. The Missouri-American average cost per 1,000 gallons is approximately $2.29/kgal when all water is purchased from one meter. The second benefit to the Missouri-American option is that the additional system capacity already exists, unlike the ACWWC and Savannah alternatives.

# 5.3 Recommended Source Alternative

If an assumption of debt service of 4.75-percent per year for 33 years was applied to the OPC numbers to generate an annual debt service cost and added to the estimated annual cost to purchase water, the new total for each alternative is summarized in Table 5-3.

**Table 5-3**
**Estimate of Annual Costs**

| | Savannah | Missouri-American | ACWWC |
|---|---|---|---|
| Est. Annual Debt Service | $2,700,000 | $3,200,000 | $5,400,000 |
| Cost of Water Per Year | $3,400,000 | $1,500,000 | $3,400,000 |
| Estimated Annual Cost | $6.1 Million | $4.7 Million | $8.8 Million |

Based on these results, Missouri-American is the lowest cost water supply alternative to serve the Stage 1 Pipeline. Further, Missouri-American already has the water treatment to serve the Stage 1 Pipeline projected water demands at the time this report was written.

# Section 6
# Conceptual Plan Preliminary Cost Opinion

This section presents the underlying information required for a water rate analysis, including initial construction costs, system replacement cost, and annual operating and maintenance (O&M) costs.

## 6.1 Opinion of Probable Cost

The assumptions used for developing the OPCs were outlined in Section 5 of this report. Based on the purchase cost of water and OPCs, Missouri-American was the supply alternative determined to be the lowest cost. The remainder of Sections 6 and 7 focus on this alternative alone.

As part of the development of Stage 1, an additional pipeline alignment to serve Daviess County PWSD No. 1 from King City was requested. The OPCs below present the base cost opinion as well as the cost to include Daviess County PWSD No. 1.

**Table 6-1**
**Missouri-American Cost Alternative**

| Item | Base Alignment | Including Daviess PWSD No. 1 |
|---|---|---|
| Pump Stations | $1,300,000 | $1,300,000 |
| Water Storage Facilities | $3,300,000 | $3,300,000 |
| Pipeline | $37,100,000 | $43,400,000 |
| **Subtotal** | **$41,700,000** | **$48,000,000** |
| Legal and Financial (5%) | $2,100,000 | $2,400,000 |
| Contingency and Inflation (20%) | $8,300,000 | $9,600,000 |
| **Total OPC** | **$52,100,000** | **$60,000,000** |

## 6.2 Replacement Cost

System replacement costs are essential to managing a water system and are an important component in determining rates. This report assumes full replacement of each component at the end of its lifespan at the inflated initial construction cost, minus 40-percent for one-time project incidentals. These expenses, such as easement acquisition and some design costs, do not need to be paid again during a replacement project. Projected lifespan is assumed as 20 years for pump stations, 40 years for storage facilities, and 60 years for pipeline. When compensating for price inflation during the lifespan of the facilities, it is assumed that cash investments set aside for depreciation will gain interest at a rate equal to inflation.

Using this assumption for the Missouri-American Alignment (Figure 4-2), annualized replacement costs are approximately $40,000 for pump station replacement, $50,000 for storage tank replacement, and $380,000 for pipeline replacement, for a total of $470,000 per year in replacement costs. Most often, investments can be chosen which exceed the rate of price inflation. If this happens, the amount of cash needed to fund depreciation is reduced.

## 6.3 Annual Operation and Maintenance Cost

O&M costs were developed using similar data from comparable water systems. Although many different factors combine to make up a system's annual budget, often the bulk of the cost is represented in four components: staffing, energy (electricity) costs, storage repainting, and pipeline maintenance and repair. Costs for these four categories have been estimated and the total of these costs are represented as the estimated annual O&M cost for the system. The annual O&M costs identified below are for the Missouri-American base alignment only.

Staffing costs assume a staffing level of one part-time and three full-time employees, comprised of two administrative and two field employees. Estimated staffing costs including benefits and employer payroll contributions total $210,000.

Electrical costs are mostly derived from pumping operations. Assuming pumping operations are active approximately 25-percent of the total hours available in a year, the system would have an annual electrical demand of approximately 735,000 kilowatt-hours (kwh). Assuming a rate cost of $0.12 per kwh, the resultant annual energy cost is approximately $89,000 per year.

Storage tank recoating represents another significant maintenance cost on the conceptual system. To develop this cost estimate, it is assumed that the coating systems used require a full blast and recoat every 15 years. Recent recoating costs for similar size tanks indicate the present value cost of recoating is approximately $150,000 per tank. If this cost is annualized, the cost to recoat both of the system's storage tanks is budgeted at approximately $30,000 per year.

The final component of the estimated O&M costs is pipeline maintenance. For this component, it is assumed that one break will occur for every 20 miles of pipeline each year. The present value repair cost represents the additional labor cost, equipment cost, and parts, and is estimated at $3,000 per repair. Multiplying those two factors show an estimated cost of upkeep for the conceptual pipeline system is approximately $15,000 per year.

Combining these four factors provides a representation of annual O&M costs for the conceptual system, excluding depreciation as represented in the previous section. This annual cost totals approximately $344,000 per year.

## 6.4 Water Purchase Cost

Water purchase costs were calculated assuming that all water for resale is purchased from Missouri-American. Assuming annual purchases of 654 million gallons, the annual water purchase costs total $1.5 million.

One additional scenario that could be considered as the Commission moves into design phase activities is to evaluate purchasing the remaining water supply available from the City of Savannah in addition to the Missouri-American supply source. The 2010 Feasibility Study states that up to 0.9 MGD could be made available to the Commission should the hours of operation increase at the WTP. The cost of water from Savannah would be approximately $5.93 per thousand gallons as compared to the averaged cost from Missouri-American of $2.30 per 1,000 gallons. Adding a second source of supply would provide redundancy for the Commission and the location of the Savannah WTP is near the proposed waterline alignment minimizing the additional construction costs. However, the ammonia feed facility at the Savannah WTP would still be necessary before purchasing water from that supply and combining it with the Missouri-American water. Following the methodology outlined in Section 7 of this report, the combined estimated cost per 1,000 gallons is $10.91.

# Section 7
# Summary of Wholesale Rate Requirements

This section of the report presents the results of financial analyzes required to provide a preliminary estimate of the wholesale rates applicable to this project. Rate requirements are composed of debt service on construction of facilities, O&M expenses of the facilities, and water cost purchased for resale. The following is based on the base scenario and does not include the demands or additional construction cost from Daviess County PWSD No. 1. These costs are estimated under the following capital improvement financing scenarios:

- Scenario 1 assumes 100-percent revenue bond financing
- Scenario 2 assumes 80-percent revenue bond financing and 20-percent grant funding
- Scenario 3 assumes 50-percent revenue bond financing and 50-percent grant funding

**Table 7-1**
**Summary of Wholesale Rate Requirements**

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Estimated Annual Debt Service | $3,200,000 | $2,600,000 | $1,600,000 |
| Estimated O&M Expense | $340,000 | $340,000 | $340,000 |
| Estimated Annual Renewal and Replacement | $470,000 | $470,000 | $470,000 |
| Estimated Annual Water Purchase | $1,500,000 | $1,500,000 | $1,500,000 |
| Total Estimated Annual Revenue Requirement | $5,500,000 | $4,900,000 | $3,900,000 |
| Estimated Water Sales (kgal/MGD) | 623,000/1.7 | 623,000/1.7 | 623,000/1.7 |
| Estimated Cost per 1,000 gallons | $8.83 | $7.87 | $6.26 |
| Estimated Customer Monthly Wholesale Cost (5,000 gal) | $44.14 | $39.33 | $31.30 |

The necessity and amount of capital and operating reserves and bond issuance costs cannot be established at this time. The bond underwriter will determine the need for reserves to provide investor security based on the actual project phasing plan to be implemented. Typically, if these reserves are deemed necessary, they can be accumulated over a period of time by the entity. Bond issuance cost is directly related to the size of the bond issues. Without a phasing plan, bond issuance sizes cannot be determined along with bond issuance costs.

It is also important to note that additional cost savings would be possible by omitting the additional 15-percent service capacity added in Section 2 of this report. Scenario 2 and 3 illustrate the impacts to the overall rate structure should grant funds be made available for this project.

For purpose of these financial analyses, the following assumptions are used:

- Total estimated capital improvements will be $52.1 million for the entire project, including transmission mains, pumping stations, and storage facilities.
- Annual water usage was calculated using the current 1.7 MGD average daily use assuming all wholesale customers are under contract for service.
- No phasing of the issuance of revenue bonds has been assumed. All revenue bonds are assumed to have been issued at a 4.75-percent interest rate, 33-year term, with equal annual debt service payments.
- All funding of any operating and capital reserves, which may be necessary for revenue bond issuance has been completed. Reserves may not be necessary should insurance be ultimately obtained.
- Estimated revenue bond issuance amounts do not reflect impact of any issuance costs nor any capitalized interest during construction.
- Water purchases are from Missouri-American.
- Estimated annual renewal and replacement cost is based on straight-line depreciation projections for various facility types.

To refine the "Summary of Wholesale Rate Requirements" presented in Table 7-1, certain key activities must be initiated and completed in order to have an accurate representation of the project's long term financial requirements. The list below denotes key activities:

- Establishment of a political entity with rate setting, enforcement, and debt issuing authority.
- Legal commitment by community members to participate in the project during design, construction, and operation of the project facilities through take or pay agreements. Development and execution of there agreements between the system and wholesale customers to establish rate stability and strengthen the financial viability of the system.
- Development of a project strategic financial plan that recognizes project "phasing" and changes in membership in order to determine the actual size of needed bond issues and timing. This will impact the need and level of "capitalized interest during construction" and reflect the financing scheme developed by the entity and its memberships for funding during construction.
- Hiring of bond council and underwriter to develop revenue bond ordinance; an official bond offering statement; projected debt service schedules; bond issuance cost; the need for amount and timing of any necessary operation and capital reserves to provide investor security; bond issuance amount; interest rate; bond term; adequate level of "capitalized interest during construction"; and bond market timing.

# Section 8
# Conclusions

The recommended potable water supply alternative for the Commission is to negotiate a water purchase contract with Missouri-American. It is still feasible for the Commission to evaluate additional or smaller water purchase contracts from others.

Figure 8-1 is a proposed project schedule for the Commission to follow towards construction completion of this project. There is still significant work for the Commission to do in order for this project to be feasible as outlined as part of the "Next Steps."

## 8.1 Recommended "Next Steps"

This PER concludes, given the assumptions and conceptual design as presented, that the project may be feasible if the rate information produced is acceptable to the member entities. The following summarizes the recommended "next steps" to be implemented for this project before moving into final design and construction:

- The Commission needs to solicit actual water sales numbers from the member utilities to verify that they will be served by the Stage 1 Pipeline and to what extent. Several of the members may request only a portion of the flow choosing to continue either purchasing water from another source or treating their own water. The assumed water demands represent the single largest assumption in this PER. Should a significant number of the utilities choose to purchase a fraction of the total water sales, the OPCs will reduce greatly, as will the volume of water sales.
- Environmental clearances need to be completed in compliance with the Missouri Water and Wastewater Review Committee Guidelines.
- Public meetings need to be held to be in compliance with the Missouri Water and Wastewater Review Committee Guidelines.
- Conduct survey of proposed pipeline alignment.
- Negotiate a water purchase contract with Missouri-American contingent on obtaining funding and receiving water sales agreements with the Commission membership.
- Obtain project funding through the Missouri Water and Wastewater Review Committee or through private lenders.
- Establish a contractual mechanism as to how to administer water sales to the customers and select a method of equitable payment for the Commission members.
- Acquire property right for pump stations, storage tanks, and pipeline.

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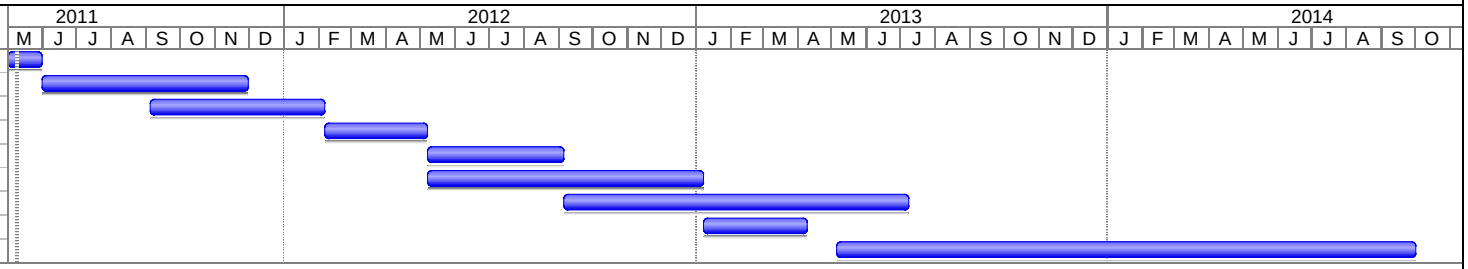
NWMO Stage I Pipeline Schedule

| ID | Task Name |
|---|---|
| 1 | PER Completion |
| 2 | Secure Funding |
| 3 | Supply and Sales Contract Negotiation |
| 4 | Revise Preliminary Design for Contracts |
| 5 | Survey |
| 6 | Final Design |
| 7 | Land Acquisition |
| 8 | MDNR Review |
| 9 | Bidding and Construction |



# Appendix A

# Reference Calculations

| CDM Calculation Form (Excel) | | Job # 6198-78941 | | Calc. By: CSC | |
|---|---|---|---|---|---|
| Client: | Northwest Missouri Water Commision | Checked By: | SAS | Date: | 12/08/10 |
| Project: | NoWMo Water Study | Date: | 12/10/10 | Calc. No.: | |
| Detail: | Water Demand Projections | Reviewed By: | K. Rood | Revision#: | |
| | | Date: | 12/10/10 | Date: | |

**Calculation Brief Title:** Water Demand projections for the NWMo Commision members

## 1.0 Purpose/Objective

Calculate the water demand for 2030

## 2.0 Procedure

1. Identify population growth trends from the Census population data (1950 to 2000).
2. Estimate 2030 population and find a Population Change per year for each district and city.
3. Analyze 2005 to 2009 measured water demands from commision members, and correlate them with the projected population to estimate a per capita consumption
4. Apply the population change slopes to estimate 2030 population.
5. Estimate 2030 Demands from 2030 estimated population and average per capita per day estimations

## 3.0 References/Data Sources

1. Source 1950 - 1990 city population figures: http://mcdc.missouri.edu/trends/historical.shtml
2. Source 2000 city population figures: http://mcdc2.missouri.edu/websas/dp3_2kmenus/mo/Places/
3. Source of 1950 - 2000 counties population figures: http://mcdc.missouri.edu/trends/historical.shtml
4. Phase II Feasibility Study
5. Data provided by each commission member
6. Phase 1 Report, Appendix H

## 4.0 Assumptions and Limitations

1. Population growth changes are linear
2. Negative population growth trends will be taken as no growth (Population Change slope = 0)

## 5.0 Calculations

See attached tables

## 6.0 Conclusions/Results

See attached tables.

# Population Analysis and Projections

| County or City | City and County US Census Population Data (1) 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | (2) 2006 | 2030 Projected Population (3) | Annual Population Change (4) | Revised 2030 Projected Population (5) | Revised Annual Population Change (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Andrew County | 11,727 | 11,062 | 11,913 | 13,980 | 14,632 | 16,492 | | 19,600 | 105 | 19,600 | 105 |
| Buchannan County | 96,826 | 90,581 | 86,915 | 87,888 | 83,083 | 85,998 | | 79,500 | -216 | 86,000 | 0 |
| City of Albany | 1,850 | 1,662 | 1,804 | 2,152 | 1,958 | 1,937 | 3600 | 4,100 | 21 | 4,100 | 21 |
| City of Barnard | 275 | 237 | 206 | 234 | 234 | 257 | 300 | 310 | 0 | 310 | 0 |
| City of Bolckow | 250 | 232 | 225 | 245 | 253 | 234 | 240 | 240 | 0 | 240 | 0 |
| City of Cameron | 3,570 | 3,674 | 3,960 | 4,519 | 4,831 | 8,312 | 9788 | 12,300 | 105 | 12,300 | 105 |
| City of Gallatin | 1,634 | 1,658 | 1,833 | 2,063 | 1,864 | 1,789 | 1834 | 1,900 | 3 | 1,900 | 3 |
| City of Grant City | 1,184 | 1,061 | 1,095 | 1,068 | 998 | 926 | 1341 | 1,300 | 0 | 1,300 | 0 |
| City of King City | 1,031 | 1,009 | 1,023 | 1,063 | 986 | 1,012 | | 1,000 | 0 | 1,020 | 0 |
| City of Maitland | 456 | 427 | 319 | 415 | 338 | 342 | 340 | 290 | -2 | 340 | 0 |
| City of Maysville | 973 | 942 | 1,045 | 1,187 | 1,176 | 1,212 | | 1,400 | 6 | 1,400 | 6 |
| City of Plattsburg | 1,655 | 1,663 | 1,832 | 2,095 | 2,248 | 2,354 | | 2,800 | 16 | 2,800 | 16 |
| City of Ravenwood | 319 | 282 | 336 | 436 | 409 | 448 | 438 | 510 | 3 | 510 | 3 |
| City of Savannah | 2,332 | 2,455 | 3,324 | 4,184 | 4,352 | 4,762 | 5000 | 6,200 | 51 | 6,200 | 51 |
| City of Stanberry | 1,651 | 1,409 | 1,479 | 1,387 | 1,310 | 1,243 | | 1,000 | -7 | 1,250 | 0 |
| City of Stewarstville | 414 | 466 | 634 | 832 | 732 | 759 | | 1,000 | 8 | 1,000 | 8 |
| Clinton County | 11,726 | 11,588 | 12,462 | 15,916 | 16,595 | 18,979 | | 23,700 | 156 | 23,700 | 156 |
| Davies County | 11,180 | 9,502 | 8,420 | 8,905 | 7,865 | 8,016 | | 6,300 | -58 | 8,100 | 0 |
| DeKalb County | 8,047 | 7,226 | 7,305 | 8,222 | 9,967 | 11,597 | | 13,900 | 77 | 13,900 | 77 |
| Gentry County | 11,036 | 8,793 | 8,060 | 7,887 | 6,848 | 6,861 | | 4,600 | -77 | 6,900 | 0 |
| Nodaway County | 24,033 | 22,215 | 22,467 | 21,996 | 21,709 | 21,912 | | 20,800 | -36 | 22,000 | 0 |

(1)

Source 1950 - 1990 city population figures: http://mcdc.missouri.edu/trends/historical.shtml

Source 2000 city population figures: http://mcdc2.missouri.edu/websas/dp3_2kmenus/mo/Places/

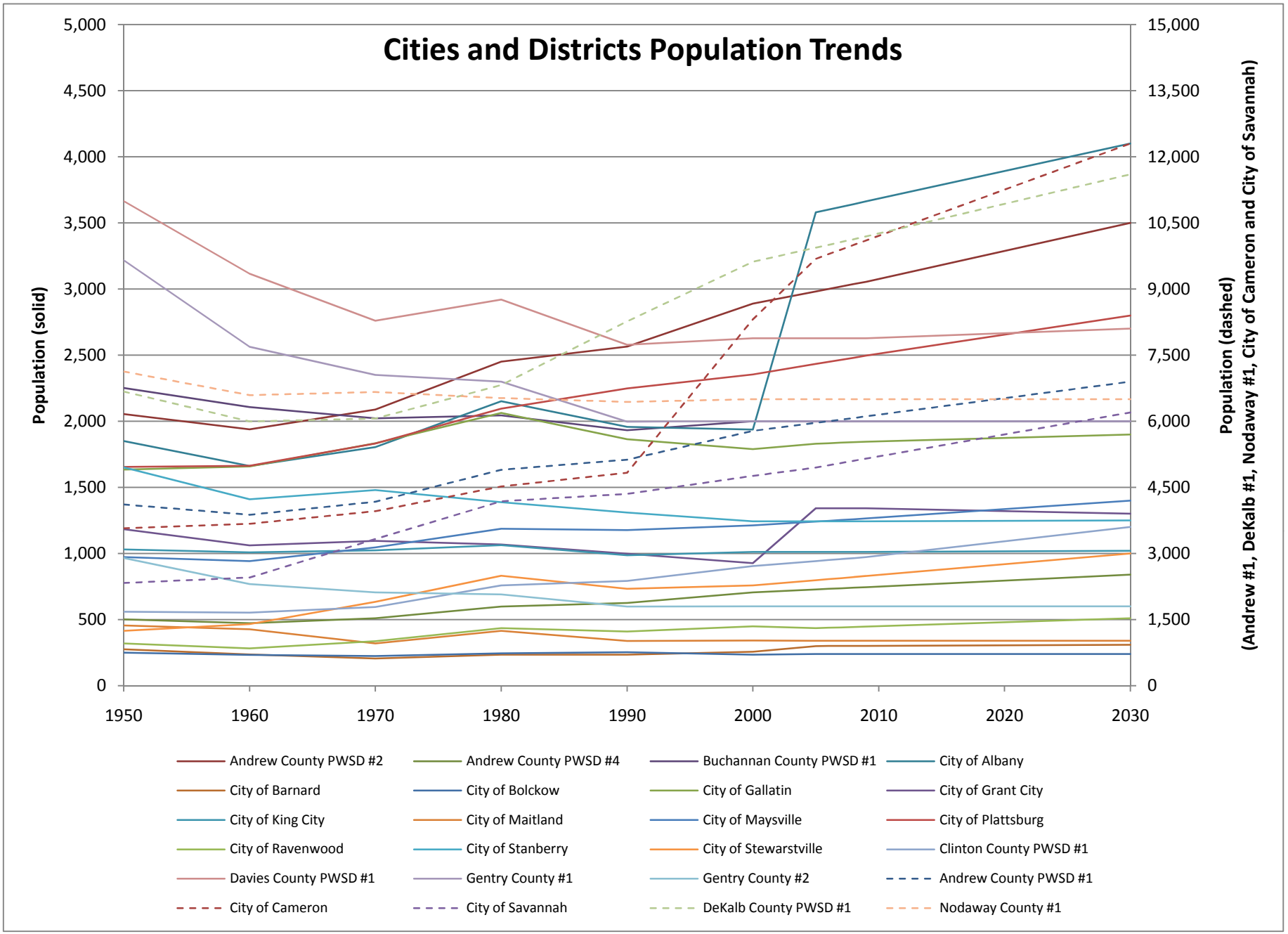
Source of 1950 - 2000 counties population figures: http://mcdc.missouri.edu/trends/historical.shtml

(2) Population in 2006, based on the Phase I report

(3) Estimated 2030 population by linear extrapolation of the 1950 to 2000 data, based in 2000 for the counties, and based in 2006 Phase I report for the cities

(4) Population Change per year based on linear interpolation (slope of the least squares regression line)

(5) Revised Projections to show no negative population growth. Areas showing negative are assumed to maintain current population and demands.


