2014 Preliminary Engineering Report

on the

Water Supply, Pumping, Storage & Distribution Facilities

for the

City of Peculiar, Missouri

May 2014

Project No. 0313045

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TABLE OF CONTENTS

I General Information 1

II Introduction and Purpose 1

A. Goal 1

B. Scope 1

III. Existing System 4

A. Water Supply, Master Meters, and Distribution System 5

B. Pump Station 6

C. Storage Facilities 6

D. Population 7

IV. Hydraulic Model 8

A. General 8

B. Demand 9

C. Existing System 11

D. Existing System with Improvements 12

V. Applicable Design Standards 13

A. Missouri Safe Drinking Water Law 14

B. Missouri Safe Drinking Water Regulations 14

C. *Minimum Design Standards for Missouri Community Water Systems* 14

D. More Recent Developments in Regulatory Requirements 17

VI. Alternate Water Supplies 19

A. Kansas City, MO 20

B. Water District No. 1 of Johnson County, KS 22

C. Tri-County Water Authority 24

VII. Water Supply Comparison and Recommendations 25

A. Decision Matrix 26

B. Benefits and Deficiencies of Each Alternate 26

C. Weighted Decision Matrix for Each Option 28

D. Kansas City, MO Hydraulics 28

VIII. Historical Operating and Maintenance Costs 31

IX. Recommended Improvements 33

A. Storage Improvements 34

B. Distribution Improvements 34

C. Supply Improvement 44

D. Emergency Interconnect 45

E. Valves and Flushing Hydrants 45

F. Security 45

X. Opinions of Probable Cost 46

XI. Funding Options 46

XII. Conclusion 49

Tables

Table III.1 – Distribution System Summary 5

Table III.2 – Minimum Storage Volume 7

Table III.3 – Projected Population 8

Table IV.1 – Historical Water Demands 10

Table IV.2 – Projected Water Demands 11

Table IV.3 – Hydraulic Results without Improvements 11

Table IV.4 – Hydraulic Results with Improvements 12

Table VI.1 – Cost Opinion on Kansas City Supply 22

Table VI.2 – Cost Opinion on WaterOne Supply 23

Table VI.3 – Cost Opinion on TCWA Supply 25

Table VII.1 – Supplier Decision Matrix 26

Table VII.2 – Weighted Decision Matrix 28

Table VII.3 – Hydraulic Results without Improvements and KCMO Supply 29

Table VII.4 – Hydraulic Results with Improvements and KCMO Supply 30

Table VII.5 – Rate and Water Purchase Cost Opinions for future Water Suppliers 31

Table VIII.1 – Summary of Revenues and Expenses 31

Table VIII.2 – Current Water Rates 33

Table X.1 – Cost Opinion on Recommended Improvements 46

Table XI.1 – Current Rates and Required Rate Adjustments 48

Figures

Figure VII.1 – Elevated Storage Tank Hydraulic Grades 29

System Map ..... in Pocket

Appendices

Appendix A – Water Purchase Contract

Appendix B – Hydraulic Analysis Reports

Appendix C – Opinions of Probable Cost

Appendix D – SRF Intended Use Planning List Letter

I. General Information

The name and mailing address of the water system's Continuing Operating Authority is as follows:

City of Peculiar, MO
250 S. Main Street
Peculiar, MO 64078
Public Water Supply Identification Number: M01010633

II. Introduction and Purpose

The City of Peculiar (City) received an engineering report grant from the Missouri Department of Natural Resources (DNR), Division of Environmental Quality, Public Drinking Branch, Financial Assistance Center. This Preliminary Engineering Report on the potable water system and its supporting information consists of a hydraulic analysis, a Capital Improvement Plan (CIP), and a submittal to obtain a DNR 5-year Owner Supervised Program for future improvements studied within. The existing system was examined by review of existing system data, information from City personnel and use of computer hydraulic modeling technology. This report includes a summary of historical water use for the last 3 years, an estimate of future water needs and recommended water system improvements. The goal of this report is to solve present problems, increase reliability and prevent future problems before they occur. Recommendations for improvements are based not only on the computer results, but also on the engineer's experience with similar systems. The report is intended to serve as a planning tool for the City as it maintains the present facilities and prepares for future demands of the system.

The DNR *Minimum Design Standards for Missouri Community Water Systems* effective December 10, 2013 will be referenced in evaluating various components of the water system.

A. Goal

The City's goal is to identify improvements, which will correct any present or future deficiencies in the system. Simulation of any future deficiencies is based on the projected growth of the system. A prioritized list of recommended improvements is included as well as a recommendation on a long term source of supply.

B. Scope

The scope of services on this report is as follows:

1. Model existing system with existing demands to determine deficiencies. Model water line, storage, and/or pumping improvements to correct any identified deficiencies.
2. Evaluate current water supply and supply alternatives.

3. Project future demands for the City service area and model improvements necessary to meet these future demands.
4. Prepare a capital improvements plan (CIP) with cost opinion and priority assigned to each improvement.
5. Furnish 6 copies of the report to the City and Staff.
6. Submit report to the Missouri Department of Natural Resources for approval.

Hydraulic Analysis

1. Meet with the City to clarify project goals and expectations.
2. Gather field data and information on current operation of the water system including records of monthly water purchases/sales. Discuss operation with City staff.
3. Use information from the current system provided by City personnel and update the existing computer hydraulic model of the City's distribution system in WaterCAD software. Incorporate the water system CAD information recently prepared by City staff into the System Exhibit. Perform a hydraulic analysis of the system for existing and future flows.
4. Perform an overall system analysis to determine existing problem areas (high and low pressure areas, fire flow deficiencies, water age, dead ends, etc.).
5. Identify sections of the distribution system with frequent broken or leaking lines, which contribute to unaccountable water losses within the system.
6. Analyze the system, and make recommendations for: additional valves and flushing devices; improvements needed to maintain pressures above 35 psi; replacement of lines made of substandard materials; replacement of lines whose capacity has been or will soon be exceeded; looping dead-end lines; finished water storage capacity and condition.
7. Prepare list of proposed distribution system improvements.
8. Examine tank maintenance records and make recommendations of any sanitary or security improvements needed.
9. Discuss control system that operates the master meters, pump station and tank levels.
10. Examine the effect on the water system from potential growth related to:
    - The proposed interchange off of I-49 at 211th Street scheduled for 2015-16.
    - Current Land Use Plan with consideration of water system boundaries.

• Possible growth within already platted subdivisions served by the City.

Water Supply

1. Review the current water supply contract with PWSD No. 2 Cass County and the condition and capacity of the master meter connections.
2. Compare current supply to other available supplies such as from Kansas City Missouri (on Route J, south of Raymore), Tri-County Water Authority, or WaterOne Evaluation will include hydraulics, main sizing, probable connection cost and cost estimate update for a possible connection and transmission main.
3. Discuss availability of flow from any adjacent system via an emergency interconnection.
4. Discuss with City personnel any areas of concern with existing system and make recommendations for improvements, if needed.
5. Estimate the future cost of improving the current supply and compare to connection to an alternate supply. This will include the cost of water (1,000 gal.), cost of improvements, and effect on operation and maintenance. Assumptions will be made for rate changes on each supply source and historical information provided.
6. Estimate effect on water rates of any recommended water supply improvements.