Cities and Districts Population Trends
Population (solid)
Population (dashed)
(Andrew #1, DeKalb #1, Nodaway #1, City of Cameron and City of Savannah)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
15,000
13,500
12,000
10,500
9,000
7,500
6,000
4,500
3,000
1,500
0
1950
1960
1970
1980
1990
2000
2010
2020
2030
Andrew County PWSD #2
Andrew County PWSD #4
Buchannan County PWSD #1
City of Albany
City of Barnard
City of Bolckow
City of Gallatin
City of Grant City
City of King City
City of Maitland
City of Maysville
City of Plattsburg
City of Ravenwood
City of Stanberry
City of Stewarstville
Clinton County PWSD #1
Davies County PWSD #1
Gentry County #1
Gentry County #2
Andrew County PWSD #1
City of Cameron
City of Savannah
DeKalb County PWSD #1
Nodaway County #1

## Average Annual Water Demand for the Cities

| District / City | Annual Water Production Purchased (gallons) | | | | | | Average Annual Water Demand | Notes | Estimated Population (4) | | | | | Gallons Per Capita Daily Demand (GPCD) (5) | | | | | Average GPCD (6) | 2030 Revised Projected Population (7) | 2030 Water Demand (8) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | | | 2005 | 2006 | 2007 | 2008 | 2009 | 2005 | 2006 | 2007 | 2008 | 2009 | | | Avg. Day (gpd) | Annual (gal) |
| City of Albany | 83,818,400 | 79,669,320 | 78,676,180 | 82,507,830 | 79,907,480 | | 80,916,000 | (3), (9) | 3,579 | 3,600 | 3,621 | 3,642 | 3,663 | 64 | 61 | 60 | 62 | 60 | 61 | 4,100 | 252,000 | 91,636,000 |
| City of Barnard | | | | | | | 8,030,000 | (1) | 300 | 300 | 300 | 301 | 301 | | | | | | 73 | 310 | 23,000 | 8,259,000 |
| City of Bolckow | | | | | | | 18,250,000 | (1) | 240 | 240 | 240 | 240 | 240 | | | | | | 208 | 240 | 50,000 | 18,250,000 |
| City of Cameron | 482,222,350 | 486,340,400 | 518,828,800 | 488,042,200 | 466,381,000 | | 488,363,000 | (3) | 9,683 | 9,788 | 9,893 | 9,999 | 10,104 | 136 | 136 | 144 | 134 | 126 | 135 | 12,300 | 1,665,000 | 607,381,000 |
| City of Gallatin | | | | | | | 137,605,000 | (1) | 1,831 | 1,834 | 1,837 | 1,841 | 1,844 | | | | | | 204 | 1,900 | 389,000 | 141,761,000 |
| City of Grant City | | | | | | | 45,625,000 | (1) | 1,341 | 1,341 | 1,341 | 1,341 | 1,341 | | | | | | 93 | 1,300 | 125,000 | 45,625,000 |
| City of King City | 38,157,000 | 36,633,800 | 36,076,400 | 37,146,800 | 34,583,500 | | 36,520,000 | (3) | 1,012 | 1,012 | 1,012 | 1,012 | 1,012 | 103 | 99 | 98 | 101 | 94 | 99 | 1,020 | 101,000 | 36,809,000 |
| City of Maitland | | | | | | | 9,125,000 | (1) | 340 | 340 | 340 | 340 | 340 | | | | | | 74 | 340 | 25,000 | 9,125,000 |
| City of Maysville | | | | | | 31,864,500 | 31,865,000 | (2) | 1,241 | 1,247 | 1,253 | 1,259 | 1,264 | | | | | | 69 | 1,400 | 97,000 | 35,282,000 |
| City of Plattsburg | | | | | | | 336,895,000 | (1) | 2,433 | 2,449 | 2,464 | 2,480 | 2,496 | | | | | | 370 | 2,800 | 1,036,000 | 377,963,000 |
| City of Ravenwood | 11,984,260 | 10,927,160 | 9,751,460 | 9,622,490 | 9,903,870 | | 10,438,000 | (3) | 435 | 438 | 441 | 444 | 447 | 75 | 68 | 61 | 59 | 61 | 65 | 510 | 34,000 | 12,084,000 |
| City of Savannah | 158,365,285 | 172,504,100 | 178,491,415 | 165,427,000 | 164,486,390 | 171,309,286 | 167,855,000 | (3) | 4,949 | 5,000 | 5,051 | 5,102 | 5,153 | 88 | 95 | 97 | 89 | 87 | 91 | 6,200 | 565,000 | 206,062,000 |
| City of Stanberry | 42,500,240 | 43,055,770 | 41,581,660 | 39,688,370 | 39,024,980 | 35,029,216 | 41,171,000 | (3), (10) | 1,243 | 1,243 | 1,243 | 1,243 | 1,243 | 94 | 95 | 92 | 87 | 86 | 91 | 1,250 | 114,000 | 41,403,000 |
| City of Stewarstville | 21,737,900 | 18,812,500 | 17,782,300 | 17,542,200 | 17,587,800 | 14,156,300 | 18,693,000 | (3) | 798 | 806 | 813 | 821 | 829 | 75 | 64 | 60 | 59 | 58 | 63 | 1,000 | 64,000 | 23,008,000 |

## Average Annual Water Demand for the Counties

| District / City | Annual Water Production Purchased (gallons) | | | | | | Average Annual Water Demand | % of County Pop. served by the PWSD | Estimated Population (4) | | | | | Gallons Per Capita Daily Demand (GPCD) (5) | | | | | Average GPCD (6) | 2030 Revised Projected Population (7) | 2030 Water Demand (8) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | | | 2005 | 2006 | 2007 | 2008 | 2009 | 2005 | 2006 | 2007 | 2008 | 2009 | | | Avg. Day (gpd) | Annual (gal) |
| Andrew County PWSD #1 | 181,270,500 | 183,473,250 | 202,632,250 | 174,327,600 | 190,350,000 | | 186,411,000 | 35% | 5,963 | 6,000 | 6,037 | 6,073 | 6,110 | 83 | 84 | 92 | 79 | 85 | 85 | 6,900 | 584,000 | 213,074,000 |
| Andrew County PWSD #2 (12) | 122,664,650 | 138,888,150 | 136,832,236 | 141,590,675 | 123,494,400 | 137,286,900 | 132,695,000 | 18% | 2,982 | 3,000 | 3,018 | 3,037 | 3,055 | 113 | 127 | 124 | 128 | 111 | 120 | 3,500 | 422,000 | 153,875,000 |
| Andrew County PWSD #4 | | 12,441,560 | 14,882,400 | 14,441,200 | 12,899,200 | 11,949,700 | 13,667,000 | 4% | 728 | 732 | 736 | 741 | 745 | | 47 | 55 | 53 | 47 | 51 | 840 | 43,000 | 15,540,000 |
| Buchannan County PWSD #1 | 66,400,000 | 61,000,000 | 69,000,000 | 63,600,000 | 63,300,000 | 64,000,000 | 64,660,000 | 2% | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 91 | 84 | 95 | 87 | 87 | 89 | 2,000 | 178,000 | 64,660,000 |
| Clinton County PWSD #1 | 20,648,000 | 22,497,600 | 22,618,400 | 23,083,300 | 24,410,400 | | 22,652,000 | 5% | 943 | 950 | 957 | 965 | 972 | 60 | 65 | 65 | 66 | 69 | 65 | 1,200 | 78,000 | 28,378,000 |
| Davies County PWSD #1 | 59,663,030 | 57,334,750 | 60,619,300 | 53,994,030 | 54,343,310 | | 57,191,000 | 33% | 2,628 | 2,628 | 2,628 | 2,628 | 2,628 | 62 | 60 | 63 | 56 | 57 | 60 | 2,700 | 161,000 | 58,758,000 |
| DeKalb County PWSD #1 (11) | | 255,953,566 | 256,983,766 | 257,223,866 | 257,178,266 | 260,609,766 | 256,835,000 | 83% | 9,936 | 10,000 | 10,064 | 10,127 | 10,191 | | 70 | 70 | 70 | 69 | 70 | 11,600 | 809,000 | 295,120,000 |
| Gentry County #1 | 43,250,600 | 47,399,680 | 48,392,820 | 44,561,170 | 47,161,520 | | 46,154,000 | 29% | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 59 | 65 | 66 | 61 | 65 | 63 | 2,000 | 127,000 | 46,154,000 |
| Gentry County #2 | 13,732,000 | 17,574,000 | 19,404,000 | 21,325,000 | 19,028,000 | | 18,213,000 | 9% | 600 | 600 | 600 | 600 | 600 | 63 | 80 | 89 | 97 | 87 | 83 | 600 | 50,000 | 18,213,000 |
| Nodaway County #1 | 162,240,050 | 157,646,980 | 171,892,620 | 164,911,713 | 164,590,140 | | 164,257,000 | 30% | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 | 68 | 66 | 72 | 70 | 69 | 69 | 6,500 | 451,000 | 164,257,000 |

(1) Data from Phase II Feasibility Study
(2) Estimated data based on City reporting 87,300 average daily production for 2010.
(3) Data provided by utility
(4) Estimated Population by linear extrapolation of U.S. Census Data with revised projections
(5) Estimated Per Capita Daily Demand = Annual water demand / Estimated population / 365 days
(6) Average of GPCD (Gallons/Capita/Day)
(7) Areas showing neagtive population change are assumed to remain at the current population
(8) Average annual water demand = GPCD x 2030 Revised Projected Population x 365 days
(9) Albany Production data minus Gentry 1 purchased water
(10) Stanberry Purchased water minus water sold to Gentry 2
(11) DeKalb purchased water minus Stewartsville purchased water
(12) Andrew #2 Water Purchased minus water sold to DeKalb County #1

# County population portions served by each PWSD

| Public Water Supply District | District Population in 2006 (1) | County served by the PWSD (2) | 2006 County Population (3) | % of County Population served by the PWSD (4) | District Annual Population Change (cap) (5) | District 2030 Projected Population (6) |
|---|---|---|---|---|---|---|
| Andrew County PWSD #1 | 6000 | Andrew County | 17,119 | 35% | 37 | 6,900 |
| Andrew County PWSD #2 | 3000 | Andrew County | 17,119 | 18% | 18 | 3,500 |
| Andrew County PWSD #4 | 732 | Andrew County | 17,119 | 4% | 4 | 840 |
| Buchannan County PWSD #1 | 2000 | Buchanan County | 85,998 | 2% | 0 | 2,000 |
| Clinton County PWSD #1 | 950 | Clinton County | 19,917 | 5% | 7 | 1,200 |
| Davies County PWSD #1 | 2628 | Daviess County | 8,016 | 33% | 0 | 2,700 |
| DeKalb County PWSD #1 | 10000 | DeKalb County | 12,058 | 83% | 64 | 11,600 |
| Gentry County #1 | 2000 | Gentry County | 6,861 | 29% | 0 | 2,000 |
| Gentry County #2 | 600 | Gentry County | 6,861 | 9% | 0 | 600 |
| Nodaway County #1 | 6500 | Nodaway County | 21,912 | 30% | 0 | 6,500 |

(1) 2006 population from Ref No. 4; Phase I report

(2) County that consumes most of the Public Water District supply

(3) Entire County population in 2006, linear extrapolation of 2000 census data with revised projections

(4) PWSD Population / County Population

(5) District Annual Population Change (County Annual Population change times Percentage of County Population served by the PWSD)

(6) District 2030 Projected Population based on 2006 Phase I Report

# Estimated Future Demands

| District / City | Current Water Demands | | | 2030 Future Projected Water Demand | | |
|---|---|---|---|---|---|---|
| | Annual Demand (MG) | Avg. Day (MGD) | Max. Day (MGD) (1) | Annual Demand (MG) | Avg. Day (MGD) | Max. Day (MGD) (1) |
| Andrew County PWSD #1 | 186 | 0.51 | 1.02 | 213 | 0.58 | 1.17 |
| Andrew County PWSD #2 | 133 | 0.36 | 0.73 | 154 | 0.42 | 0.84 |
| Andrew County PWSD #4 | 14 | 0.04 | 0.07 | 16 | 0.04 | 0.09 |
| Buchannan County PWSD #1 | 65 | 0.18 | 0.35 | 65 | 0.18 | 0.35 |
| City of Albany | 81 | 0.22 | 0.44 | 92 | 0.25 | 0.50 |
| City of Barnard | 8 | 0.02 | 0.04 | 8 | 0.02 | 0.05 |
| City of Bolckow | 18 | 0.05 | 0.10 | 18 | 0.05 | 0.10 |
| City of Cameron | 488 | 1.34 | 2.68 | 607 | 1.66 | 3.33 |
| City of Gallatin | 138 | 0.38 | 0.75 | 142 | 0.39 | 0.78 |
| City of Grant City | 46 | 0.13 | 0.25 | 46 | 0.13 | 0.25 |
| City of King City | 37 | 0.10 | 0.20 | 37 | 0.10 | 0.20 |
| City of Maitland | 9 | 0.03 | 0.05 | 9 | 0.03 | 0.05 |
| City of Maysville | 32 | 0.09 | 0.17 | 35 | 0.10 | 0.19 |
| City of Ravenwood | 10 | 0.03 | 0.06 | 12 | 0.03 | 0.07 |
| City of Stanberry | 41 | 0.11 | 0.23 | 41 | 0.11 | 0.23 |
| City of Stewarstville | 19 | 0.05 | 0.10 | 23 | 0.06 | 0.13 |
| Clinton County PWSD #1 | 23 | 0.06 | 0.12 | 28 | 0.08 | 0.16 |
| Davies County PWSD #1 | 57 | 0.16 | 0.31 | 59 | 0.16 | 0.32 |
| DeKalb County PWSD #1 | 257 | 0.70 | 1.41 | 295 | 0.81 | 1.62 |
| Gentry County #1 | 46 | 0.13 | 0.25 | 46 | 0.13 | 0.25 |
| Gentry County #2 | 18 | 0.05 | 0.10 | 18 | 0.05 | 0.10 |
| Nodaway County #1 (2) | 164 | 0.45 | 0.90 | 110 | 0.30 | 0.60 |
| TOTAL (MG) | 1,889 | 5.18 | 10.35 | 2,074 | 5.68 | 11.36 |
| | | | 15% increase | 2,385 | 6.53 | 13.07 |
| | | | 20% increase | 2,489 | 6.82 | 13.64 |
| | | | | *Annual Percentage Change:* | | *0.47%* |
| Phase I Totals (MG) | 1,289 | 3.53 | 7.06 | 1,383 | 3.79 | 7.58 |
| | | | 15% increase | 1,590 | 4.36 | 8.71 |
| | | | 20% increase | 1,660 | 4.55 | 9.09 |
| | | | | *Annual Percentage Change:* | | *0.35%* |
| City of Plattsburg | 337 | 0.92 | 1.85 | 378 | 1.04 | 2.07 |
| City of Savannah (2) | 168 | 0.46 | 0.92 | 206 | 0.56 | 1.13 |
| TOTAL (MG) | 505 | 1 | 3 | 584 | 2 | 3 |
| | | | | *Annual Percentage Change:* | | *0.75%* |

(1) Max Day = Avg. Day (gpd) x 2.0

(2) Assumption: Nodaway will only purchase 0.3 MGD (Avg. Day) and 0.6 MGD (Max. Day) from the Commision to supply current unserved areas.

CDM **Calculation Form (Excel)**

| | | | | | |
|---|---|---|---|---|---|
| **Client:** | GNWWC | **Job #** | 78941 | **Calc. By:** | SAS |
| **Project:** | Stage 1 PER | **Checked By:** | A. Szerwinski | **Date:** | 05/09/11 |
| **Detail:** | Cost Comparison | **Date:** | 05/10/11 | **Calc. No.:** | -- |
| | | **Reviewed By:** | A. Casey | **Revision#:** | |
| | | **Date:** | 05/10/11 | **Date:** | |

**Calculation Brief Title:** Determine the Annual Cost Comparison for the three water supply sources for the Stage 1 Pipeline.

## 1.0 Purpose/Objective

Determine the Annual Cost Comparison for the three water supply sources for the Stage 1 Pipeline.

## 2.0 Procedure

1 Summarize OPCC data from Bartlett & West
2 Summarize water rate data from the various water suppliers and project 2013 costs.
3 Determine O&M, Debt Service, Replacement Costs, and Staffing Costs

## 3.0 References/Data Sources

1 2010 Water Rates from Missouri American date July 1, 2010.
2 January 24, 2011 B&West letter regarding ACWWC
3 "Drinking Water Facilities Plan Water Treatment Plant Improvements" City of Savannah, MO prepared by Casey Patton from B&West. Received copy January 2011.
4 "Section 8 Conceptual Plan Preliminary Cost Estimate" from Phase II Feasibility Study dated March 6, 2009.
5 CDM 12-17-10 2030 Demands Summary Table.pdf and GNW Demand Handout.xls
6 OPCCs provided by Bartlett & West on 2-18-11 for each alternative including contingency, land acquisition, engineering & legal

## 4.0 Assumptions and Limitations

1 Assumptions are summarized throughout the document.

## 5.0 Calculations

1. See the following sheets.

Savannah Alternative Summary
Missouri American Alternative Summary
ACWWC Alternative Summary

**Current Water Demands**

| Annual Water Purchased | Annual Water Sales | |
|---|---|---|
| *(Ref. 5)* | *(Ref. 5)* | |
| 654,000 | 623,000 | kgal |

Water Sales = Water Purchased / (1 + Percentage of Unaccounted Water (Assumed to be 5% of total purchase volume))

| | | |
|---|---|---|
| Annual Est. Water Purchase Volume (kgal) | 654,000 | (1) Current Avg. Day for Stage 1 Pipeline Customers x 1.05 to account for system water loss x 365 days/year |
| Savannah Annual Purchase Volume (kgal) | 328,500 | (2) Assumes buying 0.9 MGD 365 days per year from Savannah |
| Missouri American Annual Purchase Volume (kgal) | 325,500 | (3) Total Est. Water Purchase - Savannah Purchase Volume |
| Missouri American Avg. Monthly Purchase Volume (kgal) | 27,125 | (4) MoAm Annual Purchase / 12 months per year |
| Annual Est. Water Sales Volume (kgal) | 623,000 | (5) Current Avg. Day for Stage 1 Pipeline Customers x 365 days/year |
| | | |
| Savannah Cost to Purchase Water ($/kgal) | $5.93 | |
| MoAM Cost to Purchase Water ($/kgal) | $4.95 to $2.19 | |
| OPCC, Ref 6. | $52,200,000 | |
| | | |
| Savannah Cost of Water Per Year | $1,900,000 | (6) Cost to Purchase Water ($/kgal) x Annual Est. Water Purchase Volume (kgal). Based on current water demands |
| Missouri American Cost of Water Per Year | $805,146 | (6) Cost to Purchase Water ($/kgal) x Annual Est. Water Purchase Volume (kgal). Based on current water demands |
| Est. Annual Debt Service (4) | $3,200,000 | (7) Estimated based on 33 years at 4.75% interest, assuming even payments |
| Est. O&M Costs | $433,000 | |
| Est. Replacement Costs | $504,000 | |
| | | |
| Estimated Annual Costs | $6,800,000 | |
| Cost per kgal (5) | $10.91 | (8) Cost per kgal = Estimated Annual Costs / Annual Est. Sales Volume (kgal) |

## 6.0 Conclusions/Results

Combined Rate for Missouri American and Savannah is $10.91 per 1,000 gallons

**Description:**

**Savannah Alternative Background Calculations**

**Cost of Service Number**

| | Total Sales Capacity of WTP (MGD) | Water Cost (1) ($/kgal) | Purchase Cost of Water (2) ($/kgal) | |
|---|---|---|---|---|
| Option 1 | Up to 0.9 | $4.27 | $5.93 | **Selected |
| Option 2 | Up to 2.7 | $6.02 | $8.36 | |
| Option 3 | Up to 3.9 | $3.77 | $5.24 | |
| | *(see pg. 8 - 9)* | *(see pg. 12)* | | |

*Based on "Drinking Water Facilities Plan, Water Treatment Plant Improvements, City of Savannah, MO" - Ref. 3
*Capacities from text on pages 8 and 9 - Ref. 3
(1) These numbers exclude City Admin Costs per the report. Calculations also show no "profit" to the city.
(2) ASSUMPTION: Increased purchase cost of water by 20% from what was in report to consider omitted costs, ammonia dosage and potential "profit"
(3) Increased water rates to 2013 numbers: Cost of Water * (1+0.05)^3. This assumes 5% inflation.

**Replacement Costs**

OPCC Break Down - Provided by B&West (w/o Davies 1 Extension)

| | | | Replacement Costs | (Assumed Values) Proposed Life Span (yrs.) |
|---|---|---|---|---|
| Ammonia Feed Facility | $70,000 | (Ref. 3, pg. 26) | $3,000 | 20 |
| Transmission Lines | $31,840,000 | | $319,000 | 60 |
| Elevated Water Storage Tanks | $1,520,000 | | $23,000 | 40 |
| Pump Stations | $1,330,000 | | $40,000 | 20 |
| Total | $34,760,000 | | $385,000 | |

Replacement Cost = 2013 OPCC Value * (1-0.4) / Proposed Life Span; 40% of initial OPCC is assumed as a one time expense
Proposed lifespan (Ref. 4): 20 years for pump stations, 40 years for storage facilities, 60 years for pipelines

**O&M Costs**

| O&M Cost Summary per year | |
|---|---|
| Staffing | $210,000 |
| Electrical | $89,000 |
| Storage Tanks | $20,000 |
| Piping | $15,000 |
| Total O&M | $334,000 |

Staffing Assumptions: 1 full time and 1 part time ADMIN and 2 full time field service employees, Employee cost is $60,000 per employee per year
$210,000

Electrical: Assume PS operates 25% of the time on an annual basis per Phase II O&M assumptions

| HP | KW | KW*HR | Cost / KWH | Annual Cost |
|---|---|---|---|---|
| 450 | 335.565 | 734887.35 | 0.12 | $88,186 |

(OPCC report from B&West)

Storage Tanks: Assumed $150K every 15 years for repainting and maintenance
$10,000 per tank
No. of Tanks 2 (OPCC report from B&West)

Pipelines: Assume 1 break every 20 miles and $3000 to fix each break
Total Pipeline Mileage 85.27 miles w/o Davies 1 transmission main (OPCC report from B&West)
Total Breaks Per Year 5
Total Line O&M $15,000

**OPCC**

| | | |
|---|---|---|
| Construction Cost | $34,760,000 | (Const. Cost + Ammonia Feed Facility) |
| Land Acquisition | $1,740,000 | |
| Contingency | $6,940,000 | |
| Total OPCC | $43,400,000 | |

CDM

| | | | |
|---|---|---|---|
| PROJECT: GNW Stage 1 PER | COMPUTED BY : SAS | CHECKED BY: AMS - 5/10/11 |
| JOB NO.: 78941 | DATE : 5/9/2011 | REVIEWED BY: AC - 5/10/11 |
| CLIENT: USACE KC District | REVISION NO.: -- | PAGE NO. : 3 of 3 |

**Description:**

**Missouri American Alternative Background Calculations**

**Cost of Service Number**

| | 1,000 Gallons/ Month | Public Authority / Sale for Resale Current Rates ($/kgal) | 2013 Projection ($/kgal) |
|---|---|---|---|
| Monthy Minimum Charge (1) | | $1,124.62 | $1,301.89 |
| For the first | 100 | $4.2794 | $4.95 |
| For the next | 1900 | $3.3234 | $3.85 |
| For the next | 3000 | $2.7691 | $3.21 |
| For everything over | 5000 | $1.8886 | $2.19 |

*Cost per table provided by Missouri American dated July 1, 2010
*Inflated cost by 5% per year to 2013 numbers: = 2010 Rate*(1.05)^3
(1) 2" meter size was chosen for the monthly charge.

**Replacement Costs**

OPCC Break Down - Provided by B&West (w/o Davies 1 Ex

| | | Replacement Costs | (Assumed Values) Proposed Life Span (yrs.) |
|---|---|---|---|
| Transmission Lines | $37,050,000 | $371,000 | 60 |
| Water Storage Tanks | $3,320,000 | $50,000 | 40 |
| Pump Stations | $1,330,000 | $40,000 | 20 |
| Total | $41,700,000 | $461,000 | |

Replacement Cost = 2013 OPCC Value * (1-0.4) / Proposed Life Span; 40% of initial OPCC is assumed as a one time expense
Proposed lifespan (Ref. 4): 20 years for pump stations, 40 years for storage facilities, 60 years for pipelines

**O&M Costs**

Summary:

| O&M Cost Summary per year | |
|---|---|
| Staffing | $210,000 |
| Electrical | $89,000 |
| Storage Tanks | $30,000 |
| Piping | $15,000 |
| Total O&M | $344,000 |

Staffing Assumptions: 1 full time and 1 part time ADMIN and 2 full time field service employees, Employee cost is $60,000 per employee per year
$210,000

Electrical

| Assume PS operates 25% of the time | | | | |
|---|---|---|---|---|
| HP | KW | KW*HR | Cost / KWH | Annual Cost |
| 450 | 335.565 | 734887.35 | 0.12 | $88,186 |

(OPCC report from B&West)

Storage Tanks: Assumed $150K every 15 years for repainting and maintenance
$10,000 per tank
No. of Tanks 3 (OPCC report from B&West)

Pieplines: Assume 1 break every 20 miles and $3000 to fix each break
Total Pipeline Mileage 90.68 miles w/o Davies 1 transmission main (OPCC report from B&West)
Total Breaks Per Year 5
Total Line O&M $15,000

**OPCC**

| | |
|---|---|
| Construction Cost | $41,700,000 |
| Land Acquisition | $2,090,000 |
| Contingency | $8,340,000 |
| Total OPCC | $52,130,000 |

| | | | | | |
|---|---|---|---|---|---|
| **CDM** Calculation Form (Excel) | | **Job #** | **78941** | **Calc. By:** | SAS |
| **Client:** | **GNWWC** | **Checked By:** | A. Szerwinski | **Date:** | **02/21/11** |
| **Project:** | **Stage 1 PER** | **Date:** | 02/22/11 5/9/11 | **Calc. No.:** | -- |
| **Detail:** | **Cost Comparison** | **Reviewed By:** | A. Casey | **Revision#:** | **1** |
| | | **Date:** | 05/10/11 | **Date:** | |

**Calculation Brief Title:** Determine the Annual Cost Comparison for the three water supply sources for the Stage 1 Pipeline.

## 1.0 Purpose/Objective

Determine the Annual Cost Comparison for the three water supply sources for the Stage 1 Pipeline.

## 2.0 Procedure

1 Summarize OPCC data from Bartlett & West
2 Summarize water rate data from the various water suppliers and project 2013 costs.
3 Determine O&M, Debt Service, Replacement Costs, and Staffing Costs

## 3.0 References/Data Sources

1 2010 Water Rates from Missouri American date July 1, 2010.
2 January 24, 2011 B&West letter regarding ACWWC
3 "Drinking Water Facilities Plan Water Treatment Plant Improvements" City of Savannah, MO prepared by Casey Patton from B&West. Received copy January 2011.
4 "Section 8 Conceptual Plan Preliminary Cost Estimate" from Phase II Feasibility Study dated March 6, 2009.
5 CDM 12-17-10 2030 Demands Summary Table.pdf and GNW Demand Handout.xlsx
6 OPCCs provided by Bartlett & West on 2-18-11 for each alternative including contingency, land acquisition, engineering & legal

## 4.0 Assumptions and Limitations

1 Assumptions are summarized throughout the document.

## 5.0 Calculations

1. See the following sheets.

Savannah Alternative Summary
Missouri American Alternative Summary
ACWWC Alternative Summary

**Current Water Demands**

| Annual Water Purchased | Annual Water Sales | |
|---|---|---|
| *(Ref. 5)* | *(Ref. 5)* | |
| 654,000 | 623,000 | kgal |

Water Sales = Water Purchased / (1 + Percentage of Unaccounted Water (Assumed to be 5% of total purchase volume))

***Comparison Table***

| | Alternative 1 Savannah | Alternative 2 Missouri American | Alternative 3 ACWWC |
|---|---|---|---|
| Annual Est. Water Purchase Volume (kgal) (1) | 654,000 | 654,000 | 654,000 |
| Annual Est. Water Sales Volume (kgal) (2) | 623,000 | 623,000 | 623,000 |
| Cost to Purchase Water ($/kgal) | $5.24 | $4.95 to $2.19 | $5.11 |
| Cost of Water Per Year (3) | $3,400,000 | $1,500,000 | $3,400,000 |
| | | | |
| OPCC, Ref 6. | $43,400,000 | $52,100,000 | $88,500,000 |
| | | | |
| Est. Annual Debt Service (4) | $2,700,000 | $3,200,000 | $5,400,000 |
| Est. O&M Costs | $334,000 | $344,000 | $379,000 |
| Est. Replacement Costs | $385,000 | $470,000 | $751,000 |
| | | | |
| Estimated Annual Costs | $6,800,000 | $5,500,000 | $9,900,000 |
| Cost per kgal (5) | $10.91 | $8.83 | $15.89 |

(1) Current Avg. Day for Stage 1 Pipeline Customers x 1.05 to account for system water loss x 365 days/year
(2) Current Avg. Day for Stage 1 Pipeline Customers x 365 days/year
(3) Cost to Purchase Water ($/kgal) x Annual Est. Water Purchase Volume (kgal). Based on current water demands
(4) Estimated based on 33 years at 4.75% interest, assuming even payments
(5) Cost per kgal = Estimated Annual Costs / Annual Est. Sales Volume (kgal)

## 6.0 Conclusions/Results

1 Missouri American is the least cost supplier based on both OPCC and annual costs.
Summary Table based on MoAM selected alternative

| | 100% Loan Money | 80% Loan/20% Grant | 50% Grant/Loan |
|---|---|---|---|
| Est. Annual Debt Service (4) | $3,200,000 | $2,600,000 | $1,600,000 |
| Est. O&M Costs | $340,000 | $340,000 | $340,000 |
| Est. Replacement Costs | $470,000 | $470,000 | $470,000 |
| | | | |
| Estimated Annual Costs | $5,500,000 | $4,900,000 | $3,900,000 |
| Cost per kgal (5) | $8.83 | $7.87 | $6.26 |
| Customer Monthly Wholesale Cost (5,000 gal) | $44.14 | $39.33 | $31.30 |

**Description:**

**Savannah Alternative Background Calculations**

**Cost of Service Number**

| | Quantity Available for Sale (MGD) | Water Cost (1) ($/kgal) | Purchase Cost of ($/kgal) |
|---|---|---|---|
| Option 1 | Up to 0.9 | $4.27 | $5.93 |
| Option 2 | Up to 2.7 | $6.02 | $8.36 |
| Option 3 | Up to 3.9 | $3.77 | $5.24 |
| | *(see pg. 8 - 9)* | *(see pg. 12)* | |

*Based on "Drinking Water Facilities Plan, Water Treatment Plant Improvements, City of Savannah, MO" - Ref. 3
*Capacities from text on pages 8 and 9 - Ref. 3
(1) These numbers exclude City Admin Costs per the report. Calculations also show no "profit" to the city.
(2) ASSUMPTION: Increased purchase cost of water by 20% from what was in report to consider omitted costs, ammonia dosage and potential "profit"
(3) Increased water rates for 3 years inflation: Cost of Water * (1+0.05)^3. This assumes 5% inflation.

**Replacement Costs**

OPCC Break Down - Provided by B&West (w/o Davies 1 Extension)

| | | | Replacement Costs | (Assumed Values) Proposed Life Span (yrs.) |
|---|---|---|---|---|
| Ammonia Feed Facility | $70,000 | (Ref. 3, pg. 26) | $3,000 | 20 |
| Transmission Lines | $31,840,000 | | $319,000 | 60 |
| Elevated Water Storage Tanks | $1,520,000 | | $23,000 | 40 |
| Pump Stations | $1,330,000 | | $40,000 | 20 |
| Total | $34,760,000 | | $385,000 | |

Replacement Cost = 2013 OPCC Value * (1-0.4) / Proposed Life Span; 40% of initial OPCC is assumed as a one time expense
Proposed lifespan (Ref. 4): 20 years for pump stations, 40 years for storage facilities, 60 years for pipelines

**O&M Costs**

| O&M Cost Summary per year | |
|---|---|
| Staffing | $210,000 |
| Electrical | $89,000 |
| Storage Tanks | $20,000 |
| Piping | $15,000 |
| Total O&M | $334,000 |

Staffing Assumptions: 1 full time and 1 part time ADMIN and 2 full time field service employees, Employee cost is $60,000 per employee per year
$210,000

Electrical: Assume PS operates 25% of the time on an annual basis per Phase II O&M assumptions

| HP | KW | KW*HR | Cost / KWH | Annual Cost |
|---|---|---|---|---|
| 450 | 335.565 | 734887.35 | 0.12 | $88,186 |

(OPCC report from B&West)

Storage Tanks: Assumed $150K every 15 years for repainting and maintenance
$10,000 per tank
No. of Tanks 2 (OPCC report from B&West)

Pipelines: Assume 1 break every 20 miles and $3000 to fix each break
Total Pipeline Mileage 85.27 miles w/o Davies 1 transmission main (OPCC report from B&West)
Total Breaks Per Year 5
Total Line O&M $15,000

**OPCC**

| | | |
|---|---|---|
| Construction Cost | $34,760,000 | (Const. Cost + Ammonia Feed Facility) |
| Land Acquisition | $1,740,000 | |
| Contingency | $6,940,000 | |
| Total OPCC | $43,400,000 | |

**Description:**

**Missouri American Alternative Background Calculations**

**Cost of Service Number**

| | 1,000 Gallons/ Month | Public Authority / Sale for Resale Current Rates ($/kgal) | 2013 Projection ($/kgal) |
|---|---|---|---|
| Monthy Minimum Charge (1) | | $1,124.62 | $1,301.89 |
| For the first | 100 | $4.2794 | $4.95 |
| For the next | 1900 | $3.3234 | $3.85 |
| For the next | 3000 | $2.7691 | $3.21 |
| For everything over | 5000 | $1.8886 | $2.19 |

*Cost per table provided by Missouri American dated July 1, 2010
*Inflated cost by 5% per year to 2013 numbers: = 2010 Rate*(1.05)^3
(1) 2" meter size was chosen for the monthly charge.

**Replacement Costs**

OPCC Break Down - Provided by B&West (w/o Davies 1 Ex

| | | Replacement Costs | (Assumed Values) Proposed Life Span (yrs.) |
|---|---|---|---|
| Transmission Lines | $37,050,000 | $380,000 | 60 |
| Water Storage Tanks | $3,320,000 | $50,000 | 40 |
| Pump Stations | $1,330,000 | $40,000 | 20 |
| Total | $41,700,000 | $470,000 | |

Replacement Cost = 2013 OPCC Value * (1-0.4) / Proposed Life Span; 40% of initial OPCC is assumed as a one time expense
Proposed lifespan (Ref. 4): 20 years for pump stations, 40 years for storage facilities, 60 years for pipelines

**O&M Costs**

Summary:

| O&M Cost Summary per year | |
|---|---|
| Staffing | $210,000 |
| Electrical | $89,000 |
| Storage Tanks | $30,000 |
| Piping | $15,000 |
| Total O&M | $344,000 |

Staffing Assumptions: 1 full time and 1 part time ADMIN and 2 full time field service employees, Employee cost is $60,000 per employee per year
$210,000

Electrical

| Assume PS operates 25% of the time | | | | |
|---|---|---|---|---|
| HP | KW | KW*HR | Cost / KWH | Annual Cost |
| 450 | 335.565 | 734887.35 | 0.12 | $88,186 |

(OPCC report from B&West)

Storage Tanks: Assumed $150K every 15 years for repainting and maintenance
$10,000 per tank
No. of Tanks 3 (OPCC report from B&West)

Pieplines: Assume 1 break every 20 miles and $3000 to fix each break
Total Pipeline Mileage 90.68 miles w/o Davies 1 transmission main (OPCC report from B&West)
Total Breaks Per Year 5
Total Line O&M $15,000

**OPCC**

| | |
|---|---|
| Construction Cost | $41,700,000 |
| Land Acquisition | $2,100,000 |
| Contingency | $8,300,000 |
| Total OPCC | $52,100,000 |

**Description:**

**ACWWC Alternative Background Calculations**

**Cost of Service Number**

(2) 6 MGD is total volume available. Cost of water is $4.00/kgal in Nov. 2008, increased by 5% per year to 2013 costs.

Cost of Water = $4.00 x 1.05^(2013-2008) $5.11

**Replacement Costs**

CC Break Down - Provided by B&West (w/o Davies 1 Extens

| | | Replacement Costs | (Assumed Values) Proposed Life Span (yrs.) |
|---|---|---|---|
| Transmission Lines | $67,530,000 | $676,000 | 60 |
| Elevated Water Storage Tanks | $1,520,000 | $23,000 | 40 |
| Pump Stations | $1,730,000 | $52,000 | 20 |
| Total | $70,780,000 | $751,000 | |

Replacement Cost = 2013 OPCC Value * (1-0.4) / Proposed Life Span; 40% of initial OPCC is assumed as a one time expense
Proposed lifespan (Ref. 4): 20 years for pump stations, 40 years for storage facilities, 60 years for pipelines

**O&M Costs**

O&M Cost Summary per year

| | |
|---|---|
| Staffing | $210,000 |
| Electrical | $128,000 |
| Storage Tanks | $20,000 |
| Piping | $21,000 |
| Total O&M | $379,000 |

Staffing Assumptions: 1 full time and 1 part time ADMIN and 2 full time field service employees, Employee cost is $60,000 per employee per year
$210,000

Electrical: Assume PS operates 25% of the time

| HP | KW | KW*HR | Cost / KWH | Annual Cost |
|---|---|---|---|---|
| 650 | 484.705 | 1061503.95 | 0.12 | $127,380 |

(OPCC report from B&West)

Storage Tanks: Assumed $150K every 15 years for repainting and maintenance
$10,000 per tank
No. of Tanks 2 (OPCC report from B&West)

Pieplines: Assume 1 break every 20 miles and $3000 to fix each break
Total Pipeline Mileage 126.78 miles w/o Davies 1 transmission main (OPCC report from B&West)
Total Breaks Per Year 7
Total Line O&M $21,000

**OPCC**

| | |
|---|---|
| Construction Cost | $70,780,000 |
| Contingency | $3,540,000 |
| Land Acquisition | $14,160,000 |
| Total OPCC | $88,480,000 |

# Appendix B

# Modeling Results

Date: 10 May 2011
By: Molly Pesce
Checked By: Bruce Hattig
Re: Pressure Table for Stage I

| Community | Elevation (feet) | Minimum Pressure (psi) | Maximum Pressure (psi) | $HGL_{Min}$ (feet) - Calculated | $HGL_{Max}$ (feet) - Calculated | $HGL_{Min}$ (feet) - Modeled | $HGL_{Max}$ (feet) - Modeled |
|---|---|---|---|---|---|---|---|
| Albany | 950 | 63 | 123 | 1096 | 1235 | 1095 | 1235 |
| Andrew Co PWSD # 1 | 1020 | 73 | 132 | 1189 | 1325 | 1188 | 1325 |
| Andrew Co PWSD #4 | 1010 | 74 | 117 | 1181 | 1281 | 1181 | 1280 |
| Barnard | 1010 | 74 | 117 | 1181 | 1281 | 1181 | 1280 |
| Bolckow | 948 | 103 | 149 | 1186 | 1293 | 1185 | 1292 |
| Daviess Co PWSD #1 | 780 | 183 | 197 | 1203 | 1236 | 1201 | 1235 |
| DeKalb Co PWSD #1 - 2nd Pt (25%) | 1053 | 55 | 92 | 1181 | 1266 | 1181 | 1265 |
| Gentry Co PWSD #1 | 950 | 63 | 123 | 1096 | 1235 | 1095 | 1235 |
| Gentry Co PWSD #2 | 948 | 83 | 124 | 1140 | 1235 | 1140 | 1235 |
| King City | 1081 | 60 | 67 | 1220 | 1236 | 1220 | 1235 |
| Nodaway Co PWSD #1 | 1131 | 37 | 46 | 1217 | 1238 | 1217 | 1236 |
| Stanberry | 904 | 103 | 143 | 1142 | 1235 | 1142 | 1235 |

*Max Pressure was found using 50% of peak day supply and zero demand. It was assumed that pump speed will be controlled so the critical node does not exceed 200 psi.