Facility Plan Engineering Report Preparation

1. Meet or exceed the "Responsibilities of the Engineering Firm" as stated in the Three Party Payment Agreement for Engineering Report Services.
2. Summarize the evaluation of the existing supply, storage and distribution system for condition and ability to meet DNR requirements, water system demands, and other codes and regulations.
3. Summarize improvements in order of priority with estimated costs.
4. Based on assumed financing package, determining the water rate impact of the recommended improvements.
5. Discuss the City of Peculiar's current water rates, proposed rates after improvements, and the water rates of other similar area communities. Build on information in Larkin's recent rate study.
6. Estimate the impact of the proposed improvements on the yearly operation and maintenance budget.

7. List probable sources to finance the improvement with an explanation of the requirements of each funding program. Discuss status of City's listing on the DNR SRF Intended Use Plan Priority List.
8. Combine all of the engineering report items, with exhibits and appropriate documentation into a Facility Plan, for the improvements to be constructed, that meets the DNR State Revolving Fund Requirements.
9. Present the Facility Plan Engineering Report to the City Board and staff.
10. After addressing any comments from the City, submit the report to the DNR for review and approval.
11. Submit to DNR to obtain 5-Year Owner Supervised Plan Approval (Facility Plan, Peculiar standard specification and construction details for main improvements, & City inspector resume.
12. Provide copy of WaterCad hydraulic model data files to the City.
13. Be available for design of any recommended supply, transmission, distribution and/or storage improvements.
14. Provide engineering components for funding applications.

Water System Records System Documentation

1. Input City prepared information on water system consisting of waterlines, valves, and fire hydrants from (*jpeg format) into the existing hydraulic model on file (WaterCAD format). After completion of modeling, the WaterCAD file of the existing system will be converted into an ESRI ArcView (ArcGIS for desktop) software file. Attribute (valve and hydrant) reference numbers and additional information from the City prepared maps will be input into attribute tables for each valve and hydrant. This information can then be incorporated into the GIS system the City is beginning to develop.

III. Existing System

The City serves approximately 1,537 water meters. The service area is all within the present City limits, however, the City does not serve all residents within the City limits. Some areas that have been annexed are served by one of the surrounding water districts. Water is purchased from the Cass County P.W.S.D. No. 2, from its supply from Kansas City, MO. The City's existing water system consists of the following components: supply from three meter vaults, the distribution system, a booster pump station,

and two water storage tanks. Each of these components is discussed following. These components are shown on the Existing System Map at the back of this report.

A Water Supply, Master Meters and Distribution System

The City has been purchasing potable water from Cass County P.W.S.D. No. 2 (District) since March 1990. The City entered into a new agreement with the District on March 16th, 2010. The agreement is for a maximum of 0.70 million gallons per day and for a length of 25 years. A copy of the Water Purchase and Sales Contract can be found in Appendix A.

The City purchases water at three master meters located as follows:

- Master meter #1 is west of the intersection of 211th St and Harper St. (hydraulic grade of 1,175 feet)
- Master meter #2 is located at the northeast corner of the intersection of 211th St. and Peculiar Dr. (hydraulic grade provided by Master meter #1)
- Master meter #3 is located along Peculiar Drive, approximately 550 feet north of Siena Drive (hydraulic grade of 1,150 feet)

Each master meter maintains one of the four pressure zones within the City. Master meter #1 serves the City west of Interstate 49 except for Tuscany Estates, Sutter's Creek, and Spencer's Addition and the area south of Highway J, east of Interstate 49. Master meter #2 servers the area of the City north of Highway J, east of Interstate 49. Master meter #3 serves the housing subdivisions in the north area of the City along Peculiar Drive. Master Meters #2 and #3 are always open and provide pressure to Pressure Zone #2 and #3, respectively. Master Meter #1 is always open and provides water and pressure to Pressure Zone #1 and to the City's Ground Storage Tank. Water from the ground storage tank is pumped into the elevated storage tank, which provides pressure to Pressure Zone #4. All of the Pressure Zones can be seen on the enclosed map. The master meters are all in good working order.

The City's water system contains approximately 45 miles of waterline from 2-inch to 12-inch in diameter. The distribution system consists of PVC (polyvinyl-chloride), cast iron, and ductile iron waterlines. Table III.1 summarizes the pipe lengths.

Table III.1: Distribution System Summary

Pipe Diameter(in.)	2	3	4	6	8	10	12	Total
Total length, (ft)	14,590	2,278	57,843	26,649	111,095	7,388	20,132	239,975
% of total system	6.1%	1.0%	24.1%	11.1%	46.3%	3.1%	8.3%	100.0%

Pipes within several areas of the distribution system are reported by operating personnel to experience

frequent main breaks which result in a large source of the City's unaccounted for water. These areas include:

- Peculiar Drive/Main St. between Hurly St. and E. North St.
- Along Harr-Grove Rd.
- Along Elm St.
- E. Broadway St between E. 3rd St. and N. Main St.
- Gregory between Elm St. and Kayla Dr.

B. Pump Station

The City has one pump station located adjacent to the ground storage tank at the south end of W. 3rd Street. The pump station contains two 40 HP pumps which fill the elevated storage tank on-site from the ground storage tank. The SCADA system controls the operation of the pumps based upon levels in the elevated storage tank. The pumps were replaced in a 2006 project and rebuilt with a major overhaul in 2012.

C. Storage Facilities

The City has a 428,000 gallon welded steel ground storage tank which is 24' high and 55' in diameter and was constructed in 1982. The only high level storage is a 400,000 gallon multi-column welded steel elevated storage tank which was constructed in 2006. Both tanks are located at the south end of W. 3rd Street. The City operates both tanks in the upper three feet or so with control points of 1,136.0 and 1,139.0 mean sea level (msl) for the elevated storage tank and 1,010 and 1,013.5 for the ground storage tank.

Missouri Department of Natural Resources recommends minimum storage volume in a distribution system that provides fire protection to be calculated as follows:

Average Day + Equalizing Storage + Fire Flow Reserve

Equalizing Storage to meet diurnal daily peak demands = 0.5 x Average Day

Fire Flow Reserve = 1,000 gpm x 2 hrs = 120,000 gallons

Alternatively, the minimum storage should be equal to the maximum daily flow + Fire Flow Reserve:

Maximum Day + Fire Flow Reserve

The current and future required storage based on these assumptions and the predicted demands calculated in Section IV are shown in Table III.2. The City's maximum day demand based on peak month usage and similar systems is assumed to be approximately equal to 1.5 times average day usage. This results in the two minimum storage requirements Table III.2 to be equal.