# ACWWC Input

```
[TITLE]


[JUNCTIONS]
;ID              Elev            Demand          Pattern
 10              857.809601      0                               ;New Junction
 102             1044.269305     0                               ;New Junction
 104             1095.411482     0                               ;New Junction
 106             903.047204      0                               ;New Junction
 108             1073.979188     0                               ;New Junction
 110             905.820219      0                               ;New Junction
 112             1046.223409     0                               ;New Junction
 114             866.960169      0                               ;New Junction
 116             1105.922624     0                               ;New Junction
 118             939.736083      0                               ;New Junction
 12              1081.236626     160                             ;King City
 120             828.322389      623                             ;Gallatin
 122             1052.862488     323                             ;DeKalb (25%)
 124             1142.690699     0                               ;New Junction
 126             966.687472      0                               ;New Junction
 128             974.419391      0                               ;New Junction
 132             1089.919218     0                               ;New Junction
 134             1085.452118     0                               ;New Junction
 136             1009.968566     112                             ;Barnard & Andrew
4
 138             968.939746      0                               ;New Junction
 140             948.421877      40                              ;Maitland
 142             1142.219321     0                               ;New Junction
 144             971.030920      0                               ;New Junction
 146             1153.426120     0                               ;New Junction
 148             1027.710715     56                              ;Ravenwood
 150             947.524072      80                              ;Bolckow & Andrew
4
 152             1059.031783     0                               ;New Junction
 154             773.299736      256                             ;Davies 1
 156             780.384461      0                               ;New Junction
 158             779.610107      0                               ;New Junction
 160             904.443523      184                             ;Stanberry
 162             835.894863      0                               ;New Junction
 164             950.172635      0                               ;
 166             927.761637      0                               ;New Junction
 168             1024.644839     200                             ;Grant City
 170             928.562323      0                               ;New Junction
 172             1122.841860     0                               ;New Junction
 174             1098.435806     0                               ;New Junction
 176             933.329393      0                               ;New Junction
 178             950.510050      0                               ;New Junction
 180             1061.069591     0                               ;New Junction
 182             1120.462428     0                               ;New Junction
 184             891.121420      0                               ;New Junction
 186             997.639586      0                               ;New Junction
 188             903.394734      0                               ;New Junction
 190             1005.020974     0                               ;New Junction
 192             1034.991181     0                               ;New Junction
 194             981.096012      -4215                           ;ACWWC
 196             1031.436401     0                               ;New Junction
 198             1100.310413     0                               ;New Junction
 200             886.298880      0                               ;New Junction
 28              931.309406      599                             ;Gentry 1 &
Albany
 30              840.189502      0                               ;New Junction
 32              1020.039770     934                             ;Andrew 1
 42              1122.846663     0                               ;
```

```
 44              1042.668734     0                       ;New Junction
 46              1101.459428     0                       ;New Junction
 48              997.923834      0                       ;
 54              853.906592      80                      ;Gentry 2
 56              940.257727      0                       ;New Junction
 58              948.381330      0                       ;New Junction
 60              954.501766      0                       ;New Junction
 62              1019.226867     0                       ;New Junction
 64              1117.131729     0                       ;New Junction
 66              1141.306697     0                       ;New Junction
 68              1111.461243     0                       ;New Junction
 78              1029.407103     0                       ;New Junction
 80              918.907434      0                       ;New Junction
 82              918.943579      0                       ;New Junction
 84              1156.700050     0                       ;
 86              1140.430515     0                       ;New Junction
 88              1130.523219     479                     ;Nodaway 1
 90              906.351272      0                       ;New Junction
 92              864.535480      0                       ;New Junction
 94              871.651245      0                       ;New Junction
 96              1087.661239     0                       ;New Junction
 3               1043            0                       ;
 4               872             0                       ;
 6               1000            0                       ;

[RESERVOIRS]
;ID             Head            Pattern

[TANKS]
;ID             Elevation       InitLevel       MinLevel        MaxLevel
     Diameter        MinVol          VolCurve
 1              1081            139             0               160
     50              0                               ;King City Tank
 2              1157            63              0               130
     50              0                               ;Maryville Tank
 5              1088            50              0               70
     10              0                               ;

[PIPES]
;ID             Node1           Node2           Length          Diameter
     Roughness       MinorLoss       Status
 107            28              30              9537.921914     12
     140.000000      0.000000        Open        ;New Pipe
 115            42              32              28238.778355    12.000000
     140.000000      0.000000        Open        ;New Pipe
 119            48              44              5259.850703     24
     140.000000      0.000000        Open        ;New Pipe
 123            54              56              18459.301865    12
     140.000000      0.000000        Open        ;New Pipe
 125            58              60              3823.306885     12
     140.000000      0.000000        Open        ;New Pipe
 127            62              64              13013.826416    24
     140.000000      0.000000        Open        ;New Pipe
 129            66              68              25353.873685    24
     140.000000      0.000000        Open        ;New Pipe
 139            78              80              11571.705202    6
     140.000000      0.000000        Open        ;New Pipe
 141            44              82              9084.235681     6
     140.000000      0.000000        Open        ;New Pipe
 143            84              62              10111.368967    30
     140.000000      0.000000        Open        ;New Pipe
 145            86              88              951.294959      24
     140.000000      0.000000        Open        ;New Pipe
```

```
147             90              92              15446.070030    12
    140.000000      0.000000        Open        ;New Pipe
155             12              102             23242.244643    16
    140.000000      0.000000        Open        ;New Pipe
157             104             106             25129.350635    20
    140.000000      0.000000        Open        ;New Pipe
159             108             110             21670.464670    20
    140.000000      0.000000        Open        ;New Pipe
161             48              78              15924.247181    24
    140.000000      0.000000        Open        ;New Pipe
163             112             68              4396.201801     24
    140.000000      0.000000        Open        ;New Pipe
165             114             116             41715.258354    4
    140.000000      0.000000        Open        ;New Pipe
167             118             120             53895.626546    12
    140.000000      0.000000        Open        ;New Pipe
169             102             104             9735.164451     16
    140.000000      0.000000        Open        ;New Pipe
171             122             102             12017.922714    8
    140.000000      0.000000        Open        ;New Pipe
173             124             126             8498.010350     8
    140.000000      0.000000        Open        ;New Pipe
175             12              128             72241.288684    12
    140.000000      0.000000        Open        ;New Pipe
189             132             42              24084.498481    12
    140.000000      0.000000        Open        ;New Pipe
191             134             132             5272.301439     16
    140.000000      0.000000        Open        ;New Pipe
193             46              134             3225.361603     24
    140.000000      0.000000        Open        ;New Pipe
195             78              112             10166.340821    24
    140.000000      0.000000        Open        ;New Pipe
197             80              136             1991.774638     6
    140.000000      0.000000        Open        ;New Pipe
199             138             112             7242.862487     4
    140.000000      0.000000        Open        ;New Pipe
201             116             138             7019.142244     4
    140.000000      0.000000        Open        ;New Pipe
203             140             114             2718.890522     4
    140.000000      0.000000        Open        ;New Pipe
205             142             66              11822.619789    24
    140.000000      0.000000        Open        ;New Pipe
207             64              142             1346.075690     24
    140.000000      0.000000        Open        ;New Pipe
209             86              84              2063.121682     24
    140.000000      0.000000        Open        ;New Pipe
211             62              144             6025.010030     8
    140.000000      0.000000        Open        ;New Pipe
213             144             146             20119.608793    8
    140.000000      0.000000        Open        ;New Pipe
215             146             124             11968.320398    8
    140.000000      0.000000        Open        ;New Pipe
217             126             148             6806.791630     8
    140.000000      0.000000        Open        ;New Pipe
219             82              150             4630.219333     6
    140.000000      0.000000        Open        ;New Pipe
221             110             134             15674.961160    20
    140.000000      0.000000        Open        ;New Pipe
223             152             108             1519.641879     20
    140.000000      0.000000        Open        ;New Pipe
225             106             152             9040.789911     20
    140.000000      0.000000        Open        ;New Pipe
```

```
229             128             154             14806.835473    12
    140.000000      0.000000        Open        ;New Pipe
231             156             158             696.853118      12
    140.000000      0.000000        Open        ;New Pipe
233             154             156             18054.998208    12
    140.000000      0.000000        Open        ;New Pipe
235             158             118             37390.425439    12
    140.000000      0.000000        Open        ;New Pipe
237             58              160             1536.532116     12
    140.000000      0.000000        Open        ;New Pipe
239             160             10              6239.234188     12
    140.000000      0.000000        Open        ;New Pipe
241             56              60              524.540342      12
    140.000000      0.000000        Open        ;New Pipe
243             92              54              1569.151793     12
    140.000000      0.000000        Open        ;New Pipe
245             162             90              6489.571040     12
    140.000000      0.000000        Open        ;New Pipe
247             164             162             7272.475229     12
    140.000000      0.000000        Open        ;New Pipe
249             30              164             5883.562452     12
    140.000000      0.000000        Open        ;New Pipe
251             90              94              36600.129687    8
    140.000000      0.000000        Open        ;New Pipe
253             96              166             12574.225393    8
    140.000000      0.000000        Open        ;New Pipe
255             166             168             12642.977728    8
    140.000000      0.000000        Open        ;New Pipe
257             170             172             41751.192219    30
    140.000000      0.000000        Open        ;New Pipe
259             174             86              38342.847653    24
    140.000000      0.000000        Open        ;New Pipe
261             176             178             13315.076526    30
    140.000000      0.000000        Open        ;New Pipe
263             180             182             3067.083289     30
    140.000000      0.000000        Open        ;New Pipe
265             184             186             9553.343107     30
    140.000000      0.000000        Open        ;New Pipe
267             188             190             7658.702192     30
    140.000000      0.000000        Open        ;New Pipe
269             192             194             1307.570770     30
    140.000000      0.000000        Open        ;New Pipe
271             182             192             3028.512640     30
    140.000000      0.000000        Open        ;New Pipe
273             180             176             10741.721387    30
    140.000000      0.000000        Open        ;New Pipe
275             178             184             14235.383343    30
    140.000000      0.000000        Open        ;New Pipe
277             186             188             7146.001452     30
    140.000000      0.000000        Open        ;New Pipe
279             190             196             1011.387448     30
    140.000000      0.000000        Open        ;New Pipe
281             196             170             7485.719735     30
    140.000000      0.000000        Open        ;New Pipe
283             172             198             3074.951661     24
    140.000000      0.000000        Open        ;New Pipe
285             198             200             27482.854480    24
    140.000000      0.000000        Open        ;New Pipe
287             200             174             14848.861700    24
    140.000000      0.000000        Open        ;New Pipe
1               1               12              1000            20
    100             0               Open        ;
```

```
 2               2               84              1000            24
     100             0               Open        ;
 5               3               46              24186           24
     140             0               Open        ;
 4               4               96              1000            8
     140             0               Open        ;
 7               96              5               1000            8
     140             0               Open        ;
 8               12              6               20000           16
     140             0               Open        ;
 9               6               10              35000           12
     140             0               Open        ;

[PUMPS]
;ID             Node1           Node2           Parameters
 3              44              3               HEAD 2     ;
 6              94              4               HEAD 3     ;

[VALVES]
;ID             Node1           Node2           Diameter        Type  Setting
      MinorLoss

[TAGS]

[DEMANDS]
;Junction       Demand          Pattern         Category

[STATUS]
;ID             Status/Setting

[PATTERNS]
;ID             Multipliers

[CURVES]
;ID             X-Value         Y-Value
;PUMP:
 1              0               2000
 1              3500            500
 1              3700            10
;PUMP:
 2              0               2000
 2              3300            500
 2              3500            10
;PUMP:
 3              0               2000
 3              180             500
 3              210             10

[CONTROLS]


[RULES]

[ENERGY]
 Global Efficiency     70.000000
 Global Price          0
 Demand Charge         0.000000

[EMITTERS]
;Junction       Coefficient

[QUALITY]
;Node           InitQual
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[SOURCES]
;Node            Type            Quality         Pattern

[REACTIONS]
;Type      Pipe/Tank        Coefficient


[REACTIONS]
 Order Bulk                 1.000000
 Order Tank                 1.000000
 Order Wall                 1
 Global Bulk                0.000000
 Global Wall                0.000000
 Limiting Potential         0
 Roughness Correlation      0

[MIXING]
;Tank            Model

[TIMES]
 Duration             0
 Hydraulic Timestep   1:00
 Quality Timestep     0:05
 Pattern Timestep     1:00
 Pattern Start        0:00
 Report Timestep      1:00
 Report Start         0:00
 Start ClockTime      12 am
 Statistic            None

[REPORT]
 Status               Yes
 Summary              No
 Page                 0

[OPTIONS]
 Units                GPM
 Headloss             H-W
 Specific Gravity     1.000000
 Viscosity            1
 Trials               40
 Accuracy             0.001
 CHECKFREQ            2
 MAXCHECK             10
 DAMPLIMIT            0
 Unbalanced           Stop
 Pattern              1
 Demand Multiplier    1.000000
 Emitter Exponent     0.500000
 Quality              None mg/L
 Diffusivity          1
 Tolerance            0.001000

[COORDINATES]
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| 126 | 2736884.73 | 1521398.55 |
| 128 | 2854296.86 | 1414561.68 |
| 132 | 2682202.70 | 1405422.22 |
| 134 | 2682206.46 | 1410704.93 |
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| 30 | 2827717.27 | 1486575.07 |
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| 273 | 2516549.12 | 1551921.94 |
| 273 | 2518635.27 | 1551846.34 |
| 273 | 2519412.79 | 1551834.66 |
| 273 | 2520395.50 | 1551803.49 |
| 273 | 2520652.99 | 1551748.51 |
| 273 | 2520883.78 | 1551687.34 |
| 273 | 2520989.44 | 1551666.16 |
| 273 | 2521085.24 | 1551662.04 |
| 273 | 2521508.56 | 1551650.09 |
| 273 | 2521663.34 | 1551668.03 |
| 273 | 2521933.31 | 1551666.87 |
| 273 | 2522284.04 | 1551646.03 |
| 273 | 2523329.78 | 1551623.59 |
| 273 | 2523835.25 | 1551622.60 |
| 273 | 2525206.22 | 1551615.25 |
| 275 | 2539183.96 | 1551209.38 |
| 275 | 2539123.29 | 1551173.89 |
| 275 | 2539076.22 | 1551127.14 |
| 275 | 2539027.53 | 1551063.13 |
| 275 | 2539009.07 | 1551022.61 |
| 275 | 2538981.47 | 1550844.08 |
| 275 | 2538952.92 | 1550587.98 |
| 275 | 2538938.59 | 1550053.18 |
| 275 | 2538957.24 | 1549151.18 |
| 275 | 2538954.87 | 1548653.45 |
| 275 | 2538968.04 | 1548387.52 |
| 275 | 2538965.56 | 1548275.04 |
| 275 | 2538958.66 | 1548175.30 |
| 275 | 2538942.54 | 1547978.11 |
| 275 | 2538933.78 | 1547856.79 |
| 275 | 2538912.55 | 1547704.96 |
| 275 | 2538903.43 | 1547605.26 |
| 275 | 2538898.59 | 1547380.14 |
| 275 | 2538887.74 | 1546724.24 |
| 275 | 2538860.69 | 1545916.71 |
| 275 | 2538861.52 | 1545358.45 |
| 275 | 2538844.78 | 1543412.84 |
| 275 | 2538841.08 | 1542229.14 |
| 275 | 2538844.01 | 1541036.89 |
| 275 | 2538837.77 | 1539747.12 |
| 275 | 2538830.10 | 1538797.05 |
| 275 | 2538812.24 | 1537427.01 |
| 277 | 2538713.77 | 1526906.75 |
| 277 | 2538696.99 | 1526110.16 |
| 277 | 2538668.22 | 1524871.94 |
| 277 | 2538651.74 | 1523980.03 |
| 277 | 2538562.12 | 1523982.95 |
| 277 | 2538538.56 | 1522692.88 |
| 277 | 2538542.71 | 1522448.43 |
| 277 | 2538560.49 | 1522292.94 |
| 277 | 2538650.95 | 1521935.27 |
| 277 | 2538750.24 | 1521566.93 |
| 277 | 2538788.89 | 1521457.23 |
| 277 | 2538831.42 | 1521373.56 |
| 277 | 2538939.84 | 1521232.58 |
| 277 | 2538975.88 | 1521148.80 |
| 277 | 2539017.28 | 1521004.52 |

| | | |
|---|---|---|
| 277 | 2539023.62 | 1520885.62 |
| 277 | 2539024.17 | 1520725.50 |
| 279 | 2546402.03 | 1519251.49 |
| 279 | 2546696.20 | 1519258.64 |
| 279 | 2546908.13 | 1519266.56 |
| 279 | 2547130.69 | 1519285.49 |
| 281 | 2547500.09 | 1519322.04 |
| 281 | 2547681.25 | 1519357.06 |
| 281 | 2547828.36 | 1519360.07 |
| 281 | 2548382.38 | 1519356.48 |
| 281 | 2548908.31 | 1519350.25 |
| 281 | 2549633.34 | 1519343.07 |
| 281 | 2550572.75 | 1519326.54 |
| 281 | 2551781.06 | 1519275.61 |
| 281 | 2552605.68 | 1519265.79 |
| 281 | 2554287.32 | 1519248.86 |
| 283 | 2597055.46 | 1518363.99 |
| 283 | 2598839.73 | 1518296.86 |
| 285 | 2600604.53 | 1518229.40 |
| 285 | 2602074.60 | 1518187.23 |
| 285 | 2603512.12 | 1518151.01 |
| 285 | 2604744.08 | 1518113.47 |
| 285 | 2605692.56 | 1518075.45 |
| 285 | 2607309.97 | 1518022.80 |
| 285 | 2608739.13 | 1517969.12 |
| 285 | 2609191.53 | 1517961.64 |
| 285 | 2609988.43 | 1517929.71 |
| 285 | 2610898.01 | 1517888.86 |
| 285 | 2612153.96 | 1517840.91 |
| 285 | 2613102.52 | 1517798.56 |
| 285 | 2614092.19 | 1517756.91 |
| 285 | 2614886.89 | 1517727.10 |
| 285 | 2615298.05 | 1517727.58 |
| 285 | 2615826.00 | 1517732.20 |
| 285 | 2616897.25 | 1517728.72 |
| 285 | 2617665.41 | 1517733.08 |
| 285 | 2618576.57 | 1517726.89 |
| 285 | 2619494.08 | 1517729.46 |
| 285 | 2620459.30 | 1517729.74 |
| 285 | 2621350.88 | 1517726.31 |
| 285 | 2623090.72 | 1517727.78 |
| 285 | 2624443.30 | 1517728.93 |
| 285 | 2624703.06 | 1517722.54 |
| 285 | 2625473.93 | 1517694.49 |
| 285 | 2626285.77 | 1517675.80 |
| 285 | 2627011.14 | 1517651.30 |
| 287 | 2627229.80 | 1517646.35 |
| 287 | 2627428.98 | 1517641.07 |
| 287 | 2627608.55 | 1517644.12 |
| 287 | 2627712.24 | 1517654.53 |
| 287 | 2627811.39 | 1517677.85 |
| 287 | 2627908.24 | 1517709.79 |
| 287 | 2628009.18 | 1517754.78 |
| 287 | 2628141.85 | 1517843.60 |
| 287 | 2628252.84 | 1517934.20 |
| 287 | 2628331.31 | 1518028.59 |
| 287 | 2628405.27 | 1518133.72 |
| 287 | 2628457.56 | 1518240.64 |
| 287 | 2628509.49 | 1518369.20 |
| 287 | 2628580.99 | 1518491.60 |
| 287 | 2628648.24 | 1518609.60 |
| 287 | 2628747.94 | 1518728.15 |
| 287 | 2628841.81 | 1518807.65 |

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 287             2628935.79       1518880.65
 287             2629027.94       1518934.15
 287             2629137.39       1518987.95
 287             2629238.52       1519022.12
 287             2629346.22       1519052.08
 287             2629458.54       1519064.81
 287             2629601.29       1519069.39
 287             2629909.15       1519052.49
 287             2631106.56       1518986.78
 287             2632434.51       1518913.90
 287             2632588.23       1518910.11
 287             2632748.43       1518906.34
 287             2632884.70       1518910.81
 287             2633016.63       1518915.21
 287             2633150.65       1518923.98
 287             2633243.46       1518938.53
 287             2633344.85       1518957.57
 287             2633473.96       1519000.87
 287             2633574.98       1519041.54
 287             2633708.12       1519102.22
 287             2633845.23       1519184.62
 287             2634018.71       1519291.44
 287             2634241.72       1519451.04
 287             2634405.52       1519579.32
 287             2635296.64       1520245.82
 287             2635982.71       1520753.02
 287             2636621.51       1521239.95
 287             2637399.14       1521835.27
 287             2637728.28       1522078.90
 287             2637984.85       1522262.87
 287             2638188.03       1522404.81
 287             2638346.07       1522528.68
 287             2638486.99       1522641.44
 287             2638621.78       1522732.45
 287             2638756.79       1522810.48
 287             2638909.48       1522867.18
 287             2639041.05       1522893.21
 287             2639207.53       1522902.53
 5               2684940.95       1418453.22
 5               2683426.16       1414535.66
 8               2782113.36       1415640.34
 8               2782637.23       1416982.75
 9               2782894.21       1461867.25
 9               2782894.21       1461867.25
 9               2780312.35       1465505.32

[LABELS]
;X-Coord          Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS      2486665.28       1314604.96       2958321.18       1585560.41
 UNITS           None
 FILE
 OFFSET          0.00             0.00

[END]
```

# Missouri-American Input

[TITLE]

[JUNCTIONS]

| ;ID | Elev | Demand | Pattern | |
|---|---|---|---|---|
| 10 | 857.809601 | 0 | | ; |
| 102 | 1044.269305 | 0 | | ; |
| 104 | 1095.411482 | 0 | | ;New Junction |
| 106 | 903.047204 | 0 | | ;New Junction |
| 108 | 1073.979188 | 0 | | ;New Junction |
| 110 | 905.820219 | 0 | | ;New Junction |
| 112 | 1046.223409 | 0 | | ;New Junction |
| 114 | 866.960169 | 0 | | ;New Junction |
| 116 | 1105.922624 | 0 | | ;New Junction |
| 118 | 939.736083 | 0 | | ;New Junction |
| 12 | 1081.236626 | 160 | | ;King City |
| 120 | 828.322389 | 623 | | ;Gallatin |
| 122 | 1052.862488 | 323 | | ;DeKalb (25%) |
| 124 | 1142.690699 | 0 | | ;New Junction |
| 126 | 966.687472 | 0 | | ;New Junction |
| 128 | 974.419391 | 0 | | ;New Junction |
| 132 | 1089.919218 | 0 | | ;New Junction |
| 134 | 1085.452118 | 0 | | ;New Junction |
| 136 | 1009.968566 | 112 | | ;Barnard & Andrew |
| 4 | | | | |
| 138 | 968.939746 | 0 | | ;New Junction |
| 140 | 948.421877 | 40 | | ;Maitland |
| 142 | 1142.219321 | 0 | | ;New Junction |
| 144 | 971.030920 | 0 | | ;New Junction |
| 146 | 1153.426120 | 0 | | ;New Junction |
| 148 | 1027.710715 | 56 | | ;Ravenwood |
| 150 | 947.524072 | 80 | | ;Bolckow |
| 152 | 1059.031783 | 0 | | ;New Junction |
| 154 | 773.299736 | 0 | | ; |
| 156 | 780.384461 | 256 | | ;Davies 1 |
| 158 | 779.610107 | 0 | | ;New Junction |
| 160 | 904.443523 | 184 | | ;Stanberry |
| 162 | 835.894863 | 0 | | ;New Junction |
| 164 | 950.172635 | 599 | | ;Albany & Gentry |
| 1 | | | | |
| 166 | 927.761637 | 0 | | ;New Junction |
| 168 | 1024.644839 | 200 | | ;Grant City |
| 32 | 1020.039770 | 934 | | ;Andrew 1 |
| 34 | 1033.037074 | 0 | | ;New Junction |
| 42 | 1122.846663 | 0 | | ; |
| 44 | 1042.668734 | 0 | | ;New Junction |
| 46 | 1101.459428 | 0 | | ;New Junction |
| 48 | 997.923834 | 0 | | ; |
| 50 | 1103.505249 | 0 | | ;-4125 |
| 54 | 853.906592 | 0 | | ; |
| 56 | 940.257727 | 0 | | ;New Junction |
| 58 | 948.381330 | 80 | | ;Gentry 2 |
| 60 | 954.501766 | 0 | | ;New Junction |
| 62 | 1019.226867 | 0 | | ;New Junction |
| 64 | 1117.131729 | 0 | | ;New Junction |
| 66 | 1141.306697 | 0 | | ;New Junction |
| 68 | 1111.461243 | 0 | | ;New Junction |
| 78 | 1029.407103 | 0 | | ;New Junction |
| 80 | 918.907434 | 0 | | ;New Junction |
| 82 | 918.943579 | 0 | | ;New Junction |

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 84              1156.700050     0                               ;
 86              1140.430515     0                               ;New Junction
 88              1130.523219     479                             ;Nodaway 1
 90              906.351272      0                               ;New Junction
 92              864.535480      0                               ;New Junction
 94              871.651245      0                               ;New Junction
 96              1087.661239     0                               ;New Junction
 3               1100            0                               ;
 5               872             0                               ;