Table III.2: Minimum Storage Volume		
Year	**Volume Based On Average Day + Equalizing Storage + Fire Flow Reserve (gallons)**	**Volume Based On Maximum Day + Fire Flow Reserve (gallons)**
2013	505,500	505,000
2018	547,448	547,448
2033	696,864	696,864

With both tanks in service, the City has 828,000 gallons of finished water storage; which is enough to meet the DNR criteria. The only caveat is that the booster pump station is not backed up by an emergency or secondary power source. The DNR's Minimum Design Standards state that system serving a population of 3,300 or more shall make arrangements for back-up power in either the form of a secondary independent utility source or auxiliary generator.

A supplement to system storage volume during an emergency can be contracted for through the elevated storage from a wholesale water provider. P.W.S.D. No. 2 Cass County has a 500,000 gallon elevated tank located on 203rd Street, just west of Peculiar Drive.

The Missouri Department of Natural Resources has guidelines for the inspection of water storage facilities that requires periodic inspection of both a tank's sanitary features, as well as condition of the structure. Annual inspections are required to ascertain that screens are in place covering the vent and overflow pipes to prevent contamination from intrusion by pests. On every third year, the tank is to be washed out and the condition of the coating and accessories assessed. The City has a contract for the ground storage tank to be emptied and rehabilitated with a new coating system and sanitary features beginning in late April 2014 and completion set for June 2014.

D. Population

The City has experienced substantial population increases over the past two decades. The City population has grown at an average of 4.21% each year. If this population growth factor is utilized, the City's population would be greater than 10,000 by the year 2033, as seen in the Table III.3. Table III.3 shows past Census population and predicts future City population at a 4.21% annual increase.

Table III.3: Projected Population

Year	Population	Annual % Change	Population Change
1980	1571		
1990	1777	1.24%	206
2000	2604	3.90%	827
2010	4054	4.53%	1450
2011	4225	4.21%	171
2012	4403	4.21%	178
2013	4588	4.21%	185
2014	4781	4.21%	193
2015	4982	4.21%	201
2016	5192	4.21%	210
2017	5411	4.21%	219
2018	5638	4.21%	228
2019	5876	4.21%	237
2020	6123	4.21%	247
2021	6381	4.21%	258
2022	6650	4.21%	269
2023	6930	4.21%	280
2024	7221	4.21%	292
2025	7525	4.21%	304
2026	7842	4.21%	317
2027	8172	4.21%	330
2028	8516	4.21%	344
2029	8875	4.21%	359
2030	9248	4.21%	374
2031	9638	4.21%	389
2032	10044	4.21%	406
2033	10466	4.21%	423

IV. Hydraulic Model

A. General

A hydraulic model of the City's water distribution system was created using Bentley's, WaterCAD software program. WaterCAD links hydraulic modeling capability with a scaled map of the system, drawn in AutoCAD. Input variables to the program include pipe length, pipe diameter, pipe friction factor (C), pipe connectivity, location of storage tanks, overflow elevations of storage tanks, pump curves, customer locations, and customer demands. Pipe friction factors of 120 to 150 were used throughout the distribution system for existing waterlines. New pipes are analyzed at a C factor of 150.

Customer demands were based on the data presented in Section IV-B. Information regarding current operation of the system, including current water sales records, pump flows, storage operating range and recent piping improvements has been gathered and incorporated into the hydraulic model.

The DNR's *Minimum Design Standards for Missouri Community Water Systems* states that systems shall be designed to maintain at least 35 pounds per square inch (psi) normal working pressure at ground level at all points in the distribution system under all conditions of design flow, not including fire flow. The DNR will consider approving design of a lower working pressure on a case by case basis:

- Transmission mains that have no current or anticipated retail or commercial services;
- Dedicated pump supply lines from storage in a treatment plant yard piping;
- Supply from a ground storage tank or reservoir provided no services are on the supply until it reaches 35 psi or greater;
- On unplanned and emergency connections or consolidation projects where providing 35 psi to the new area would require major revisions to present infrastructure. No more than 5% of service connections representing the entire service area (current plus proposed) may be designed under 35 psi and none under 25 psi; and
- The DNR suggests that distribution systems should be designed to provide approximately 60 to 80 psi.

Water pressures in distribution systems below 20 psi are a violation of Missouri Safe Drinking Water Regulation and are considered by the DNR to be an imminent hazard to public health. For this report, a minimum of 35 psi was utilized to size improvements.

B. Demand

The City has experience a minor amount of growth in water usage over the past four years. Historical water demands for these last four fiscal years are shown in Table IV.1. Finished water purchased from the District between October 2012 and September 2013 was approximately 94.89 million gallons (MG) and water sales were approximately 80.1 MG (with 80,000 gallons of the water not sold accounted for). This calculates to 15% Total Water Not Sold in that year. A portion of the Total Water Not Sold is internal water used by the City for flushing and filling new lines. Maintaining monthly records of estimated water lost to flushing, filling, etc. is recommended. The City has implemented a record keeping program. Since October 2013, the City's average monthly water loss has decreased every month and averages 5.45 a month water loss.

The primary objective of a water system is to furnish an adequate supply of safe, treated water to meet the demands of its customers. To properly meet this need, water demands must be accurately projected so that adequate facilities can be planned, designed, financed, and constructed prior to their actual need.

Water usage varies with the time of the day and the seasons of the year. Three terms are used to define usage demands: average day, maximum day, and peak hour:

Average daily flow (ADF) use is the yearly total quantity of water distributed, divided by the number of days in the year. The ADF, calculated from existing City water use data, is 0.11 gallons per minute per meter (gpm/meter). When flow records are not available, the ADF is used with assumed peaking factors to estimate maximum daily flow and peak hour projections.

Maximum daily flow (MDF) use is the maximum quantity of water distributed in any 24-hour period during the year. Typically this occurs during hot summer months when water use is the greatest due to high temperatures, operation of swimming pools, and watering of livestock and lawn/gardens. In the absence of daily master meter readings, the MDF to ADF ratio is assumed to be 1.5 for a municipal system like Peculiar. The calculated MDF from ADF records is then 0.17 gallons per minute per meter (gpm/meter). This ratio was utilized in this model to estimate future maximum daily flows.

Peak Hourly Flow (PHF) use is the maximum quantity of water distributed during any 60-minute period of the year. This condition generally occurs in the morning when many customers are simultaneously consuming water for showering, or in the evening when many customers are returning home from work and simultaneously consuming water for meal preparation and other activities. A typical peak hour to maximum day factor of 2.0 was used in the hydraulic calculations resulting in a peak hourly demand rate of 0.34 gpm/meter.

Table IV.1. – Historical Water Demands

Year	2010	2011	2012	2013	Average
Customers	1,509	1,525	1,540	1,537	1,528
Annual Percent Change - (%)		1.06%	0.98%	-0.19%	0.62%
Annual Water Purchased (gal)	87,230,287	94,070,020	99,276,682	94,465,030	93,760,505
Annual Percent Change – (%)		7.84%	5.53%	-4.85%	2.84%
Annual Water Sales (gal.)	74,145,744	79,959,517	84,385,180	80,295,276	79,696,429
Annual Percent Change – (%)		7.84%	5.53%	-4.85%	2.84%
Total Water Not Sold – (gal)	13,084,543	14,110,503	14,891,502	14,169,755	14,064,076
Total Water Not Sold – (%)*	15%	15%	15%	15%	0.15
Avg. Consumption (gpm/meter)	0.11	0.12	0.12	0.11	0.11
Avg. Day Purchases (gal./day)	238,987	257,726	271,991	258,808	256,878

**Estimated water loss for 2010 through 2012*

The average growth rate has been 2.84% over the past 2 years. For this report a conservative growth factor of 2.0% was utilized to predict future demands. This allows for a 1% growth in residential water demands and a 1% growth for anticipated industrial and commercial growth. Industrial and commercial growth is most likely to occur near the proposed interchange at 211th and I-49. This area has

significant electrical service capacity available and the Missouri Department of Transportation and the City are investing in the construction of an interchange.

Water purchases and sales within the City service area will increase with population growth. Table IV.2: Projected Water Demands uses a 4.21% growth rate and a Max day/Average day ratio of 1.5.

Table IV.2 –Projected Water Demands			
Year	2018	2028	2033
Annual Finished Water Purchased (gal.)	116,096,211	175,352,517	215,505,811
Annual Water Sales (gal.)	98,681,779	149,049,640	183,179,939
Average Day Water Purchased (gal.)	317,203	479,105	590,427
Maximum Day Water Purchased (gal).	475,804	718,658	885,640

The City's current demands, plus reasonable growth, are reflected in the 2033 Maximum Day Water Purchase projection of 885,640 gallons. At this growth rate the City would have a maximum day water purchased of over one million gallons by the year 2036.

C. Existing System

Several cases were developed using the existing system to determine the location of, and priority for, needed improvements. The existing system was analyzed at average day, max day, and peak hour. The outlet pressures at all three master meters were set to the gradients discussed in III.A. These conditions were analyzed for the years 2013, 2018, and 2033. Locations of additional demands were based upon existing platted areas and the growth predicted to occur at the proposed 211th and I-49 interchange. The following table shows the average, high and low pressures of these scenarios when ran at steady state with the elevated storage tank 10' below overflow (note this is lower than the City currently operates the tank but was utilized to find any deficiencies). Table IV.3 does not include low pressure readings that occur between the ground storage tank and the suction side of the pump station. (See Appendix B for full results).

Table IV.3 – Hydraulic Results Existing System without Improvements			
Scenario	Low Pressure (psi)	Average Pressure (psi)	High Pressure (psi)
Year 2013			
• ADF	28.9	61.1	118.6
• MDF	27.8	60.7	118.1
• PHF	24.5	59.3	115.8
Year 2018			
• ADF	28.4	60.9	118.6
• MDF	27.0	60.4	118.1
• PHF	22.9	58.8	115.8
Year 2033			
• ADF	27.8	60.7	118.2
• MDF	26.1	60.0	117.4
• PHF	21.2	57.9	113.4

Results of the hydraulic analysis of the existing system show a minimum pressure in the system of approximately 29 psi under 2013 ADF demands at Junction 708 near the intersection of 222nd St. and Setter's Pointe Blvd (this is lower than the desired 35 psi). The highest pressure in the system under the same scenario is approximately 119 psi on Highway J at a stream crossing north of Cemetery Road at Junction 898. Under 2013 ADF, approximately 60 junctions had pressure less than 35 psi. Most of these were located in Pressure Zone 1, east of S. Peculiar Dr. between Tuscany Pkwy and Lions Dr. This area is fed directly from PWSD No. 2 Cass and does not receive pressure from the City's elevated storage tank. As demands increase within the system, the hydraulic analysis indicated additional junction pressures will drop below the DNR's Minimum Design Standards recommendations. Most of these junctions continued to fall within Pressure Zone 1, but with additional other junctions spread throughout Pressure Zone 2.

D. Existing System with Improvements

Section IX lists the recommended improvements utilized to enhance the City's distribution system. These improvements first focused on replacing mains that have deficient pipe as evidenced by many main breaks. Also larger diameter waterlines are recommended to improve deficient pressures in Pressure Zone 1 and other improvements will eliminate dead-end lines with looping. Table IV.4 contains the results of the hydraulic analysis with all improvements constructed (this table has the same limitations as Table IV.3).

Table IV.4 – Hydraulic Results with Recommended Improvements

Scenario	Low Pressure (psi)	Average Pressure (psi)	High Pressure (psi)
Year 2013			
• ADF	42.1	66.0	118.7
• MDF	41.5	65.8	118.3
• PHF	39.6	64.8	116.6
Year 2018			
• ADF	41.8	65.9	118.6
• MDF	41.1	65.6	118.3
• PHF	38.8	64.5	116.6
Year 2033			
• ADF	41.5	65.8	118.4
• MDF	40.6	65.3	117.8
• PHF	37.7	63.9	114.9

With the improvements in place, junctions in all 9 scenarios now meet the 35 psi goal of the Study. (See Appendix B for full results). Distribution improvements are prioritized in Section IX based on the findings of these analyses and discussions with City personnel.

A steady state fire flow analysis was also performed on the distribution system. Within the existing system, approximately 46% of the junctions were able to meet a fire flow demand of 1,000 gpm while maintaining a system minimum pressure of 20 psi at 2033 demands. With the recommended system improvements, this number climbed to 74%. The areas not meeting the fire flow requirements are on waterlines less than 8-inches in diameter. As expansion occurs in these areas, the City should evaluate the opportunity to work with development to have larger diameter waterlines installed.

V. Applicable Design Standards

The DNR is authorized to monitor and enforce regulations pertaining to the production and distribution of potable water. The DNR establishes standards and guidelines to be followed in the design, construction, and operation of public water supply (PWS) facilities. Facilities must meet the requirements of the Missouri Safe Drinking Law and the Missouri Safe Drinking Water Regulations. Pertinent excerpts of the following documents are presented in this section:

Missouri Safe Drinking Water Law

(Sections 640.100 through 640.140, Revised Statutes of Missouri)

Missouri Safe Drinking Water Regulations

(10 CSR 60-1.010 through 10 CSR 60-16.030)

Excerpts from *Minimum Design Standards for Missouri Community Water Systems* effective December 10, 2013.