[RESERVOIRS]
;ID             Head            Pattern

[TANKS]
;ID             Elevation       InitLevel       MinLevel        MaxLevel
     Diameter        MinVol          VolCurve
 1               1081            139             0               160
     50              0                                   ;King City Tank
 2               1157            63              0               130
     50              0                                   ;Maryville Tank
 4               1088            50              0               70
     10              0                                   ;

[PIPES]
;ID             Node1           Node2           Length          Diameter
     Roughness       MinorLoss       Status
 109             32              34              25889.584309    24
     140.000000      0.000000        Open        ;New Pipe
 115             42              32              28628.27        24
     140.000000      0.000000        Open        ;New Pipe
 117             44              46              24186.604064    12
     140.000000      0.000000        Open        ;New Pipe
 119             48              44              5259.850703     12
     140.000000      0.000000        Open        ;New Pipe
 123             54              56              18459.301865    12
     140.000000      0.000000        Open        ;New Pipe
 125             58              60              3823.306885     12
     140.000000      0.000000        Open        ;New Pipe
 127             62              64              13013.826416    12
     140.000000      0.000000        Open        ;New Pipe
 129             66              68              25353.873685    12
     140.000000      0.000000        Open        ;New Pipe
 139             78              80              11571.705202    6
     140.000000      0.000000        Open        ;New Pipe
 141             44              82              9084.235681     6
     140.000000      0.000000        Open        ;New Pipe
 143             84              62              10111.368967    12
     140.000000      0.000000        Open        ;New Pipe
 145             86              88              951.294959      12
     140.000000      0.000000        Open        ;New Pipe
 147             90              92              15446.070030    12
     140.000000      0.000000        Open        ;New Pipe
 155             12              102             23242.244643    16
     140.000000      0.000000        Open        ;New Pipe
 157             104             106             25129.350635    20
     140.000000      0.000000        Open        ;New Pipe
 159             108             110             21670.464670    20
     140.000000      0.000000        Open        ;New Pipe
 161             48              78              15924.247181    12
     140.000000      0.000000        Open        ;New Pipe
```

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163             112             68              4396.201801     12
    140.000000      0.000000        Open        ;New Pipe
165             114             116             41715.258354    4
    140.000000      0.000000        Open        ;New Pipe
167             118             120             53895.626546    12
    140.000000      0.000000        Open        ;New Pipe
169             102             104             9735.164451     16
    140.000000      0.000000        Open        ;New Pipe
171             122             102             12017.922714    8
    140.000000      0.000000        Open        ;New Pipe
173             124             126             8498.010350     8
    140.000000      0.000000        Open        ;New Pipe
175             12              128             72241.288684    12
    140.000000      0.000000        Open        ;New Pipe
187             34              50              2763.671968     24
    140.000000      0.000000        Open        ;New Pipe
189             132             42              24016.78        24
    140.000000      0.000000        Open        ;New Pipe
191             134             132             5272.301439     24
    140.000000      0.000000        Open        ;New Pipe
193             46              134             3225.361603     12
    140.000000      0.000000        Open        ;New Pipe
195             78              112             10166.340821    12
    140.000000      0.000000        Open        ;New Pipe
197             80              136             1991.774638     6
    140.000000      0.000000        Open        ;New Pipe
199             138             112             7242.862487     4
    140.000000      0.000000        Open        ;New Pipe
201             116             138             7019.142244     4
    140.000000      0.000000        Open        ;New Pipe
203             140             114             2718.890522     4
    140.000000      0.000000        Open        ;New Pipe
205             142             66              11822.619789    12
    140.000000      0.000000        Open        ;New Pipe
207             64              142             1346.075690     12
    140.000000      0.000000        Open        ;New Pipe
209             86              84              2063.121682     12
    140.000000      0.000000        Open        ;New Pipe
211             62              144             6025.010030     8
    140.000000      0.000000        Open        ;New Pipe
213             144             146             20119.608793    8
    140.000000      0.000000        Open        ;New Pipe
215             146             124             11968.320398    8
    140.000000      0.000000        Open        ;New Pipe
217             126             148             6806.791630     8
    140.000000      0.000000        Open        ;New Pipe
219             82              150             4630.219333     6
    140.000000      0.000000        Open        ;New Pipe
221             110             134             15674.961160    20
    140.000000      0.000000        Open        ;New Pipe
223             152             108             1519.641879     20
    140.000000      0.000000        Open        ;New Pipe
225             106             152             9040.789911     20
    140.000000      0.000000        Open        ;New Pipe
229             128             154             14806.835473    12
    140.000000      0.000000        Open        ;New Pipe
231             156             158             696.853118      12
    140.000000      0.000000        Open        ;New Pipe
233             154             156             18054.998208    12
    140.000000      0.000000        Open        ;New Pipe
```

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 235             158             118             37390.425439    12
     140.000000      0.000000        Open        ;New Pipe
 237             58              160             1536.532116     12
     140.000000      0.000000        Open        ;New Pipe
 239             160             10              6239.234188     12
     140.000000      0.000000        Open        ;New Pipe
 241             56              60              524.540342      12
     140.000000      0.000000        Open        ;New Pipe
 243             92              54              1569.151793     12
     140.000000      0.000000        Open        ;New Pipe
 245             162             90              6489.571040     12
     140.000000      0.000000        Open        ;New Pipe
 247             164             162             7219.68         12
     140.000000      0.000000        Open        ;New Pipe
 251             90              94              36600.129687    8
     140.000000      0.000000        Open        ;New Pipe
 253             96              166             12574.225393    8
     140.000000      0.000000        Open        ;New Pipe
 255             166             168             12642.977728    8
     140.000000      0.000000        Open        ;New Pipe
 1               1               12              1000            24
     140             0               Open        ;
 2               2               84              1000            12
     140             0               Open        ;
 3               12              3               20000           16
     140             0               Open        ;
 4               3               10              35008.020082    12
     140             0               Open        ;
 6               4               96              100             8
     140             0               Open        ;
 8               5               96              29725.922466    8
     140             0               Open        ;

[PUMPS]
;ID             Node1           Node2           Parameters
 9              94              5               HEAD 2     ;

[VALVES]
;ID             Node1           Node2           Diameter        Type  Setting
     MinorLoss

[TAGS]

[DEMANDS]
;Junction       Demand          Pattern         Category

[STATUS]
;ID             Status/Setting
 9              Closed

[PATTERNS]
;ID             Multipliers

[CURVES]
;ID             X-Value         Y-Value
;PUMP: PUMP:
 1              0               2000
 1              3000            500
 1              3200            10
;PUMP: PUMP:
```

```
 2               0               2000
 2               180             500
 2               210             10

[CONTROLS]



[RULES]


[ENERGY]
 Global Efficiency     70.000000
 Global Price          0
 Demand Charge         0.000000

[EMITTERS]
;Junction        Coefficient

[QUALITY]
;Node            InitQual

[SOURCES]
;Node            Type            Quality         Pattern

[REACTIONS]
;Type      Pipe/Tank        Coefficient


[REACTIONS]
 Order Bulk                1.000000
 Order Tank                1.000000
 Order Wall                1
 Global Bulk               0.000000
 Global Wall               0.000000
 Limiting Potential        0
 Roughness Correlation     0

[MIXING]
;Tank            Model

[TIMES]
 Duration             0:00
 Hydraulic Timestep   1:00
 Quality Timestep     0:05
 Pattern Timestep     1:00
 Pattern Start        0:00
 Report Timestep      1:00
 Report Start         0:00
 Start ClockTime      12 am
 Statistic            NONE

[REPORT]
 Status               Yes
 Summary              No
 Page                 0

[OPTIONS]
 Units                GPM
 Headloss             H-W
```

| | |
|---|---|
| Specific Gravity | 1.000000 |
| Viscosity | 1 |
| Trials | 40 |
| Accuracy | 0.001 |
| CHECKFREQ | 2 |
| MAXCHECK | 10 |
| DAMPLIMIT | 0 |
| Unbalanced | Stop |
| Pattern | 1 |
| Demand Multiplier | 1.000000 |
| Emitter Exponent | 0.500000 |
| Quality | None mg/L |
| Diffusivity | 1 |
| Tolerance | 0.001000 |

[COORDINATES]

| ;Node | X-Coord | Y-Coord |
|---|---|---|
| 10 | 2780454.89 | 1469510.73 |
| 102 | 2758855.25 | 1415487.11 |
| 104 | 2749550.50 | 1416474.04 |
| 106 | 2723973.99 | 1418435.66 |
| 108 | 2714517.67 | 1418813.91 |
| 110 | 2696280.95 | 1412932.18 |
| 112 | 2685645.66 | 1468909.31 |
| 114 | 2629679.73 | 1470035.78 |
| 116 | 2671386.54 | 1469196.31 |
| 118 | 2907800.85 | 1392181.46 |
| 12 | 2781446.58 | 1415881.53 |
| 120 | 2936642.36 | 1368195.83 |
| 122 | 2758291.93 | 1403351.44 |
| 124 | 2728398.36 | 1521190.79 |
| 126 | 2736884.73 | 1521398.55 |
| 128 | 2854296.86 | 1414561.68 |
| 132 | 2682202.70 | 1405422.22 |
| 134 | 2682333.00 | 1410762.56 |
| 136 | 2698631.04 | 1461178.24 |
| 138 | 2678404.26 | 1469055.06 |
| 140 | 2626672.75 | 1469804.13 |
| 142 | 2684216.82 | 1509395.43 |
| 144 | 2696316.10 | 1521755.47 |
| 146 | 2716433.19 | 1521465.22 |
| 148 | 2740687.24 | 1524151.91 |
| 150 | 2698757.93 | 1439201.27 |
| 152 | 2715948.84 | 1418462.53 |
| 154 | 2868903.49 | 1415355.80 |
| 156 | 2887130.29 | 1413195.54 |
| 158 | 2887826.54 | 1413166.58 |
| 160 | 2777682.03 | 1473146.63 |
| 162 | 2815686.98 | 1483549.80 |
| 164 | 2821774.87 | 1486461.79 |
| 166 | 2815057.93 | 1560610.38 |
| 168 | 2815537.69 | 1573244.25 |
| 32 | 2686592.79 | 1355843.19 |
| 34 | 2685559.31 | 1330855.90 |
| 42 | 2686526.95 | 1382879.89 |
| 44 | 2685032.30 | 1437572.32 |
| 46 | 2683063.92 | 1413803.70 |
| 48 | 2684979.62 | 1443223.05 |
| 50 | 2685650.86 | 1328101.48 |
| 54 | 2792060.71 | 1483964.98 |

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 56              2777975.02       1479337.24
 58              2777892.87       1474990.17
 60              2777965.11       1478812.79
 62              2690291.36       1521812.16
 64              2684321.60       1510552.18
 66              2683883.74       1497590.61
 68              2685780.51       1473303.44
 78              2685343.99       1458750.75
 80              2696769.35       1459040.35
 82              2694111.67       1437726.71
 84              2680596.70       1522064.72
 86              2677448.88       1522076.96
 88              2678340.36       1523110.32
 90              2809198.39       1483633.21
 92              2793758.24       1483910.74
 94              2813748.25       1518368.96
 96              2814621.91       1548043.88
 3               2782927.32       1442033.13
 5               2813812.26       1519169.65
 1               2780711.92       1415031.39
 2               2680474.91       1522455.21
 4               2812810.11       1547949.72

[VERTICES]
;Link            X-Coord          Y-Coord
 109             2687445.31       1355401.85
 109             2687636.79       1355120.86
 109             2687780.11       1354806.59
 109             2687964.63       1353973.32
 109             2688242.66       1352889.91
 109             2688331.61       1352428.56
 109             2688327.06       1349797.60
 109             2688254.06       1349309.17
 109             2688255.04       1346832.58
 109             2688229.65       1346409.92
 109             2688147.04       1346010.65
 109             2687948.51       1345260.27
 109             2687666.69       1344151.22
 109             2687169.69       1342315.88
 109             2686738.25       1340928.24
 109             2686530.38       1340250.79
 109             2686462.77       1339924.85
 109             2686326.24       1338866.96
 109             2686190.80       1337744.13
 109             2686085.33       1337255.16
 109             2685883.06       1337211.16
 109             2685768.62       1335804.49
 109             2685730.46       1334691.41
 109             2685572.89       1332951.08
 115             2686924.81       1382209.92
 115             2687120.92       1381948.85
 115             2687589.85       1381104.14
 115             2687575.85       1376142.57
 115             2687518.17       1370879.82
 115             2687535.91       1368858.24
 115             2687437.40       1367955.26
 115             2687374.51       1367832.40
 115             2687411.35       1367573.18
 115             2687474.10       1367062.63
 115             2687510.74       1366007.69
```

| | | |
|---|---|---|
| 115 | 2687488.08 | 1364456.38 |
| 115 | 2687511.28 | 1364042.65 |
| 115 | 2687608.48 | 1363573.32 |
| 115 | 2687837.55 | 1362505.33 |
| 115 | 2687987.55 | 1361793.29 |
| 115 | 2688232.10 | 1360287.07 |
| 115 | 2688324.80 | 1360085.63 |
| 115 | 2688345.05 | 1358397.00 |
| 115 | 2688321.50 | 1357381.61 |
| 115 | 2688224.70 | 1356860.30 |
| 115 | 2687951.35 | 1356214.23 |
| 115 | 2687758.16 | 1356113.54 |
| 115 | 2687547.92 | 1356061.29 |
| 115 | 2687116.04 | 1356151.48 |
| 117 | 2685040.28 | 1435197.07 |
| 117 | 2685048.35 | 1434720.81 |
| 117 | 2685175.75 | 1434226.72 |
| 117 | 2685205.42 | 1433644.96 |
| 117 | 2685175.52 | 1432671.81 |
| 117 | 2685122.66 | 1430705.78 |
| 117 | 2685136.24 | 1429508.40 |
| 117 | 2685082.27 | 1427608.53 |
| 117 | 2685027.82 | 1424166.97 |
| 117 | 2684941.44 | 1419871.33 |
| 117 | 2684918.33 | 1418494.69 |
| 117 | 2684859.43 | 1418063.62 |
| 117 | 2684760.17 | 1417671.56 |
| 117 | 2684538.13 | 1417105.41 |
| 117 | 2683989.67 | 1415885.33 |
| 117 | 2683423.92 | 1414512.77 |
| 119 | 2685083.33 | 1439195.00 |
| 119 | 2685042.92 | 1438961.97 |
| 119 | 2685021.34 | 1438280.10 |
| 119 | 2685032.06 | 1437645.08 |
| 123 | 2791464.54 | 1483988.64 |
| 123 | 2787235.74 | 1484034.78 |
| 123 | 2783292.84 | 1484045.39 |
| 123 | 2778731.66 | 1484045.53 |
| 123 | 2778273.17 | 1483728.55 |
| 123 | 2778049.16 | 1483260.91 |
| 127 | 2690228.30 | 1520424.81 |
| 127 | 2690152.40 | 1520008.77 |
| 127 | 2690022.67 | 1519342.96 |
| 127 | 2689855.84 | 1518419.38 |
| 127 | 2689774.18 | 1517853.94 |
| 127 | 2689621.40 | 1517569.31 |
| 127 | 2689253.23 | 1517029.19 |
| 127 | 2688867.61 | 1516527.95 |
| 127 | 2688510.84 | 1515940.06 |
| 127 | 2687928.57 | 1515159.94 |
| 127 | 2687208.65 | 1514077.68 |
| 127 | 2686898.45 | 1513782.10 |
| 127 | 2686590.64 | 1513345.54 |
| 127 | 2685659.61 | 1511994.26 |
| 127 | 2685223.05 | 1511323.27 |
| 127 | 2684624.01 | 1510939.84 |
| 127 | 2684378.46 | 1510744.89 |
| 129 | 2683899.04 | 1497471.34 |
| 129 | 2685701.52 | 1495845.24 |
| 129 | 2686303.02 | 1495263.77 |

| | | |
|---|---|---|
| 129 | 2686278.83 | 1489701.85 |
| 129 | 2686030.03 | 1483426.15 |
| 129 | 2685774.11 | 1475492.08 |
| 139 | 2687472.32 | 1458642.38 |
| 139 | 2694859.37 | 1458613.29 |
| 139 | 2696014.50 | 1458555.86 |
| 141 | 2688056.34 | 1437723.71 |
| 143 | 2681037.19 | 1522079.56 |
| 143 | 2681563.12 | 1522067.50 |
| 143 | 2681672.54 | 1522076.35 |
| 143 | 2681765.57 | 1522089.58 |
| 143 | 2681892.17 | 1522116.21 |
| 143 | 2681981.59 | 1522136.38 |
| 143 | 2682109.16 | 1522174.67 |
| 143 | 2682228.82 | 1522198.85 |
| 143 | 2682380.29 | 1522202.58 |
| 143 | 2682739.55 | 1522188.86 |
| 143 | 2683327.32 | 1522173.18 |
| 143 | 2684076.02 | 1522153.24 |
| 143 | 2685051.05 | 1522121.97 |
| 143 | 2685365.85 | 1522117.99 |
| 143 | 2685403.50 | 1522097.64 |
| 143 | 2685450.21 | 1522023.83 |
| 143 | 2685486.02 | 1521974.31 |
| 143 | 2685528.33 | 1521954.05 |
| 143 | 2686421.61 | 1521931.89 |
| 143 | 2687253.15 | 1521907.52 |
| 143 | 2688102.13 | 1521885.78 |
| 143 | 2688970.96 | 1521862.05 |
| 143 | 2689866.78 | 1521828.28 |
| 147 | 2804324.03 | 1483860.00 |
| 147 | 2793925.19 | 1483896.89 |
| 157 | 2748214.30 | 1417816.72 |
| 157 | 2732851.51 | 1418376.64 |
| 159 | 2704855.40 | 1418518.89 |
| 159 | 2703839.07 | 1418092.35 |
| 159 | 2703556.25 | 1416654.66 |
| 159 | 2703080.84 | 1414497.25 |
| 159 | 2701672.46 | 1413040.59 |
| 159 | 2700357.78 | 1412097.28 |
| 159 | 2698311.33 | 1412062.79 |
| 167 | 2908251.50 | 1392192.04 |
| 167 | 2908378.34 | 1389655.28 |
| 167 | 2909773.56 | 1389528.44 |
| 167 | 2910027.23 | 1386738.00 |
| 167 | 2913451.86 | 1386484.32 |
| 167 | 2913832.38 | 1379761.90 |
| 167 | 2915861.79 | 1379761.90 |
| 167 | 2918525.39 | 1378366.68 |
| 167 | 2921442.67 | 1378620.36 |
| 167 | 2921950.02 | 1366190.21 |
| 167 | 2927277.23 | 1366190.21 |
| 167 | 2934690.39 | 1366518.13 |
| 169 | 2750535.56 | 1415457.64 |
| 173 | 2732543.97 | 1521095.70 |
| 175 | 2801410.81 | 1415284.68 |
| 175 | 2834619.28 | 1415591.92 |
| 175 | 2835884.87 | 1415360.90 |
| 187 | 2685536.08 | 1330065.47 |
| 187 | 2685524.15 | 1329241.60 |

| | | |
|---|---|---|
| 187 | 2685640.03 | 1328471.35 |
| 189 | 2681953.20 | 1390355.43 |
| 189 | 2682511.04 | 1388570.30 |
| 189 | 2682986.53 | 1387335.94 |
| 189 | 2683156.12 | 1386908.44 |
| 189 | 2683382.40 | 1386490.01 |
| 189 | 2684284.85 | 1385457.71 |
| 189 | 2686543.73 | 1382954.15 |
| 191 | 2682285.14 | 1410629.49 |
| 193 | 2683053.31 | 1413732.38 |
| 193 | 2682359.95 | 1412079.79 |
| 195 | 2685334.34 | 1458764.71 |
| 205 | 2684197.70 | 1509174.07 |
| 205 | 2684066.40 | 1506641.87 |
| 205 | 2683985.99 | 1505022.98 |
| 205 | 2683762.72 | 1498534.00 |
| 207 | 2684301.72 | 1510378.61 |
| 209 | 2678529.91 | 1522006.75 |
| 209 | 2679033.63 | 1521997.80 |
| 209 | 2679177.46 | 1522039.87 |
| 209 | 2679319.08 | 1522074.91 |
| 209 | 2679465.57 | 1522097.21 |
| 209 | 2679618.13 | 1522105.63 |
| 209 | 2680085.69 | 1522098.40 |
| 213 | 2708969.21 | 1521636.41 |
| 217 | 2737194.04 | 1521420.13 |
| 217 | 2740438.28 | 1521311.98 |
| 219 | 2696061.37 | 1437551.01 |
| 221 | 2695940.68 | 1413046.36 |
| 221 | 2694502.99 | 1413329.19 |
| 221 | 2693179.70 | 1412897.49 |
| 221 | 2691563.24 | 1411642.04 |
| 221 | 2690864.23 | 1410606.76 |
| 221 | 2688921.84 | 1410471.68 |
| 229 | 2854729.67 | 1414542.89 |
| 235 | 2892904.08 | 1412993.51 |
| 235 | 2892904.08 | 1406905.27 |
| 235 | 2894299.30 | 1404749.02 |
| 235 | 2896709.22 | 1397138.73 |
| 235 | 2896709.22 | 1394982.48 |
| 235 | 2902797.46 | 1394601.97 |
| 235 | 2902926.11 | 1392067.00 |
| 239 | 2777864.95 | 1473452.89 |
| 239 | 2778915.77 | 1473431.75 |
| 239 | 2779398.22 | 1473430.57 |
| 239 | 2779723.72 | 1473415.85 |
| 239 | 2779835.84 | 1473411.52 |
| 239 | 2779924.73 | 1473400.57 |
| 239 | 2780004.52 | 1473375.46 |
| 239 | 2780095.37 | 1473341.20 |
| 239 | 2780178.51 | 1473302.15 |
| 239 | 2780236.81 | 1473259.56 |
| 239 | 2780293.74 | 1473206.05 |
| 239 | 2780341.46 | 1473144.61 |
| 239 | 2780378.24 | 1473086.10 |
| 239 | 2780413.63 | 1473018.22 |
| 239 | 2780435.99 | 1472984.36 |
| 239 | 2780475.78 | 1472932.12 |
| 239 | 2780496.42 | 1472815.75 |
| 239 | 2780497.01 | 1472730.19 |

```
 239             2780484.92       1472667.72
 239             2780482.44       1472169.68
 239             2780478.91       1471642.06
 239             2780470.09       1470782.87
 239             2780460.33       1470163.32
 245             2813142.71       1483545.31
 247             2821521.41       1486392.93
 247             2820831.04       1486072.01
 247             2820223.19       1485443.24
 247             2819010.10       1484031.12
 247             2818245.06       1483554.31
 251             2808930.92       1501635.49
 251             2810304.27       1505696.71
 251             2810143.07       1515212.05
 253             2814716.96       1551631.46
 3               2782316.20       1416026.33
 3               2782757.56       1441557.81
 4               2783007.84       1461937.82
 4               2782269.05       1463292.27
 4               2780483.64       1465816.47

[LABELS]
;X-Coord           Y-Coord          Label & Anchor Node
 2660805.75       1385527.66       "Savannah"
 2705131.92       1460854.07       "Andrew 4"
 2702444.52       1443881.44       "Bolckow"
 2621467.45       1478956.13       "Maitland"
 2702444.52       1467030.20       "Barnard"
 2737969.35       1532668.04       "Ravenwood"
 2672531.59       1532289.78       "Nodaway 1"
 2819428.44       1579467.04       "Grant City"
 2785629.21       1422596.44       "King City"
 2837828.11       1492573.23       "Gentry 1"
 2813241.67       1496355.76       "Albany"
 2784494.45       1492194.98       "Gentry 2"
 2749982.15       1483978.40       "Stanberry"
 2745534.40       1396875.25       "DeKalb (25%)"
 2884025.85       1422818.73       "Davies 1"
 2927852.30       1377206.10       "Gallatin"
 2691065.99       1359428.21       "Andrew 1"
 2625144.19       1417839.08       "Flow Control Structure"

[BACKDROP]
 DIMENSIONS      2486665.00       1314604.00       2958321.00       1585560.00
 UNITS           None
 FILE
 OFFSET          0.00             0.00

[END]
```