Disinfectants and Disinfection By-Products Rule (D/DBPR) Stage 1 and 2

Safe Drinking Water Act Reauthorization (SDWA)

Surface Water Treatment Rule (SWTR)

Interim Enhanced Surface Water Treatment Rule (IESWTR)

Long-Term Enhanced Surface Water Treatment Rule (LT2 Rule))

Lead and Copper Rule

Total Coliform Rule

Occupational Safety and Health Administration Rules

The City currently purchases water indirectly from the city of Kansas City, which utilizes a combination of groundwater and surface water as a source. Surface water treatment regulations apply to this source. Kansas City uses chloramines as the residual disinfectant. The City is considered a "consecutive system" since the City purchases water from PWSD No. 2 Cass County, which purchases water from Kansas City. Regulations that apply to Kansas City, as a large system (serving greater than 100,000 population) also apply to Peculiar due to the consecutive system classification.

A. Missouri Safe Drinking Water Law

Key points of the law are presented as follows:

Statute 640.115.1--Every water system authorized to supply drinking water to the public shall file with the DNR a certified copy of the plans and surveys of the waterworks with a description of the methods of purification and of the source from which the supply of water is derived, and no source of supply shall be used without a written permit of approval from the DNR, or water dispensed to the public without first obtaining such written permit or approval.

Statute 640.115.2--Construction, extension, or alteration of a public water system shall be in accordance with the rules and regulations of the DNR.

Statute 640.120.4--The DNR may authorize variances and exemptions from state primary water regulations.

B. Missouri Safe Drinking Water Regulations

A review of state safe drinking water regulations applicable to surface water is presented as follows.

10 CSR 60-4.055 (1)(E) Disinfection Requirements:

Primary systems which use water obtained from groundwater not under the direct influence of surface water and which the department requires to disinfect and secondary public water systems do not have to meet the requirements of section (2) (CT requirements) of this rule but may be required to provide disinfection detention as deemed necessary by the department. These systems also do not have to submit reports to the department as required by 10 CSR 60-7.010(5) but must maintain the information on file at the system treatment plant or office.

10 CSR 60-7.010(5) Disinfection information must be reported within ten (10) days after the end of each month the system serves water to the public.

C. Minimum Design Standards for Missouri Community Water Systems

The DNR has prepared a set of minimum standards and guidelines for use by professional engineers in the preparation, submission, review and approval of engineering reports, plans and specifications for the design and construction of public water supply facilities. These minimum standards must be followed in order to ensure that facilities are in compliance with the Missouri Safe Drinking Water Law and Missouri Safe Drinking Water Regulations.

DNR standards and guidelines are not totally inflexible. From time to time new processes and equipment appear. The DNR states that new processes and equipment may be acceptable if they meet at least one of the following conditions: 1) they have been thoroughly tested in full scale comparable installations under competent supervision, 2) they have been thoroughly tested as pilot plant operated for a sufficient time to indicate satisfactory performance, or 3) a performance bond or other acceptable

arrangements have been made so the owners or official custodians are adequately protected financially in case of failure of the process or equipment.

An excerpt of pertinent guidelines follow:

(1) SUBMISSION OF PLANS

(1.1) Engineering Report

1.1.2. Extent of the water system(s), including--

(I) Usage rates and population per service connection based on historical data from the public water system if this data is available. If historical data is not available, the following information may be used for design purposes. Other usage criteria may also be used if adequate justification is provided by the engineer.

(a) Population per service connection for permanent residential dwelling units including houses, mobile homes, condominiums, apartments, and multiplexes should use approximately three (3.0) persons/dwelling unit;

(b) Domestic water usage for residential dwelling units excluding lawn/garden irrigation usage should be an average of eighty (80) gallons per person per calendar day.

(II) In addition to peak demand, a reasonable coordination of lawn water among homeowners may be assumed. If no other information is available the estimates in the following table may be used:

Housing Type	Sprinkler Type	Flow per House
Moderate/Middle Class	End of Hose	5 gpm
Estate	Automatic	16 gpm

(III) Peak flow (one to four hour instantaneous rates) shall be based on historical data as documented by the public water supply. If historical data is not available, the following information may be used for design purposes. Other peak flow criteria may also be used if adequate justification is provided by the engineer.

(a) Instantaneous Peak Flow = Domestic Peak Flow + Lawn/garden Irrigation Peak Flow + Commercial, Larger Users, Confined Feeding Operation;

(b) Domestic peak flow should be calculated as the greater of one (1) gallon per minute per connection or Peak = 12 (number of connections) to the 0.515 power.

(IV) Maximum day flow shall be based on historical data if this data is available from the public water system. If historical data is not available, the following information may be used for design purposes. Other maximum day flow criteria may be used if adequate justification is given by the engineer.

Maximum Day Flow = 150% of Average Daily Flow

(1.2) Supervised Program

C. Detailed Plans

(I) Owner-Supervised Program

(a) A supplier of water may apply for an owner-supervised program in lieu of submitting plans and specifications for expansion and/or modification of an existing water distribution system.

(b) A written request to the Department of Natural Resources for approval of a supervised program must include the following information:

1. An engineer-prepared report or a master plan showing the proposed waterlines over at least the next five (5) years, along with engineering rationale, including hydraulic analyses, for sizing and locating the lines. The engineering report must discuss adequacy of present water system with regard to the source, storage and existing distribution piping, discuss problems that need to be resolved (leaks, low pressures, etc), discuss fire protection need (if applicable). A priority listing of proposed improvements along with cost estimates should also be included in the engineering report;
2. A current layout map of the distribution system (standard size 24" x 36"). The map must show waterline sizes (existing and proposed), location of valves, fire hydrants and flushing devices, along with street names;
3. Adoption of a minimum pipe size for waterline replacements not otherwise shown on the master plan which will maintain a minimum pressure of twenty pounds per square inch (20 psi) under all normal operating conditions;
4. Examples of permanent records and drawings of the distribution system including lines, valve, hydrants and cleanouts;

5. Technical specifications prepared by an engineer covering construction materials, installation, and disinfection procedures in accordance with American Water Works Association standards;
6. Typical detail drawings by an engineer of special crossings, meter settings, valve settings, hydrant settings, cleanouts, thrust blockings, etc.; and
7. A brief statement about qualifications of the person responsible for construction inspection.

(8.1.1) Pressure

All water mains shall be sized in accordance with a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 35 psi at ground level at all points in the distribution system under all conditions of design flow not including fire flow. The normal working pressure in the distribution system should be approximately 60 psi.

D. More Recent Developments in Regulatory Requirements

Many changes have been introduced into the regulations governing water treatment in the last ten years and some of these are in various stages of effect at this time. The most notable items of regulation that will affect the City are as follows:

Stage 2 - Disinfection Byproducts Rule (DBPR2)

Stage 2 of the DBPR, published in January 2006 and effective March 6, 2006, further expands the scope of Stage 1 by using a locational running annual average (LRAA) to ensure total trihalomethane (TTHM) and the sum of five haloacetic acids (HAA5) compliance and requiring Initial Distribution System Evaluations (IDSE) to be performed. All community water systems adding a disinfectant other than ultraviolet light are covered by the DBPR2. Suppliers will have to perform an additional year of TTHM and HAA5 monitoring, in addition to Stage 1 requirements, as the first step in meeting the IDSE requirement of the Rule. This information, along with data from Stage 1 DBPR monitoring, was used to select new locations for Stage 2 monitoring.

To be in compliance with Stage 2 monitoring requirements, the City had to take two samples for TTHMs and HAA5s every 90 days at four locations within the distribution system. Since the City serves less than 10,000 people, the IDSE Schedule 4 applies. This means that a standard monitoring plan had to be submitted by April 1, 2008. This plan included standard monitoring which was to be finished by March 31, 2010. The City had until July 1, 2010 to submit an Initial Distribution System Evaluation

(IDSE) report for the water system. By the final deadline of October 1, 2013, the City needed to demonstrate compliance on a LRAA for TTHM and HAA5 MCLs at each location for compliance with Stage 2 DBPR monitoring.

Surface Water Treatment Rule (SWTR) - Effective on June 29, 1993. The major purpose of the rule is to control waterborne pathogens, particularly Giardia lamblia cysts and viruses that could enter public water distribution systems. Three categories of source waters were defined: surface water, ground water, and ground water under the direct influence of surface water. The rule requires additional monitoring and minimum treatment plant performance on surface supplies and supplies classified as ground water under the direct influence of surface water. Prescribed treatment techniques are used in place of testing due to the uncertain methods currently available for Giardia and Cryptosporidium identification. Summary of new requirements include:

- 0.5 NTU turbidity maximum in 95% of the required samples to be taken every 4 hours of plant run time minimum.
- Requires 99.9% (3-log) removal of Giardia and 99.99% (4-log) removal of viruses.
- Requires continuous and recording chlorine residual monitoring.

Long-Term Enhanced Surface Water Treatment Rule (LT2 Rule)) –

The LT2 Rule was published January 5, 2006 and requires public water systems that use surface water or GWUDI of surface water to monitor their water treatment influent water (source water) for *Cryptosporidum*, and/or *E. Coli*, and turbidity for the length of time based on the population served by the plant. With the current population served by the water treatment plant, the City will have to comply with Schedule 4 of the LT2 Rule Monitoring Requirements. This means the City must begin monthly monitoring for a year on October 1, 2008. This monitoring can be avoided if the water treatment plant provides 5.5 log treatment of *Cryptosporidum*.

The EPA recommends contacting labs to perform sample analysis of *Cryptosporidum*, and *E. Coli*, as well as verifying that the party in charge of turbidity measurement is approved by the State by June 2006. A sampling schedule (or intent to provide full treatment), description of sampling location, and monitoring description is required to be submitted to the EPA by January 1, 2008 (July 1, 2006). The sampling schedule and initial monitoring data can only be sent to the EPA through the LT2/Stage 2 Data Collection and Tracking System.

Lead and Copper Rule—The 1986 Safe Drinking Water Act amendments directed EPA to set regulations for both lead and copper in drinking water. The final regulations were adopted by EPA in

1991, and later adopted by reference in the CSR. This regulation applies to all community water systems, and non-community water systems that are non-transient. These water systems are required to monitor for lead and copper on a scheduled basis in the distribution system at the customer's tap. If monitoring results indicate unacceptable levels, the water system is required to initiate corrosion control treatment techniques to minimize lead and copper contamination. Action levels set by this regulation are 0.015 mg/L for lead and 1.3 mg/L for copper. The City has historically tested below the action level for both lead and copper.

Total Coliform Rule—All public water supply systems are required by state regulation 10 CSR 60-4 to disinfect all drinking water provided to the public. To evaluate the effectiveness of the disinfection method employed, all systems are required by state regulations to submit monthly water samples for total coliform testing. Total coliform testing is used as an indicator of the presence of other bacteriological contaminants. Systems can choose to have this bacteriological testing performed by DNR's microbiology laboratory or by a private certified laboratory.

Systems that fail to collect any water samples within the monthly compliance period are assessed a routine monitoring violation. Systems that have a water sample test positive are required to do three repeat samples (also called check samples). If the system fails to collect these repeat (check) samples, the system then is assessed a repeat monitoring violation. Both of these monitoring violations require the system to issue public notice by publishing the violation notice in a local newspaper of general circulation.

Systems can incur a maximum contaminant level (MCL) violation if water samples test positive for total coliform, or the system can incur an acute maximum contaminant level (acute MCL) violation if fecal coliform or *E. coli* is found. In either case, the system is required to issue public notice by notifying the public of the violation through the electronic news media (radio and television) and publishing the violation notice in a local newspaper of general circulation.

Occupational Safety and Health Administration Rules (OSHA) – Of particular interest to utility systems are the January 14, 1993 rules that pertain to Confined Spaces. 29 CFR Parts 1910 Permit Required Confined Spaces for General Industry contains requirements for practices and procedures to protect employees from the hazards of entry into permit-required confined spaces.

VI. ALTERNATE WATER SUPPLIES

The City presently purchases water from Cass County P.W.S.D. No. 2, which purchases water from Kansas City. The City has emergency interconnections with PWSD No's 10 and 7 of Cass County.

This report will examine the feasibility of purchasing water directly from a water producer in order to reduce the City's cost of water. This would avoid the wheeling fees (additional charges for utilizing an intermediate's facilities to transport water on top of the cost of water) required by purchasing water through a secondary source. The City has narrowed a list of potential water sources to Kansas City, Water District No. 1 of Johnson County, Kansas, and the Tri-County Water Authority. If the City decides to pursue a new water provider, the contract with District No. 2 requires a 1-year notice that water purchase will cease.

A. Kansas City, MO

Kansas City is the producer of the City's current source. Kansas City Water Services maintains and operates water supply, treatment, and distribution systems for 170,000 residential and business customers in Kansas City and 33 wholesale customers in the Kansas City region. Kansas City has 2,800 miles of water main in its system. Each year the City has a cost of service rate study completed that establishes the new wholesale rate to become effective on May 1st. The costs of administration, larger water mains, pumping facilities, storage facilities, supply and treatment works are shared with wholesale customers.

In April 2014 voters in Kansas City voted to approve $500 million dollars of revenue bond authority in order to pay for water capital improvement projects for the next 7-10 years. Kansas City has a goal to replace approximate 1% of its water mains, or 28 miles, every year under this plan. At this time most of the planned replacement mains are 12" in size or smaller in neighborhoods.