# Savannah Input

[TITLE]

[JUNCTIONS]

| ;ID | Elev | Demand | Pattern | |
|---|---|---|---|---|
| 10 | 857.809601 | 0 | | ;New Junction |
| 102 | 1044.269305 | 0 | | ;New Junction |
| 104 | 1095.411482 | 0 | | ;New Junction |
| 106 | 903.047204 | 0 | | ;New Junction |
| 108 | 1073.979188 | 0 | | ;New Junction |
| 110 | 905.820219 | 0 | | ;New Junction |
| 112 | 1046.223409 | 0 | | ;New Junction |
| 114 | 866.960169 | 0 | | ;New Junction |
| 116 | 1105.922624 | 0 | | ;New Junction |
| 118 | 939.736083 | 0 | | ;New Junction |
| 12 | 1081.236626 | 160 | | ;King City |
| 120 | 828.322389 | 623 | | ;Gallatin |
| 122 | 1052.862488 | 323 | | ;DeKalb (25%) |
| 124 | 1142.690699 | 0 | | ;New Junction |
| 126 | 966.687472 | 0 | | ;New Junction |
| 128 | 974.419391 | 0 | | ;New Junction |
| 132 | 1089.919218 | 0 | | ;New Junction |
| 134 | 1085.452118 | 0 | | ;New Junction |
| 136 | 1009.968566 | 112 | | ;Barnard & Andrew |
| 4 | | | | |
| 138 | 968.939746 | 0 | | ;New Junction |
| 140 | 948.421877 | 40 | | ;Maitland |
| 142 | 1142.219321 | 0 | | ;New Junction |
| 144 | 971.030920 | 0 | | ;New Junction |
| 146 | 1153.426120 | 0 | | ;New Junction |
| 148 | 1027.710715 | 56 | | ;Ravenwood |
| 150 | 947.524072 | 80 | | ;Bolckow |
| 152 | 1059.031783 | 0 | | ;New Junction |
| 154 | 773.299736 | 0 | | ; |
| 156 | 780.384461 | 256 | | ;Davies 1 |
| 158 | 779.610107 | 0 | | ;New Junction |
| 160 | 904.443523 | 184 | | ;Stanberry |
| 162 | 835.894863 | 0 | | ;New Junction |
| 164 | 950.172635 | 599 | | ;Albany & Gentry |
| 1 | | | | |
| 166 | 927.761637 | 0 | | ;New Junction |
| 168 | 1024.644839 | 200 | | ;Grant City |
| 32 | 1020.039770 | 934 | | ;Andrew 1 |
| 42 | 1122.846663 | -4125 | | ; |
| 44 | 1042.668734 | 0 | | ;New Junction |
| 46 | 1101.459428 | 0 | | ;New Junction |
| 48 | 997.923834 | 0 | | ; |
| 54 | 853.906592 | 0 | | ; |
| 56 | 940.257727 | 0 | | ;New Junction |
| 58 | 948.381330 | 80 | | ;Gentry 2 |
| 60 | 954.501766 | 0 | | ;New Junction |
| 62 | 1019.226867 | 0 | | ;New Junction |
| 64 | 1117.131729 | 0 | | ;New Junction |
| 66 | 1141.306697 | 0 | | ;New Junction |
| 68 | 1111.461243 | 0 | | ;New Junction |
| 78 | 1029.407103 | 0 | | ;New Junction |
| 80 | 918.907434 | 0 | | ;New Junction |
| 82 | 918.943579 | 0 | | ;New Junction |
| 84 | 1156.700050 | 0 | | ; |
| 86 | 1140.430515 | 0 | | ;New Junction |
| 88 | 1130.523219 | 479 | | ;Nodaway 1 |
| 90 | 906.351272 | 0 | | ;New Junction |
| 92 | 864.535480 | 0 | | ;New Junction |

```
 94              871.651245      0                               ;New Junction
 96              1087.661239     0                               ;New Junction
 3               1100            0                               ;
 5               872             0                               ;

[RESERVOIRS]
;ID             Head            Pattern

[TANKS]
;ID             Elevation       InitLevel       MinLevel        MaxLevel
     Diameter        MinVol          VolCurve
 1               1081            139             0               160
     50              0                                   ;King City Tank
 2               1157            63              0               130
     50              0                                   ;Maryville Tank
 4               1088            50              0               70
     10              0                                   ;

[PIPES]
;ID             Node1           Node2           Length          Diameter
     Roughness       MinorLoss       Status
 115             42              32              28628.27        12
     140.000000      0.000000        Open        ;New Pipe
 117             44              46              24186.604064    12
     140.000000      0.000000        Open        ;New Pipe
 119             48              44              5259.850703     12
     140.000000      0.000000        Open        ;New Pipe
 123             54              56              18459.301865    12
     140.000000      0.000000        Open        ;New Pipe
 125             58              60              3823.306885     12
     140.000000      0.000000        Open        ;New Pipe
 127             62              64              13013.826416    12
     140.000000      0.000000        Open        ;New Pipe
 129             66              68              25353.873685    12
     140.000000      0.000000        Open        ;New Pipe
 139             78              80              11571.705202    6
     140.000000      0.000000        Open        ;New Pipe
 141             44              82              9084.235681     6
     140.000000      0.000000        Open        ;New Pipe
 143             84              62              10111.368967    12
     140.000000      0.000000        Open        ;New Pipe
 145             86              88              951.294959      12
     140.000000      0.000000        Open        ;New Pipe
 147             90              92              15446.070030    12
     140.000000      0.000000        Open        ;New Pipe
 155             12              102             23242.244643    16
     140.000000      0.000000        Open        ;New Pipe
 157             104             106             25129.350635    20
     140.000000      0.000000        Open        ;New Pipe
 159             108             110             21670.464670    20
     140.000000      0.000000        Open        ;New Pipe
 161             48              78              15924.247181    12
     140.000000      0.000000        Open        ;New Pipe
 163             112             68              4396.201801     12
     140.000000      0.000000        Open        ;New Pipe
 165             114             116             41715.258354    4
     140.000000      0.000000        Open        ;New Pipe
 167             118             120             53895.626546    12
     140.000000      0.000000        Open        ;New Pipe
 169             102             104             9735.164451     16
     140.000000      0.000000        Open        ;New Pipe
 171             122             102             12017.922714    8
     140.000000      0.000000        Open        ;New Pipe
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173             124             126             8498.010350     8
    140.000000      0.000000        Open        ;New Pipe
175             12              128             72241.288684    12
    140.000000      0.000000        Open        ;New Pipe
189             132             42              24016.78        24
    140.000000      0.000000        Open        ;New Pipe
191             134             132             5272.301439     24
    140.000000      0.000000        Open        ;New Pipe
193             46              134             3225.361603     12
    140.000000      0.000000        Open        ;New Pipe
195             78              112             10166.340821    12
    140.000000      0.000000        Open        ;New Pipe
197             80              136             1991.774638     6
    140.000000      0.000000        Open        ;New Pipe
199             138             112             7242.862487     4
    140.000000      0.000000        Open        ;New Pipe
201             116             138             7019.142244     4
    140.000000      0.000000        Open        ;New Pipe
203             140             114             2718.890522     4
    140.000000      0.000000        Open        ;New Pipe
205             142             66              11822.619789    12
    140.000000      0.000000        Open        ;New Pipe
207             64              142             1346.075690     12
    140.000000      0.000000        Open        ;New Pipe
209             86              84              2063.121682     12
    140.000000      0.000000        Open        ;New Pipe
211             62              144             6025.010030     8
    140.000000      0.000000        Open        ;New Pipe
213             144             146             20119.608793    8
    140.000000      0.000000        Open        ;New Pipe
215             146             124             11968.320398    8
    140.000000      0.000000        Open        ;New Pipe
217             126             148             6806.791630     8
    140.000000      0.000000        Open        ;New Pipe
219             82              150             4630.219333     6
    140.000000      0.000000        Open        ;New Pipe
221             110             134             15674.961160    20
    140.000000      0.000000        Open        ;New Pipe
223             152             108             1519.641879     20
    140.000000      0.000000        Open        ;New Pipe
225             106             152             9040.789911     20
    140.000000      0.000000        Open        ;New Pipe
229             128             154             14806.835473    12
    140.000000      0.000000        Open        ;New Pipe
231             156             158             696.853118      12
    140.000000      0.000000        Open        ;New Pipe
233             154             156             18054.998208    12
    140.000000      0.000000        Open        ;New Pipe
235             158             118             37390.425439    12
    140.000000      0.000000        Open        ;New Pipe
237             58              160             1536.532116     12
    140.000000      0.000000        Open        ;New Pipe
239             160             10              6239.234188     12
    140.000000      0.000000        Open        ;New Pipe
241             56              60              524.540342      12
    140.000000      0.000000        Open        ;New Pipe
243             92              54              1569.151793     12
    140.000000      0.000000        Open        ;New Pipe
245             162             90              6489.571040     12
    140.000000      0.000000        Open        ;New Pipe
247             164             162             7219.68         12
    140.000000      0.000000        Open        ;New Pipe
```

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 251             90              94              36600.129687    8
     140.000000      0.000000        Open        ;New Pipe
 253             96              166             12574.225393    8
     140.000000      0.000000        Open        ;New Pipe
 255             166             168             12642.977728    8
     140.000000      0.000000        Open        ;New Pipe
 1               1               12              1000            24
     140             0               Open        ;
 2               2               84              1000            12
     140             0               Open        ;
 3               12              3               20000           16
     140             0               Open        ;
 4               3               10              35008.020082    12
     140             0               Open        ;
 6               4               96              100             8
     140             0               Open        ;
 8               5               96              29725.922466    8
     140             0               Open        ;

[PUMPS]
;ID             Node1           Node2           Parameters
 9              94              5               HEAD 2     ;

[VALVES]
;ID             Node1           Node2           Diameter        Type  Setting
     MinorLoss

[TAGS]

[DEMANDS]
;Junction       Demand          Pattern         Category

[STATUS]
;ID             Status/Setting

[PATTERNS]
;ID             Multipliers

[CURVES]
;ID             X-Value         Y-Value
;PUMP:
 1              0               2000
 1              3000            500
 1              3200            10
;PUMP:
 2              0               2000
 2              180             500
 2              210             10

[CONTROLS]


[RULES]

[ENERGY]
 Global Efficiency     70.000000
 Global Price          0
 Demand Charge         0.000000

[EMITTERS]
;Junction       Coefficient

[QUALITY]
```

```
;Node            InitQual

[SOURCES]
;Node            Type            Quality         Pattern

[REACTIONS]
;Type      Pipe/Tank        Coefficient


[REACTIONS]
 Order Bulk                 1.000000
 Order Tank                 1.000000
 Order Wall                 1
 Global Bulk                0.000000
 Global Wall                0.000000
 Limiting Potential         0
 Roughness Correlation      0

[MIXING]
;Tank            Model

[TIMES]
 Duration             0
 Hydraulic Timestep   1:00
 Quality Timestep     0:05
 Pattern Timestep     1:00
 Pattern Start        0:00
 Report Timestep      1:00
 Report Start         0:00
 Start ClockTime      12 am
 Statistic            None

[REPORT]
 Status               Yes
 Summary              No
 Page                 0

[OPTIONS]
 Units                GPM
 Headloss             H-W
 Specific Gravity     1.000000
 Viscosity            1
 Trials               40
 Accuracy             0.001
 CHECKFREQ            2
 MAXCHECK             10
 DAMPLIMIT            0
 Unbalanced           Stop
 Pattern              1
 Demand Multiplier    1.000000
 Emitter Exponent     0.500000
 Quality              None mg/L
 Diffusivity          1
 Tolerance            0.001000

[COORDINATES]
;Node            X-Coord          Y-Coord
 10              2780454.89       1469510.73
 102             2758855.25       1415487.11
 104             2749550.50       1416474.04
 106             2723973.99       1418435.66
 108             2714517.67       1418813.91
 110             2696280.95       1412932.18
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 2702444.52       1467030.20       "Barnard"
 2737969.35       1532668.04       "Ravenwood"
 2672531.59       1532289.78       "Nodaway 1"
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 2813241.67       1496355.76       "Albany"
 2784494.45       1492194.98       "Gentry 2"
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 FILE
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[END]
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# Appendix C

# Supplier Information

## Stewart, Sarah

**From:** Michael.Wood@amwater.com
**Sent:** Friday, January 28, 2011 11:53 AM
**To:** Stewart, Sarah
**Cc:** Bernard.Meyer@amwater.com; Derek.Linam@amwater.com; Christopher.Parrish@amwater.com
**Subject:** Great Northwest Wholesale Water Commission
**Attachments:** 2009 WQ Report.pdf; 2982_001.pdf

Sarah:

I promised you a response today. I can write a letter next week addressing everything if this is not adequate but wanted to pass along what I have to date. I will address each of your bullet points below.

There have been no significant changes in operations or water treatment from our last update provided. Majority of that information can be utilized for this update.

1) We do utilize chloramines for disinfection and the plant is rated at 30 mgd.

2) The Missouri American Water Company's St. Joseph District owns and operates a well field and treatment plant in southwestern Andrew County.
Raw water is taken from the Missouri River alluvium by seven, 3 MGD vertical-drilled wells and/or one collector well consisting of seven horizontal-drilled wells, and containing three pumping units rated at 6 MGD each. The raw water travels from the well field to the 30mgd ground water treatment plant through two, 36-inch raw water lines.

The raw water enters the plant and an initial dose of chlorine is added for disinfection/oxidation. The water then moves through two mixing chambers where ferric, polymer, and carbon can be added to condition the water for removal of excess iron and manganese. The water then flows to any of 3 process clarifiers. At the point the water enters the clarifiers, slaked lime is added to raise the pH and reduce hardness. The clarifiers allow the precipitated minerals to settle for removal to lagoons located on the plant property. Prior to filtration, polyphosphate is added to sequester the remaining minerals. The water then proceeds to any of 6 dual-media filters, which have a rating of six MGD each. After filtration, additional chlorine is added with ammonia to create a chloramine for disinfection purposes. The water is then fluoridated and stored in a 1.5 mg below ground concrete clear well.

Meeting Phase 1 Demand - should not be a major issue if current demands do not change.
Meeting Total Commission Demand - I will have our Engineering Department evaluate and provide comments.

Preferred connection point would be at our Treatment Plant.

I am attaching a copy (pdf) of our most recent Consumer Confidence Report.
(See attached file: 2009 WQ Report.pdf)

Necessary Capital Improvements - requires further review

Capability to finance - May not be applicable depending upon Engineering comments from bullet point above.

Cost of water - See attached pdf of current rates.

(See attached file: 2982_001.pdf)

5 Year average of Wholesale Customers - not readily available.

Timeline to construct improvements - May not be applicable depending upon Engineering comments from bullet point above.

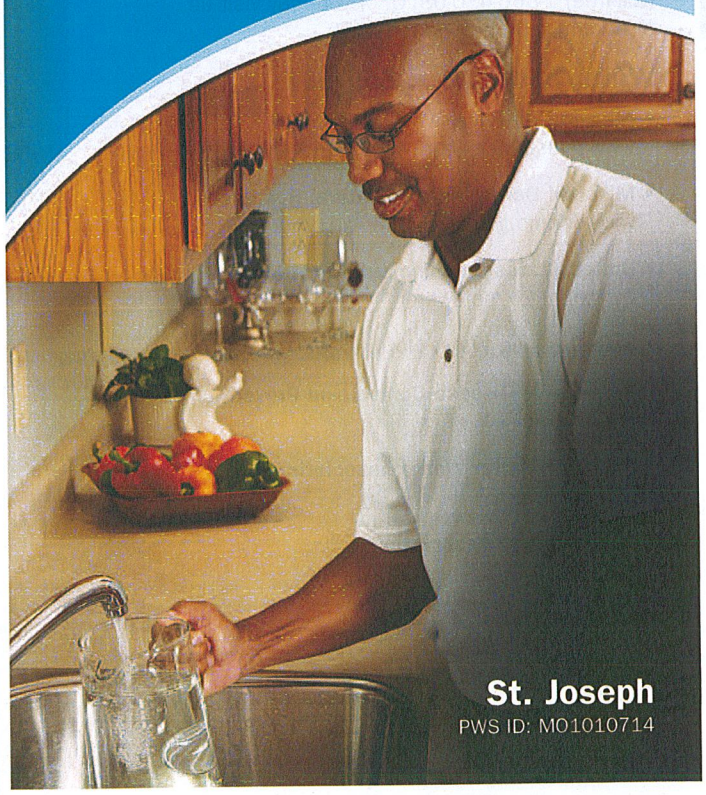
I hope this supplies you with enough information to proceed with study. If you need anything additional, please advise.

Thanks

Michael Wood
Operations Manager
Missouri American Water Company
Northwest Operations
3901 Beck Road, Suite B
St. Joseph, MO 64506
Office (816) 233-4000 Ext. 2222
Internal 7-412-2222
Cell (816) 262-5246
Home (816) 689-6306

# 2009 Annual Water Quality Report

MISSOURI AMERICAN WATER



**St. Joseph**
PWS ID: MO1010714

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo o hable con alguien que lo entienda bien.

## A Message from the Missouri American Water President

*Missouri American Water is proud to be your local water company. Our lives revolve around water. It's in everything we do, everything we use. That's why it's important that we share with our customers information about our commitment to providing high-quality water service – a service you enjoy at about a penny a gallon.*

*I am pleased to provide you with the 2009 Annual Water Quality Report with detailed information about the source and quality of your drinking water. We have prepared this report using the data from water quality testing conducted for your local water system from January through December 2009. You'll find that we supply water that surpasses or meets all federal and state water quality regulations.*

*Just as important, we place a strong focus on acting as stewards of our environment. In Missouri, we participate in activities that help communities protect the watershed and educate customers on how to use water wisely. You can learn more about these programs on our website at www.missouriamwater.com.*

*Also in 2009, RWE Group sold its remaining shares of American Water stock, completing the divestiture of American Water from RWE Group. As a subsidiary of American Water, we are proud to celebrate this milestone.*

*At Missouri American Water, we deliver more than just water. We deliver a key resource for public health, fire protection, economic opportunity and the overall quality of life we enjoy. We also deliver value – our water service costs about a penny a gallon! It's part of our commitment to serve you and everyone in the community. For more information or for additional copies of this report, visit us online at www.missouriamwater.com or contact our Customer Service Center at 1-866-430-0820.*

*Sincerely,*

*Frank Kartmann*
*President*
*Missouri American Water*

## A+ WATER QUALITY FOR LESS THAN A PENNY

**Did you know that you pay less than a penny for a gallon of your tap water?**

Providing high-quality water service is our business. Our team of water quality experts and certified operators monitor your water from source to tap, and we have an exceptional track record when it comes to water quality. **Our compliance record for meeting or surpassing state and federal drinking water standards was 100 percent last year.** That beats the national average.

**Tap water: an exceptional value!**

**WE CARE ABOUT WATER. IT'S WHAT WE DO.**

## What is a Water Quality Report?

To comply with state and U.S. Environmental Protection Agency (USEPA) regulations, Missouri American Water issues a report annually describing the quality of your drinking water. The purpose of this report is to raise your understanding of drinking water and awareness of the need to protect drinking water sources. In 2009, we conducted tests for hundreds of contaminants, all of which were below state and federal maximum allowable levels. This report provides an overview of last year's (2009) water quality. It includes details about where your water comes from and what it contains.

If you have any questions about this report or your drinking water, please call our Customer Service Center at (toll-free) 1-866-430-0820.

## About Missouri American Water

Founded in 1886, American Water is the largest investor-owned U.S. water and wastewater utility company. With headquarters in Voorhees, N.J., the company employs more than 7,000 dedicated professionals who provide drinking water, wastewater and other related services to approximately 15 million people in 32 states and Ontario, Canada.

At Missouri American Water, and all of American Water, we work hard everyday to provide our customers with water they can enjoy and use with confidence.

## Source Water Information

Missouri American Water supplies quality drinking water to more than 32,000 residential, commercial and industrial customers in the City of St. Joseph. The St. Joseph District also supplies water to four water districts and the neighboring cities of Elwood and Wathena, Kansas. The St. Joseph water treatment plant uses groundwater taken from numerous vertical wells and a horizontal collector well.

## How to Contact Us

For more information regarding this report or any of the other services provided by Missouri American Water, please call our Customer Service Center at (toll-free) 1-866-430-0820, or you may visit us at www.missouriamwater.com.