This is the initial source for the City's current potable water supply. Kansas City has a supply capacity of 240 million gallons per day (MGD) and produces an average of 112 MGD. Eighty percent of its raw water comes from the Missouri River with the other 20% produced from alluvial wells near the river intake. Kansas City utilizes the following treatment processes:

- Iron removal through permanganate addition and sequestration
- Rapid Mixing
- Softening via lime and soda ash addition
- Disinfection utilizing gaseous chlorine
- Chloramines for disinfection by-product control
- Filtration
- Odor and taste control via powdered activated carbon
- Fluoridation
- Particulate removal through coagulation, sedimentation, and flocculation

Kansas City has two wholesale water rates: unrestricted and restricted. The restricted rate is

approximately 5 cents per 1,000 gallons lower than the unrestricted rate. Qualification for the two rates depends upon the wholesale customers' current storage facilities volume and whether or not the supply is a sole supply or a partial supply. The City of Peculiar, if purchasing a sole supply, has enough storage capacity to qualify for the restricted rate. The restricted rate is $2.73 per 1,000 gallons effective May1, 2014. Kansas City also charges repumping fees depending on where the delivery point is within the KC system. The repump charges effective May 1, 2014 are $0.25 and $0.35 per 1,000 gallons for the first and second repump, respectively. Kansas City has a 24-inch diameter transmission main that extends south of the intersection of Highway J and Hubach Hill Road to the Raymore elevated storage tank. According to information from Kelly Finn with Kansas City Water Services, the Raymore tank operates at a minimum hydraulic grade of 1226 feet. When Raymore constructed the elevated tank, Kansas City also reserved capacity in the Raymore elevated tank for future wholesale customers.

To reach a connection point adjacent to the Raymore elevated tank would require approximately 5 miles of main be installed north of the City along Route J. On the south end of the new service transmission main the City system can be connected at two locations, at a point on Highway J, just east of I-49 to an existing waterline at Branic Road. The second connection point would connect to a proposed main that will be relocated in preparation for the new 211th Street interchange.

Table VI.1 has a cost opinion for this water supply option. This opinion also includes a capacity charge of approximately $820,000 for 1.0 MGD of capacity from Kansas City. This is based on the original construction cost of the transmission main and Kansas City's share of the Raymore elevated tank.

Table VI.1: Cost Opinion on Kansas City Supply

Item No.	Description	Quantity	Units	Unit Price	Cost
1	12" PVC	26,200	LF	$55	$1,441,000
2	Connections	4	EA	$5,000	$20,000
3	Valves	14	EA	$3,000	$42,000
4	Road Crossings	14	EA	$10,000	$140,000
5	Master Meter	1	EA	$75,000	$75,000
6	Air Release Valves	3	EA	$2,000	$6,000
7	Highway J Crossing	1	EA	$20,000	$20,000
8	Driveway Crossing	26	EA	$2,000	$52,000
9	Parking Lot Crossing	1	LS	$10,000	$10,000
10	Stream Crossing	190	FT	$500	$95,000
	(Directional Bore and Case)				
11	Flushing Hydrant	5	EA	$3,750	$18,750
12	SCADA Modifications	1	LS	$5,000	$5,000
13	Bond/Insurance/Mobilization	1	LS	$60,000	$60,000
14	Connection Fee	1	LS	$820,000	$820,000
		Construction Cost			$2,804,750
		Contingency		15%	$420,713
		Engineering, Legal, & Admin.		10%	$280,475.
		Construction Observation		4.5%	$126,214
		Survey		5.0%	$140,238
		Total			$3,772,389

If the City chooses to pursue a direct water supply from Kansas City, we recommend having an alternate bid for a 16-inch transmission main.

B. Water District No. 1 of Johnson County, KS

Water District No 1 of Johnson County Kansas (WaterOne) is located in eastern Johnson County. WaterOne has a supply capacity of 200 million gallons per day (MGD) and produces an average of 68 MGD. WaterOne utilizes water from the Kansas and Missouri rivers as well as alluvial wells adjacent to these rivers. WaterOne utilizes the following treatment processes:

- Aeration
- Rapid Mixing
- Softening via lime and soda ash addition
- Disinfection utilizing chlorine dioxide
- Chloramines for disinfection by-product control

- Filtration
- Fluoridation
- Alum and polymer addition
- Carbon Dioxide for pH balance
- Particulate removal through coagulation, sedimentation, and flocculation

In preliminary discussions between WaterOne and the City, a monthly service charge of $139.30 and a rate of $3.07 rate per 1,000 gallons were discussed. The City would need to get a guarantee from WaterOne of service arability equal to WaterOne's existing customers. The City would need to install a waterline (approximately 11 miles) from the northwest portion of the City, north and west to near the intersection of 175th St. and Kenneth Rd. in Johnson County. Table VI.2 has a cost opinion for this option.

Table VI.2: Cost Opinion on WaterOne Supply

Item No.	Description	Quantity	Units	Unit Price	Cost
1	12" PVC	58,000	LF	$55	$3,190,000
2	Connections	2	EA	$5,000	$10,000
3	Valves	24	EA	$3,000	$72,000
4	Road Crossings	15	EA	$10,000	$150,000
5	Pump Station	2	EA	$200,000	$400,000
6	Master Meter	1	EA	$75,000	$75,000
7	Air Release Valves	6	EA	$2,000	$12,000
8	Highway Y Crossing	1	EA	$25,000	$25,000
9	Highway D Crossing	1	EA	$25,000	$25,000
10	Stream Crossing	100	FT	$500	$50,000
11	Stream Crossing	100	FT	$500	$50,000
12	Stream Crossing	90	FT	$500	$45,000
13	Ditch Crossing	2	EA	$5,000	$10,000
14	Railroad Crossing	1	LS	$50,000	$50,000
15	Driveway Crossing	62	EA	$2,000	$124,000
16	Flushing Hydrant	15	EA	$3,750	$56,250
17	SCADA Modifications	1	LS	$25,000	$25,000
18	Bond/Insurance/Mobilization	1	LS	$130,000	$130,000
		Construction Cost			$4,499,250
		Contingency		15%	$674,888
		Engineering, Legal, & Admin.		10%	$449,925
		Construction Observation		4.5%	$202,466
		Survey		5.0%	$224,963
		Total			$6,051,491

C. Tri-County Water Authority

Tri-County Water Authority (TCWA) has a supply capacity of 10.5 MGD and produces an average of 4.4 MGD. TCWA uses ground water from alluvial wells located south of the Missouri River, outside of Atherton, Missouri. Originally all the wells were vertical wells, but now a significant portion of the supply comes from a horizontal collector well. This well is closer to the Missouri River bank and is likely classified as groundwater under the direct influence of surface water (GWUDI). TCWA utilizes the following treatment processes:

- Iron removal through aeration
- Rapid Mixing
- Softening via lime and soda ash addition
- Disinfection utilizing gaseous chlorine
- Chloramines for disinfection by-product control
- Filtration
- Particulate removal through coagulation and sedimentation

All existing capacity south of Colbern Road is under contract with current members. In 2010, TCWA began investigating serving entities west of their current service area. Interested potential customers at that time included PWSD No. 1 Jackson County (Grandview) and the City of Belton. This project has not moved forward at this time. The City could come to an agreement with an existing entity to purchase a portion of their water. TCWA has two water rate structues. The first is for all of the TCWA's capacity prior to 2005 and it charges $1.87 per 1,000 gallons for water costs and $2.43 per 1,000 gallons for fixed costs. For capacity created after 2005, the water costs are the same; however, the fixed costs fluctuate. An entity is required to pay a percentage of any debt service needed to fund the capacity construction equal to the percentage of that capacity purchased. This fixed cost will be divided equally over 12 months and is not dependent on water purchased. With no current capacity availaibe, the City would have to fund required construction costs within TCWA or find themselves partners to team with for the construction. Based upon previous discussions with TCWA personnel, a connection fee of approximately $3.5 million per 1 MGD of capacity is a reasonable assumption of what would be assessed to new customers. Currently, TCWA has facilitates near the intersection of E. 215th St. and Ore Road, approximately 7 miles east of the City. Table VI.3 has a cost opinion for this option. This opinion also assumes a connection charge of $3,500,000.