## Water Information Sources

- **Missouri American Water**
  www.missouriamwater.com
- **Missouri Department of Natural Resources**
  www.dnr.mo.gov
- **United States Environmental Protection Agency**
  www.epa.gov/safewater
- **Safe Drinking Water Hotline:** (800) 426-4791
- **Centers for Disease Control and Prevention**
  www.cdc.gov
- **American Water Works Association**
  www.awwa.org
- **Water Quality Association**
  www.wqa.org
- **National Library of Medicine/ National Institute of Health**
  www.nlm.nih.gov/medlineplus

## Substances Expected to be in Drinking Water

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and groundwater wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk.

**Contaminants that may be present in source water include:**

**Microbial Contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.

**Inorganic Contaminants**, such as salts and metals, which can be naturally occurring or may result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.

**Pesticides and Herbicides**, which may come from a variety of sources, such as agriculture, urban stormwater runoff, and residential uses.

**Organic Chemical Contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.

**Radioactive Contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.

For more information about the contaminants and potential health effects, call the USEPA's Safe Drinking Water Hotline at (800) 426-4791.

## St. Joseph Water Treatment Facility Earns Special Recognition

The Missouri Department of Natural Resources honored Missouri American Water's St. Joseph Treatment Facility for successful completion of the Missouri Environmental Management Partnership Program (MEMP). The partnership encourages organizations to improve their environmental performance by developing and implementing an environmental management system (EMS). Missouri American Water is the first company in Missouri to receive this distinction. Environmental management is an integral part of Missouri American Water's operations. Achieving Advanced Partner status in the MEMP Program has allowed us to increase environmental awareness and reduce environmental risks. Missouri American Water's participation in this program is an example of the company's dedication to making environmental management a fundamental part of the business. As providers of high quality, affordable water, our responsibility is to not only protect one of our most precious resources but to improve the environment.

## Special Health Information

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants may be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/CDC guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the USEPA's Safe Drinking Water Hotline (800) 426-4791.

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Missouri American Water is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

To ensure that tap water is of high quality, the USEPA prescribes regulations limiting the amount of certain substances in water provided by public water systems. U.S. Food and Drug Administration regulations establish limits for contaminants in bottled water, which must provide the same protection for public health. Missouri American Water's advanced water treatment processes are designed to reduce any such substances to levels well below any health concern.

## How to Read This Table

Missouri American Water conducts extensive monitoring to ensure that your water meets all water quality standards. The results of our monitoring are reported in the following tables. While most monitoring was conducted in 2009, certain substances are monitored less than once per year because the levels do not change frequently. For help with interpreting this table, see the "Table Definitions" section.

Starting with a **Substance**, read across. **Year Sampled** is usually in 2009 or year prior. **MCL** shows the highest level of substance (contaminant) allowed. **MCLG** is the goal level for that substance (this may be lower than what is allowed). **Results** represents the measured amount (less is better). **Range** tells the highest and lowest amounts measured. A **Yes** under **Compliance Achieved** means the amount of the substance met government requirements. **Typical Source** tells where the substance usually originates.

Unregulated substances are measured, but maximum contaminant levels have not been established by the government.

## Definitions of Terms Used in This Report

- **AL (Action Level)**: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.
- **MCL (Maximum Contaminant Level)**: The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
- **MCLG (Maximum Contaminant Level Goal)**: The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
- **MRDL (Maximum Residual Disinfectant Level)**: The highest level of disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- **MRDLG (Maximum Residual Disinfectant Level Goal)**: The level of drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.
- **NA**: Not applicable
- **ND**: Not detected
- **pCi/L (picocuries per liter)**: Measurement of the natural rate of disintegration of radioactive contaminants in water (also beta particles).
- **ppm (parts per million)**: One part substance per million parts water, or milligrams per liter.
- **ppb (parts per billion)**: One part substance per billion parts water, or micrograms per liter.

## Water Quality Statement

We are pleased to report that during the past year, the water delivered to your home or business complied with all state and federal drinking water requirements. For your information, we have compiled a list in the table, showing what substances were detected in your drinking water during 2009. Although all of the substances listed below are under the Maximum Contaminant Level (MCL) set by the USEPA, we feel it is important that you know exactly what was detected and how much of the substance was present in the water. For additional information concerning our results, please contact our customer service department at (toll-free) 1-866-430-0820.

Monitoring was also done during 2008 and 2009 under the U.S. Environmental Protection Agency (USEPA) Unregulated Contaminant Monitoring Rule 2 (UCMR2). Data is available on the USEPA's web site (www.epa.gov/safewater/data/ucmrgetdata.html).

There are many unforeseen and unpredictable factors that may cause a source water to be contaminated. The Missouri Department of Natural Resources routinely monitors all public water supplies to ensure public health is protected. Source Water Assessments have been assembled by the Missouri Department of Natural Resources to evaluate the susceptibility of contamination to our drinking water sources. For more information about these assessments call the Missouri Department of Natural Resources at (800) 361-4827.

## Water Quality Results

**Regulated Substances (Measured on the Water Leaving the Treatment Facility)**

| Substance (units) | Year Sampled | MCL | MCLG | Results | Range Low-High | Compliance Achieved | Typical Source |
|---|---|---|---|---|---|---|---|
| Alpha emitters (pCi/L) | 2008 | 15 | 0 | 2.4 | 1.5 - 3.9 | Yes | Erosion of natural deposits |
| Barium (ppm) | 2009 | 2 | 2 | 0.12 | 0.11 - 0.13 | Yes | Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits |
| Chloramines (ppm) | 2009 | TT | NA | 3.1 | 2.8 - 3.4 | Yes | Water additive used to control microbes |
| Di(2-ethylhexyl)phthalate (ppb) | 2009 | 6 | 0 | 0.4 | ND - 1.1 | Yes | Discharge from rubber and chemical factories |
| Fluoride (ppm) | 2009 | 4 | 4 | 0.7 | 0.7 - 0.8 | Yes | Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories |
| Nitrate (as N) (ppm) | 2009 | 10 | 10 | 0.05 | 0.03 - 0.07 | Yes | Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits |
| Nitrite (as N) (ppm) | 2009 | 1 | 1 | 0.01 | 0.01 - 0.01 | Yes | Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits |

**Bacterial Results (from the Distribution System)**

| Substance (units) | Year Sampled | MCL | MCLG | Highest Percentage Detected | Compliance Achieved | Typical Source |
|---|---|---|---|---|---|---|
| Total Coliform Bacteria | 2009 | 5% Pos. Samples | 0 | 0 | Yes | Naturally present in the environment |

**Other Compounds (Measured in the Distribution System)**

| Substance (units) | Year Sampled | MCL | MCLG | Results | Range Low-High | Compliance Achieved | Typical Source |
|---|---|---|---|---|---|---|---|
| Chloramines (ppm) | 2009 | MRDL = 4 | MRDLG = 4 | 2.3 | 2.3 - 3.0 | Yes | Water additive used to control microbes |
| TTHMs [Total trihalomethanes] (ppb) | 2009 | 80 | NA | 4.1 | 2.0 - 4.9 | Yes | By-product of drinking water disinfection |
| HAA5 [Haloacetic Acids] (ppb) | 2009 | 60 | NA | 5.2 | 3.7 - 6.2 | Yes | By-product of drinking water disinfection |

**Unregulated Substances (Measured on the Water Leaving the Treatment Facility)**

| Substance (units) | Year Sampled | Results | Range Low-High | Typical Source |
|---|---|---|---|---|
| Bromodichloromethane (ppb) | 2009 | 1.1 | ND - 1.8 | By-product of disinfection |
| Chloroform (ppb) | 2009 | 3.3 | 1.4 - 4.8 | By-product of disinfection |
| Sulfate (ppm) | 2009 | 112 | 94.2 - 145.7 | Erosion of natural deposits |

**Tap Water Samples: Lead and Copper Results**

| Substance (units) | Year Sampled | Action Level | MCLG | Number of Samples | 90th Percentile | Number of Samples Above Action Level | Typical Source |
|---|---|---|---|---|---|---|---|
| Copper (ppm) | 2007 | AL = 1.3 | 1.3 | 30 | 0.163 | 0 | Corrosion of household plumbing systems; Erosion of natural deposits; Leaching from wood preservatives |
| Lead (ppb) | 2007 | AL = 15 | 0 | 30 | 4.0 | 0 | Corrosion of household plumbing systems; Erosion of natural deposits |

Missouri-American Water Company
Name of Issuing Corporation

For City of St. Joseph and Vicinity Areas Only
Community, Town or City

## CLASSIFICATION OF SERVICE
## GENERAL WATER SERVICE

Availability

Available for any metered customer located on Company mains suitable for supplying the service requested.

**Rate**

Billing Rate as follows:

**Water Usage – 1,000 Gallons – Rate per 1,000 Gallons Per Month**

| | | Residential | Commercial | Industrial | Public Authority | Sale For Resale | |
|---|---|---|---|---|---|---|---|
| For the first | 100 | $ 4.2705 | $4.2794 | $6.2732 | $ 4.2794 | $ 4.2794 | + |
| For the next | 1,900 | 4.2705 | 3.3234 | 3.5141 | 3.3234 | 3.3234 | + |
| For the next | 3,000 | 4.2705 | 2.7691 | 2.1196 | 2.7691 | 2.7691 | + |
| For all over | 5,000 | 4.2705 | 1.8886 | 1.7316 | 1.8886 | 1.8886 | + |

**Water Usage – CCF – Rate per CCF**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| For the first | 134 | $ 3.2029 | $ 3.2096 | $4.7049 | $3.2096 | $3.2096 | + |
| For the next | 2,533 | 3.2029 | 2.4925 | 2.6356 | 2.4925 | 2.4925 | + |
| For the next | 4,000 | 3.2029 | 2.0768 | 1.5897 | 2.0768 | 2.0768 | + |
| For all over | 6,667 | 3.2029 | 1.4164 | 1.2987 | 1.4164 | 1.4164 | + |

**Monthly Minimum Charge**

| Meter Size | Per Month | Meter Size | Per Month | |
|---|---|---|---|---|
| 5/8" | $ 9.26 | 4" | $ 128.45 | + |
| 3/4" | 11.85 | 6" | 252.50 | + |
| 1" | 16.80 | 8" | 401.35 | + |
| 1 1/2" | 29.22 | 10" | 681.79 | + |
| 2" | 44.11 | 12" | 1,124.62 | + |
| 3" | 78.85 | | | + |

These rates do not include any municipal, state or federal taxes computed on either billing or consumption basis. Any such taxes applicable shall be added as separate items in rendering each bill.

**Billing**

Bills for water service will be distributed on a monthly basis. The due date on the tariff shall be ten (10) days after the "date of rendition" of the bill to the customer. The customer's bill will be due and payable after this due date. The delinquent date printed on the bill will not be less than twenty-one (21) days after the date of the postmark of the bill. Any accounts remaining unpaid at the expiration of twenty-one (21) days shall be considered delinquent and the Company may take such action as specified in its filed rules and regulations.

* Indicates new rate or text
\+ Indicates change

DATE OF ISSUE: June 18, 2010

DATE OF EFFECTIVE: July 1, 2010

ISSUED BY: Frank Kartmann, President
727 Craig Road, St. Louis, MO 63141

BARTLETT & WEST

SERVICE. THE BARTLETT & WEST WAY.

January 24, 2011

Ms. Sarah A. Stewart, P.E.
CDM, Inc.
9200 Ward Parkway, Ste. 500
Kansas City, MO 64114

Subject: Re: Request for Proposals to Supply Potable Water to Great Northwest Wholesale Water Commission

Dear Ms. Stewart:

The following are responses to your January 6th, 2011, request:

- The initial phase of construction is under design and scheduled to go on line in mid 2013. The initial phase will have a firm capacity of 2.5 million gallons per day (MGD). The site was selected to allow for future expansions to a total capacity of 10 MGD. Of this total, approximately 4 MGD is planned to be held in reserve for the Atchison County area. The remaining 6 MGD is potentially available for sale to the Great Northwest Wholesale Water Commission.
- The residual disinfectant used by the plant will be chloramines.
- The supply will come from nearby alluvial wells and the treatment process will include aerations, lime softening, pH adjustment and filtration.
- All of the initial phase capacity is slated for existing members of the Atchison County Wholesale Water Commission (ACWWC). Providing water to the Great NW Wholesale Water Commission would require additional construction in well, treatment and transmission systems.
- A copy of the 2010 Community Confidence Report cannot be included since there was no water treatment conducted in 2010.
- Financing any future improvements will be considered on a case by case basis.
- The wholesale rate would depend on agreed upon financing terms, up front contributions and the level of grants available from the federal government. Following is an estimate using the November 2008 Facility Plant rate estimates (Table 9.5) and these assumptions:
    - No grant funds.
    - Construction of wells and treatment similar to the project under design.
    - Similar financing terms as indicated in Table 9.5.
    - Similar reserve practices as indicated in Table 9.5.
    - A population served that fully uses the contracted supply. The numbers shown in the first scenario of Table 9.5 anticipates expansion in the local water district and customers in Atchison County by a factor of 5,076/2,157 or 2.35. The resulting wholesale rate for 5,000 gallons is $64 per month or $12.80 per thousand gallons.
    - Total project costs for supply and plant, excluding transmission is 73% ((22-6)/22) of the loan indicated in Table 9.5.

250 NE TUDOR ROAD ■ LEE'S SUMMIT MO 64086-5696
816.525.3562 ■ FAX 816.525.9041 ■ 866.869.8030
WWW.BARTWEST.COM

- Maximum supply is 6 MGD.

The resulting calculation is: $12.80 per thousand gallons x 73% / 2.35 = $3.98 per thousand gallons or approximately $4.00 per thousand gallons. These numbers should be escalated to account for inflation since November 2008.

If you have any further questions, please contact me.

Sincerely,

Bruce Hattig, P.E.

cc: Kyra Mills, Chairperson, Atchison County Wholesale Water Commission

# Drinking Water Facilities Plan

# Water Treatment Plant Improvements

# City of Savannah, Missouri

**By**

BARTLETT & WEST
SERVICE. THE BARTLETT & WEST WAY.
3110 KARNES ROAD • ST JOSEPH MO 64506
816.364.3551 • FAX 816.364.6548 • 888.863.5844
WWW.BARTWEST.COM

| City Contact | Engineer Contact |
|---|---|
| Mike Fischer, City Administrator<br>City Hall<br>402 Court Street<br>Savannah, MO 64485<br>Ph 816-324-3315 | Casey Patton<br>Bartlett & West<br>3110 Karnes Rd,<br>St Joseph, MO 64506<br>Ph 816-364-3551 |

Only relevant portions of this Drinking Water Facilities Plan are included for reference to the Stage 1 Pipeline PER.

## Introduction

This study was commissioned by the City of Savannah, Missouri in an effort to develop a long-term plan for improving the efficient use and expansion of their water treatment plant and related facilities. Specifically the City identified three areas of concern for evaluation within the study to assist them in addressing their long-term planning needs. Those areas and their corresponding divisions within the study are as follows:

- **PART I - EXPANSION OF THE WATER TREATMENT FACILITY**

  Develop a facility plan for expansion of their water treatment plant (WTP) in order to provide future service to wholesale water customers and support growth of the City.

- **PART IIA - ALTERNATE WIND ENERGY SOURCE**

  Review the potential costs and related benefits for developing an alternate wind energy source.

- **PART IIB -METHODS OF ENERGY CONSERVATION**

  Review methods of energy conservation within current operations that would lower their electrical costs.

- **PART III - CHLORINE VERSUS CHLORAMINE**

  Address the issues related to the use of free chlorine versus chloramines as it relates to potential service to wholesale customers and the City service. Review the efficiencies of current disinfection operations and areas for improvement.

In each section of this study, a number of alternatives were considered and the benefits and costs evaluated. Upon evaluation, recommendations are made to assist the City in moving forward.

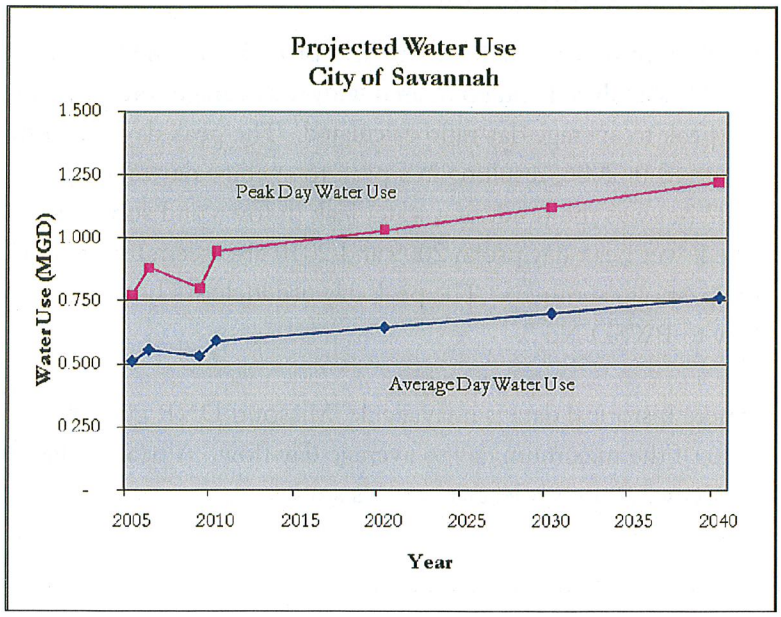
| Year | Average Day Use * | Peak Day Use ** | Ratio of Peak to Avg. Day Use |
|---|---|---|---|
| 2004 | 412,816 | 620,000 | 1.50 |
| 2005 | 510,444 | 774,000 | 1.52 |
| 2006 | 556,016 | 881,000 | 1.58 |
| 2007 | 575,315 | 1,003,000 | 1.74 |
| 2008 | 533,205 | | |
| 2009 | 530,174 | 800,000 | 1.51 |
| 2010 | 552,165 | 793,000 | 1.44 |

**Total water use and the peak to average day ratio includes both Savannah municipal water use and water sold to Public Water Supply District No.3 (PWSD No 3) of Andrew County.*
*** Peak Day in 2007 is high due to a leak in the system, no data is available for 2008.*

While the City meters water use at each household within town, this information was not readily available to compare with metered use at the water treatment plant. However the per capita-day water use is consistent with other towns the size of Savannah. As such, we would anticipate the unaccounted for water use, as a percent of the total demand to be approximately 10%. Unaccounted for water use reflects water loss due to backwashing, fighting fires, flushing mains and hydrants, system leaks and repairs, and unmetered parks, swimming pools, or other public facilities. There are 2,061 household meters within the City and the City is currently implementing a program to replace each meter with a wireless read system to further track and reduce water loss.

**Water Use Projections**

The following table and graph are provided showing the current and future water use projections for the City of Savannah and Andrew County PWS District No 3. As indicated, water use projections are determined using the estimates of population growth presented earlier in this study, a water use rate of 95 gallons per capita-day and a peaking factor of 1.60. Water use projections similar to population projections are for the 30-year study period.



| Population and Water Use Projections City of Savannah, Missouri | | | |
|---|---|---|---|
| Year | City Population | Avg.Day Water Use MGD | Peak Day Water Use MGD |
| 2005 | 4,812 | 0.510 | 0.77 |
| 2006 | 5,002 | 0.556 | 0.88 |
| 2009 | 5,107 | 0.530 | 0.80 |
| 2010 | 5,150 | 0.563 | 0.90 |
| 2020 | 5,605 | 0.612 | 0.98 |
| 2030 | 6,100 | 0.666 | 1.07 |
| 2040 | 6,639 | 0.725 | 1.16 |

**Wholesale Water Use and Sales**

As indicated, the City currently sells water to PWSD No 3 of Andrew County and has done so since November of 2004. The interconnection is located west of town near the old treatment plant and the intersection of highway 71 and County Road 427. Sales to their system are metered at the point of connection and for the purposes of this study will be estimated at about 15% of water used or 81,000 gallons per day. The City is currently renegotiating a new purchase agreement with PWSD No 3.

Informally, the City of Savannah has also discussed the potential of interconnection and selling water to Andrew County PWSD 1. Their estimated water use, as documented in a letter in 2007 (see Appendix), indicates a current peak day of 900,000 gallons per day and a future peak day of 1.4 MGD. In the fall of 2008, the City of Savannah also voted and agreed to join the Great Northwest Wholesale Water Commission (GNWWC) and has since been active in participating in planning sessions and hosting the regional meetings.

## V. Discussion of Alternatives

For this study, three different WTP expansion levels or alternatives were considered and evaluated for feasibility and planning purposes. Depending on the growth and development of other regional systems in proximity to the City of Savannah, these expansion alternatives may also be considered in phases. A brief description of each alternative is provided below along with a comparison of the additional system capacity and demand.

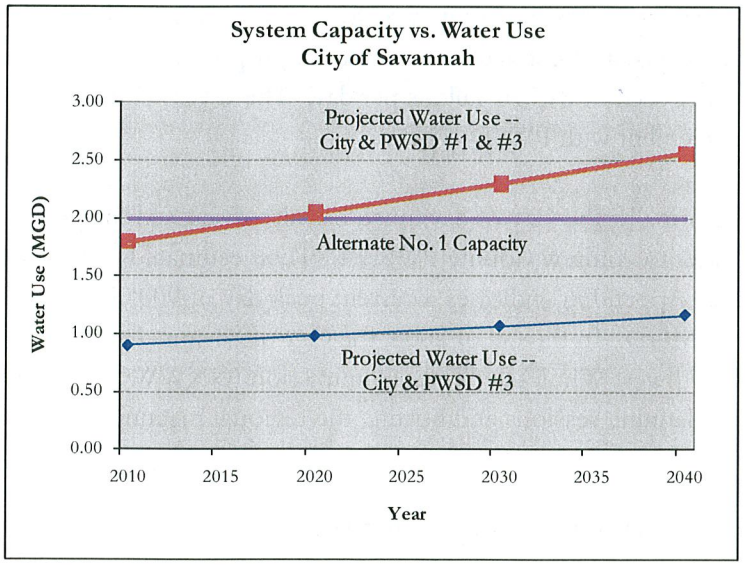
**Alternate No. 1**

This alternate considers the improvements needed within the system to maximize the use of their current treatment plant and related facilities with a minimum amount of capital expenditure. The improvements of this alternate requires increasing the system run time during peak conditions to 22 hours per day along with the following proposed capital improvements. The current treatment process, depending on water use and other system variables has a run time of 6-10 hours.

- Well Field/Raw Water Line --In an effort to increase the firm capacity at the well field and not to stress the existing wells which are all hydraulically connected, a third well in the area already test drilled is proposed along with the approximately one mile of connecting raw water line.

- WTP Improvements – Little physical expansion of the WTP is anticipated however the addition of a third high service pump (HSP) is proposed and added staff and maintenance expenses are anticipated with the added system run time.

As can be seen in the adjoining chart, the proposed improvements under Alternate No. 1 meet the current and future demand needs of the City and their current wholesale user PWSD No 3, to the year 2040 and beyond. In addition, the proposed improvements provide excess capacity of nearly 1.0 MGD and enable the City to add a large wholesale user with similar water use requirements of Andrew County PWSD #1. However, while initially meeting those demands, further expansion of the system would likely be required within a few years depending on growth and their final demand requirements.



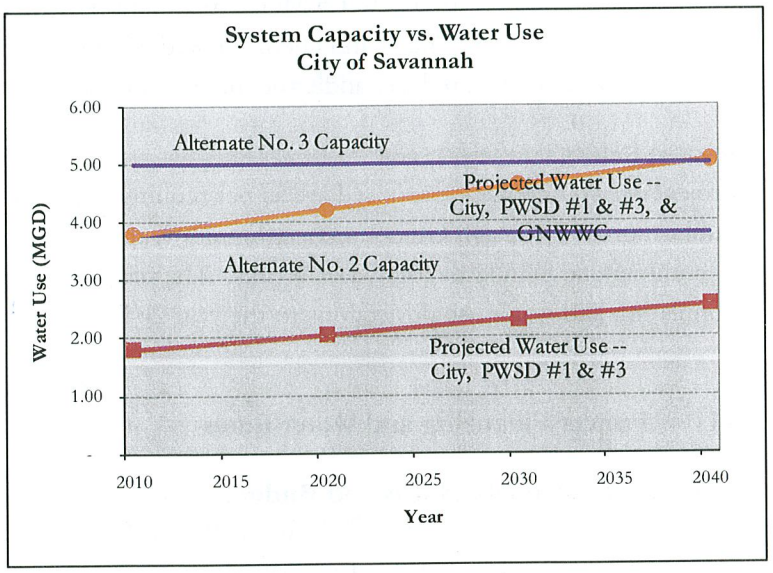

**Alternate No. 2**

This expansion alternative addresses the system improvements that are needed to meet the water use of a wholesale customer equivalent to the size of PWSD No 1 of Andrew County in the year 2040. Those demands are estimated at 900,000 gpd for their current peak day use and 1.4 MGD for future peak day demand. The expansion effort in this scenario will require increasing the size and capacity of the major system components to 3.5 to 4.0 MGD. Specifically the improvements needed are as follows.

- Well Field/Raw Water Line –In addition to adding a fourth well as indicated above, a fifth well is proposed such that the peak day demand can be met with the largest well of the five wells out of service.

- WTP /Clearwell Improvements – As indicated above, this alternative would require expansion of major system components. In addition to chemical feed expansions, a two new solids contact basins and three or four additional filter cells would be required, depending on filter arrangement and design criteria. Additionally, clearwell capacity would likely need to be doubled at this stage, resulting in an overall cost of WTP & clearwell improvements of approximately $4,060,000.

The adjoining chart compares the system capacity developed with Alternate No. 2 and Alternate No. 3 with potential water use.




**Alternate No. 3**

In this alternative, consideration was given to expansion of the treatment facilities and well field to meet a larger regional wholesale user such as the GNWWC. The projected system capacity for this alternate is estimated at 5.0 MGD. This is sufficient to meet projected water use needs for the City of Savannah and potential wholesale users Andrew County PWSD No. 1 and No. 3 with an additional 2.0 to 2.5 MGD dedicated to serving the regional needs of the Great Northwest Wholesale Water Commission GNWWC.

While it may be feasible to expand facilities beyond the limits of Alternate 3, additional effort beyond the scope of this study is needed to project that capacity. One constraint, without completing additional exploration and test pumping, is projecting the yield and development of new wells. For the purposes of this study, it is estimated that three new wells similar to the test well in 2004 can be developed. Other possible constraints include the availability of land at the WTP site for lime sludge lagoons and ready reconfiguration of the piping at the treatment facilities.

In addition to the three wells, the improvements of Alternate No. 3 include construction of new raw water pipeline, additional clearwell capacity, and a new 3.0 MGD treatment train; including solids contact basins, multi-media rapid rate filters, waste residuals handling and associated chemical feed equipment.

- Well Field/Raw Water Line – Approximately $1,680,000 of improvements, including construction of three new 1,200 gpm wells and approximately 5 miles of 18" diameter raw water transmission pipeline.

- WTP Improvements – Approximately $5,180,000 of improvements, including construction of two new 1.5 MGD treatment trains, each consisting of a solids contact basin, rapid rate filters, and chemical feed equipment. Also included are additional waste lagoons as required to handle the increased treatment residuals.

**Project Criteria**
Project design criteria as proposed are as per requirements for distribution systems, MoDNR Publication 417 -Design Guide for Community Water Systems and the 10 State Standards – Recommended Standards for Water Works. The project design period is 30 years with population and water use projections to the year 2040.

## VI. Project Financing and Water Rates

**City's Current Indebtedness and Budget**
As part of the improvements in 2005 and 2006, the City issued 20-year revenue bonds for approximately 8 million in loans to construct the water system improvements. In 2009-2010, the debt service payment on the principle and interest of the bonds was $699,000 or about 45% of the City budget of approximately 1.5 million. The debt service is slated to increase by approximately $10,000 per year for the next 15 years before finally decreasing for eight years before the final two payments.

A summary of the current City water budget and an estimate of associated revenues from both bulk and metered sales are provided below.

## VII. Project Budget with O & M Costs

### Life Cycle Costs and Comparison of Alternatives

For each of the proposed alternates or level of expansion, capital costs were estimated and life cycle costs were developed. These life cycle costs are summarized below and include a comparison of the debt service, annual operating and maintenance (O & M) expenses, along with funds for long-term replacement and reserves. Annual operating costs include both the fixed and variable costs, the latter comprised of mostly chemical and electrical expenses.

| Summary of Life Cycle Costs and Comparison of Alternatives | Current Budget | Alternate 1 | Alternate 2 | Alternate 3 |
|---|---|---|---|---|
| **Water Use and Plant Capacity** | | | | |
| Estimated Annual Water Use ( X 1000gal) | 197,465 | 410,692 | 410,692 | 866,942 |
| City Annual Sales (X 1000gal) | 167,845 | 174,572 | 174,572 | 174,572 |
| Bulk Annual Sales (X 1000gal) | 29,620 | 236,119 | 236,119 | 692,369 |
| System Capacity | 1.0 MGD | 2.0 MGD | 3.8 MGD | 5.0 MGD |
| **Capital Cost Summary** | | | | |
| Well Field/Raw Water Line | $0 | $260,000 | $490,000 | $1,680,000 |
| WTP Improvements | $0 | $120,000 | $4,060,000 | $5,180,000 |
| **Total New Capital Costs** | **$0** | **$380,000** | **$4,550,000** | **$6,860,000** |
| **Annual Expenses & Production Costs** | | | | |
| **Annual Debt Service** | | | | |
| New Improvements Debt Service | $0 | $30,094 | $360,336 | $543,276 |
| Current Annual Debt Service (P & I) | $699,000 | $799,000 | $799,000 | $799,000 |
| **Total Annual Debt Service** | $699,000 | $829,094 | $1,159,336 | $1,342,276 |
| **Admin Costs** | | | | |
| **City Annual Retail/Admin Costs** | $220,800 | $220,800 | $220,800 | $220,800 |
| **Annual Operating Costs** | | | | |
| Fixed Operating Costs | $337,200 | $437,200 | $660,000 | $760,000 |
| Variable Operating Costs, ($0.93/kgal) | $183,000 | $382,000 | $382,000 | $806,000 |
| Subtotal | $520,200 | $819,200 | $1,042,000 | $1,566,000 |
| Rehab/Reserve, Existiing Facilities | $92,000 | $92,000 | $92,000 | $92,000 |
| Rehab/Reserves, New Improvements | $0 | $15,047 | $180,168 | $271,638 |
| **Annual Operating Costs** | $612,200 | $926,247 | $1,314,168 | $1,929,638 |
| **Total Annual Expenses** | **$1,532,000** | **$1,976,141** | **$2,694,304** | **$3,492,713** |
| **Unit Price Cost Comparison** | | | | |
| Cost of Debt Service ($/kgal) | $3.54 | $2.02 | $2.82 | $1.55 |
| Cost of Operation ($/kgal) | $3.10 | $2.26 | $3.20 | $2.23 |
| *Total Production Cost ($/kgal) | $6.64 | $4.27 | $6.02 | $3.77 |
| * Excludes City Admin Costs | | | | |

The production costs as tabulated above include both the debt service and operating costs divided by the projected annual water sales. It does not include the City administration and billing costs. The unit price cost comparison of production costs is intended as a tool to evaluate the economic feasibility of the different alternatives.

### Capacity Charge

As an alternate to charging bulk users their debt service charge in their water bill, the City may consider providing bulk users the option of a lump sum capacity charge. This capacity charge allows the bulk user, based on their projected peak demand to "purchase" treatment and source capacity from the City. This defines the maximum allowable water use in their User Agreement and allows the bulk user to seek alternate forms of financing their share of the debt service.

The advantage of this approach is it recognizes that some bulk users may have access to better loan terms or even be able to secure grants for which the City of Savannah may not be eligible or be able to access. In this approach the basis for the bulk user's water rates are the operating costs and the perimeters for this calculation are mutually agreed upon prior to connection.

## VIII. Conclusions and Recommendations

### Maximize Existing Facility

As a first step in improving efficiencies, the City should consider maximizing the use of their existing treatment plant by increasing run times and securing additional bulk water sales. With rather small capital expenditures at the well field and high service pumps, the City could significantly increase production and sell the excess to a large wholesale user. This would spread the debt service and fixed operating costs over a larger number of users and resulting in lower production costs.

Important in adding a new large wholesale user will be the wording of the agreement to protect and enable the City to manage future system growth. As noted by the higher operating and debt service unit costs for Alternate No. 2, an expansion of facilities must be carefully phased with added demand to maintain these efficiencies and cost savings.

### Expansion of the Treatment Plant

The efficiencies of expanding and operating a larger system will, in the long-term, have an impact on lowering the City's production costs on a unit price basis. This is due to the efficiencies of operating a larger treatment facility as well as having a larger number of users participating in the system operating costs and repayment of debt service. The most cost efficient expansion is the larger 5.0 MGD facility that allows Savannah to serve the local wholesale users as well as the Great Northwest Wholesale Water Commission (GNWWC).

### Recover Production Costs

It is important to note that the success of any future expansion of facilities is contingent on the City negotiating a rate for their bulk water sales that covers their cost of production and debt service for capital expenses as well as contributing to the equipment reserve and replacement fund. In all of the alternates outlined in this study, the average water bill in the City would be negatively impacted if these costs are not shared by all the users.

the City. As such, the change from chlorine to chloramines to reduce DBPs provides little advantage for the City users. The change already outlined is also complex, with the potential for nitrification and biofilm formation. This would be true not only for the City distribution system but also for their current wholesale user Andrew County PWSD No. 3.

While switching to chloramines would extend the residual within the distribution system, the current use of free chlorine has worked well for the City, allowing them to maintain a consistent residual within their distribution system, despite the shorter residual time of free chlorine.

Finally, because the City must continue to use free chlorine as the primary disinfectant at their treatment plant the addition of another disinfectant at the treatment facility will add costs and complexity to the operation.

**Recommended Alternative**

It is recommended that the City consider each potential wholesale user on a case by case basis. If a new wholesale user requires the addition of chloramines for secondary disinfection in their system, the injection point can be provided at the master meter location. The cost increase for adding a liquid chlorine and ammonia injection system at a master meter pit location is estimated at about $70,000. This would include a 6 x 10 foot building, free and total chlorine analyzers, metering and chemical feed equipment, and a 100-200 gallon mixing tank with palletized dry chemical storage area. Depending on flows required, a gas chlorination system may prove to be more economical, though it would likely require a larger building and initial capital costs would be closer to $125,000. However depending on the chlorine residual and output requirements, chemical costs for a liquid chlorine system would be about $0.05 per thousand gallons while chemical costs for a gas system would be less than half that amount. The City could have the new wholesale user pay for this as part of the connection fee and also make them responsible of the operation and maintenance of the new facility.

## VI. Secondary Disinfection's Point of Injection

Currently the third injection site for the chlorine gas is located between the filters and the clearwell. The purpose of this chlorine injection location is to provide both primary disinfection, 4-log virus removal/inactivation, and secondary disinfection, maintaining a residual in the distribution system. Typically, the primary disinfection is located downstream of the filters to help reduce DBP formation and the secondary disinfection would be provided as the water enters the distribution system, if needed. If a secondary disinfectant system is considered to be a benefit for the distribution system then the injection point should be located between the ground storage reservoir and the high service pumps.

## VII. Conclusions

# Appendix D

# Cost Options

# ACWWC Cost Options

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Atchison Co Alternative

Assumptions & Givens:

| | |
|---|---|
| KC CCI Value for Dec. 2010 = | 10410.12 |
| KC CCI Value for March 2009 = | 9667.81 |
| KC CCI Value for Dec. 2001 = | 6477.21 |

**OPCC Pipeline without Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per foot)[1] | Extension |
|---|---|---|---|
| 6 | 27,300 | $ 27.00 | $ 740,000 |
| 8 | 12,100 | $ 39.00 | $ 480,000 |
| 12 | 164,800 | $ 60.00 | $ 9,890,000 |
| 16 | 58,300 | $ 81.00 | $ 4,730,000 |
| 20 | 74,000 | $ 101.00 | $ 7,480,000 |
| 24 | 202,500 | $ 121.00 | $ 24,510,000 |
| 30 | 130,400 | $ 151.00 | $ 19,700,000 |
| | | Total | $ 67,530,000 |

1) Notes: Unit prices include design, material, installation and land.

2) Notes: Pipe lengths were rounded to the nearest 100, unit cost per foot were rounded to nearest dollar and every subtotal was rounded up to the nearest $10,000.

**OPCC Pipeline for Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per foot)[1] | Extension |
|---|---|---|---|
| 12 | 105,100 | $ 60.00 | $ 6,310,000 |
| | | Total | $ 6,310,000 |

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Atchison Co Alternative

| OPCC Elevated Water Storage Tanks/Stand Pipes | | | |
|---|---|---|---|
| Tank ID | Height (feet) | Volume (x1000 gal) | Extension[1] |
| 1 | 140 | 400 | $ 970,000 |
| 2 | 63 | 200 | $ 550,000 |
| | | Total | $ 1,520,000 |

| OPCC Pump Stations | | | | | | |
|---|---|---|---|---|---|---|
| Pump Station ID | Flow (gal/min) | Flow (MGD) | Head | Total HP | Number of Pumps | Extension[1] |
| 1 | 4,170 | 6.00 | 376 | 650 | 4 | $ 1,730,000 |
| | | | | | Total | $ 1,730,000 |

| OPCC for ACWWC Stage I Option | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Transmission Lines | $ 67,530,000 | $ 73,840,000 |
| Elevated Water Storage Tanks | $ 1,520,000 | $ 1,520,000 |
| Pump Stations | $ 1,730,000 | $ 1,730,000 |
| Total | $ 70,780,000 | $ 77,090,000 |

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Atchison Co Alternative

| Total Cost Summary | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Construction, Land & Engineering | $ 70,780,000 | $ 77,090,000 |
| Legal & Financial (5%) | $ 3,540,000 | $ 3,860,000 |
| Contingency & Inflation (20%) | $ 14,160,000 | $ 15,420,000 |
| Total | $ 88,480,000 | $ 96,370,000 |

# Missouri-American Cost Options

Date: 26 April 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage 1 Total Cost, MO American Alternative

***Revised to add storage to the suction side of the Pump Station near Missouri American's WTP. One storage unit is assumed for Stage I.***

Assumptions & Givens:

| | |
|---|---|
| Kansas City Construction Cost Index (KC CCI) Value for Dec. 2010 = | 10410.12 |
| KC CCI Value for March 2009 = | 9667.81 |
| KC CCI Value for Dec. 2001 = | 6477.21 |

**Opinion of Probable Construction Costs (OPCC) Pipeline without Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per linear foot)[1] | Extension |
|---|---|---|---|
| 6 | 27,300 | $ 27.00 | $ 740,000 |
| 8 | 12,100 | $ 39.00 | $ 480,000 |
| 12 | 225,800 | $ 60.00 | $ 13,550,000 |
| 16 | 53,000 | $ 81.00 | $ 4,300,000 |
| 20 | 73,000 | $ 101.00 | $ 7,380,000 |
| 24 | 87,600 | $ 121.00 | $ 10,600,000 |
| | | Total | $ 37,050,000 |

1) Notes: Unit prices include design, material, installation and land.

2) Notes: Pipe lengths were rounded to the nearest 100, unit cost per foot were rounded to nearest dollar and every subtotal was rounded up to the nearest $10,000.

**OPCC Pipeline for Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per linear foot)[1] | Extension |
|---|---|---|---|
| 12 | 105,100 | $ 60.00 | $ 6,310,000 |
| | | Total | $ 6,310,000 |

Date: 26 April 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage 1 Total Cost, MO American Alternative

| OPCC Elevated Water Storage Tanks/Stand Pipes | | | |
|---|---|---|---|
| Tank ID | Height (feet) | Volume (x1000 gal) | Extension[1] |
| 1 | 140 | 400 | $ 970,000 |
| 2 | 63 | 200 | $ 550,000 |
| ***Clearwell*** | **--** | ***900*** | ***$ 1,800,000*** |
| | | Total | $ 3,320,000 |

| OPCC Pump Stations/Flow Control | | | | | | |
|---|---|---|---|---|---|---|
| Pump Station ID | Flow (gal/min) | Flow (MGD) | Head | Total HP | Number of Pumps | Extension[1] |
| 1 | 4,170 | 6.00 | 255 | 450 | 3 | $ 1,250,000 |
| Flow Control Structure | -- | -- | -- | -- | -- | $ 80,000 |
| | | | | | Total | $ 1,330,000 |

| OPCC for MO American Stage I Option | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Transmission Lines | $ 37,050,000 | $ 43,360,000 |
| Elevated Water Storage Tanks | $ 3,320,000 | $ 3,320,000 |
| Pump Stations | $ 1,330,000 | $ 1,330,000 |
| Total | $ 41,700,000 | $ 48,010,000.00 |

Date: 26 April 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage 1 Total Cost, MO American Alternative

| Total Cost Summary | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Construction, Land & Engineering | $ 41,700,000 | $ 48,010,000 |
| Legal & Financial (5%) | $ 2,090,000 | $ 2,410,000 |
| Contingency & Inflation (20%) | $ 8,340,000 | $ 9,610,000 |
| Total | $ 52,130,000 | $ 60,030,000 |

# Savannah Cost Options

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Savannah Alternative

Assumptions & Givens:

| | |
|---|---|
| KC CCI Value for Dec. 2010 = | 10410.12 |
| KC CCI Value for March 2009 = | 9667.81 |
| KC CCI Value for Dec. 2001 = | 6477.21 |

**OPCC Pipeline without Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per foot)[1] | Extension |
|---|---|---|---|
| 6 | 27,300 | $ 27.00 | $ 740,000 |
| 8 | 12,100 | $ 39.00 | $ 480,000 |
| 12 | 254,500 | $ 60.00 | $ 15,270,000 |
| 16 | 53,000 | $ 81.00 | $ 4,300,000 |
| 20 | 73,000 | $ 101.00 | $ 7,380,000 |
| 24 | 30,300 | $ 121.00 | $ 3,670,000 |
| | | Total | $ 31,840,000 |

1) Notes: Unit prices include design, material, installation and land.

2) Notes: Pipe lengths were rounded to the nearest 100, unit cost per foot were rounded to nearest dollar and every subtotal was rounded up to the nearest $10,000.

**OPCC Pipeline for Davies 1[2]**

| Diameter | Length (feet) | Unit Cost (per foot)[1] | Extension |
|---|---|---|---|
| 12 | 105,100 | $ 60.00 | $ 6,310,000 |
| | | Total | $ 6,310,000 |

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Savannah Alternative

| OPCC Elevated Water Storage Tanks/Stand Pipes | | | |
|---|---|---|---|
| Tank ID | Height (feet) | Volume (x1000 gal) | Extension[1] |
| 1 | 140 | 400 | $ 970,000 |
| 2 | 63 | 200 | $ 550,000 |
| | | Total | $ 1,520,000 |

| OPCC Pump Stations | | | | | | |
|---|---|---|---|---|---|---|
| Pump Station ID | Flow (gal/min) | Flow (MGD) | Head | Total HP | Number of Pumps | Extension[1] |
| 1 | 4,170 | 6.00 | 255 | 450 | 3 | $ 1,250,000 |
| Flow Control Structure | -- | -- | -- | -- | -- | $ 80,000 |
| | | | | | Total | $ 1,330,000 |

| OPCC for Savannah Stage I Option | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Transmission Lines | $ 31,840,000 | $ 38,150,000 |
| Elevated Water Storage Tanks | $ 1,520,000 | $ 1,520,000 |
| Pump Stations | $ 1,330,000 | $ 1,330,000 |
| Total | $ 34,690,000 | $ 41,000,000 |

Date: 7 March 2011
By: Molly Pesce
Checked: Bruce Hattig
Re: 16164.010 Great NW Phase IV, Stage I Total Cost, Savannah Alternative

| Total Cost Summary | | |
|---|---|---|
| | w/o Davies I | w/ Davies I |
| Construction, Land & Engineering | $ 34,690,000 | $ 41,000,000 |
| Legal & Financial (5%) | $ 1,740,000 | $ 2,050,000 |
| Contingency & Inflation (20%) | $ 6,940,000 | $ 8,200,000 |
| Total | $ 43,370,000 | $ 51,250,000 |