Table VI.3: Cost Opinion on TCWA Supply

Item No.	Description	Quantity	Units	Unit Price	Cost
1	12" PVC	35,800	LF	$55	$1,969,000
2	Connections	3	EA	$5,000	$15,000
3	Valves	17	EA	$3,000	$51,000
4	Road Crossings	11	EA	$10,000	$110,000
5	Pump Station	1	EA	$200,000	$200,000
6	Master Meter	1	EA	$75,000	$75,000
7	Driveway Crossings	36	EA	$2,000	$72,000
8	Highway 291 Crossing	1	LS	$50,000	$50,000
9	Railroad Crossing	1	LS	$50,000	$50,000
10	Air Release Valves	4	EA	$2,000	$8,000
11	Flushing Hydrant	10	EA	$3,750	$37,500
12	Stream Crossing	190	FT	$500	$95,000
	(Directional Bore and Case)				
13	SCADA Modifications	1	LS	$5,000	$5,000
14	Bond/Insurance/Mobilization	1	LS	$85,000	$85,000
15	Connection Fee	1	LS	$3,500,000	$3,500,000
		Construction Cost			$6,322,500
		Contingency		15%	$948,375
		Engineering, Legal, & Admin.		10%	$632,250
		Construction Observation		4.5%	$284,513
		Survey		5.0%	$316,125
		Total			$8,503,763

VII. WATER SUPPLY COMPARISON AND RECOMMENDATIONS

Four different suppliers were evaluated to provide potable water to the City. The evaluation consisted of construction costs involved in each alternate, water rates, future costs, and ease of construction. The four Suppliers are listed below:

Cass No. 2—Existing facilities on 211th and along Peculiar Drive. Supplier purchases water from KCMO (Section III.A)

KCMO—Connection at Raymore elevated tank on Highway J, south of Hubach Hill Rd., produces City's existing supply (Section VI.A)

WaterOne—Connection near the intersection of 175th St. and Kenneth Rd in Johnson County, Kansas (Section VI.B)

TCWA— Connection near the intersection of E. 215th St. and Ore Rd (Section VI.C)

The advantage and disadvantage of each alternate is analyzed in Section VII.B. In order to help

distinguish between the alternates, a decision matrix was made to prioritize the advantages and disadvantages of each supplier.

A. Decision Matrix:

The following decision matrix was created in order to aid in selecting the appropriate supplier for recommendation. Points are then awarded to each supplier and the supplier with the most points is the recommended solution. Table VII.1 shows a breakdown of the matrix.

Table VII.1: Supplier Decision Matrix

Item	Consideration	Percent
1	20-Year Life Cycle Analysis	20
2	Water Rates	25
3	Capital Cost	20
4	Maintenance (Time) Requirements	10
5	Environmental	10
6	Accessibility	5
7	ROW Acquisition	5
8	Utility Consideration	5
		100

B. Benefits and Deficiencies of Each Alternate:

1. *Cass No. 2*

Benefits:

- Lowest capital costs
- Least amount of new waterline required
- No new right of way or easements required
- Most waterlines under the City's responsibility are within City Limits.
- Land Disturbance permit not required for supply improvement

Deficiencies:

- Operation and Maintenance Fee in addition to water costs
- Cost for 15% water loss is required by contract
- If Cass 2 replaces/upgrades internal supply mains they may assess the City a portion of the cost as shared facilities, especially if additional flow is made available.

2. Kansas City, MO

Benefits:

- Lowest water rate

- Significant replacement or repairs on the new supply main are unlikely within 30 years or more after construction
- Lower capital costs than the WaterOne and TCWA construction
- Less right-of-way acquisition and easement requirements than WaterOne and TCWA options

Deficiencies:

- Capital costs higher than maintaining Cass No. 2 supply
- Greater chance of right-of-way, easement, and utility conflicts than Cass No. 2
- Larger area of disturbed land for construction than Cass No. 2
- City staff will have to monitor approximately 2.7 miles of waterline outside of City limits

3. WaterOne

Benefits:

- No connection fee
- Lower water rates than Cass No. 2 and TCWA

Deficiencies:

- This supply requires the most supply main construction.
- Largest chance of right-of-way, easement, and utility conflicts
- Inter-state design regulation differences
- City staff will have to monitor approximately 11 miles of waterline outside of City limits
- Larger capital costs that Cass No. 2 or Kansas City
- Largest area of disturbed land for construction

4. Tri-County Water Authority

Benefits:

- City may become a voting member of the Authority

Deficiencies:

- This supply is the most expensive.
- Largest connection fee
- Higher water rates than Kansas City and WaterOne.
- City staff will have to monitor approximately 7 miles of waterline outside of City limits
- Greater chance of right-of-way, easement, and utility conflicts than Cass No. 2 or Kansas City
- Larger area of disturbed land for construction than Cass No. 2 or Kansas City
- Second highest water rate

C. Weighted Decision Matrix for Each Option:

Below is a ranking of each supply based on the categories selected for this study. Each alternate with the "best" consideration for each category is awarded full points. Every other alternate is a percentage based on a comparison against the top ranked.

Table VII.2 Weighted Decision Matrix

Item	Consideration	Percent	Cass No. 2	KCMO	WaterOne	TCWA
1	20-Year Life Cycle Analysis	20	15	20	17	18
2	Water Rates	25	10	25	24	14
3	Capital Cost	20	20	7	5	3
4	Minimizing maintenance time	10	8	10	5	7
5	Environmental	10	10	8	4	6
6	Accessibility	5	5	4	2	3
7	ROW Acquisition	5	5	4	2	3
8	Utility Consideration	5	5	4	2	3
		100	78	82	61	57

The Kansas City, Missouri source is the high ranked supply based upon the results of the weighted decision matrix. This supply has the lowest water rates and the lowest capital costs of any of the three new suppliers. As water demands grow within the City and Cass No. 2, waterline improvements within Cass No. 2 necessary to feed water to the City are likely to be required. Associated costs for these improvements are likely to be shared with the City. A direct supply from Kansas City requires a one-time connection fee for construction of the existing transmission main. Future KCMO system improvements, however, will be paid for within the Kansas City rates, which also would be added to the Cass No. 2 rate, along with a 15% increase for water losses, if the City maintained its current water supply.

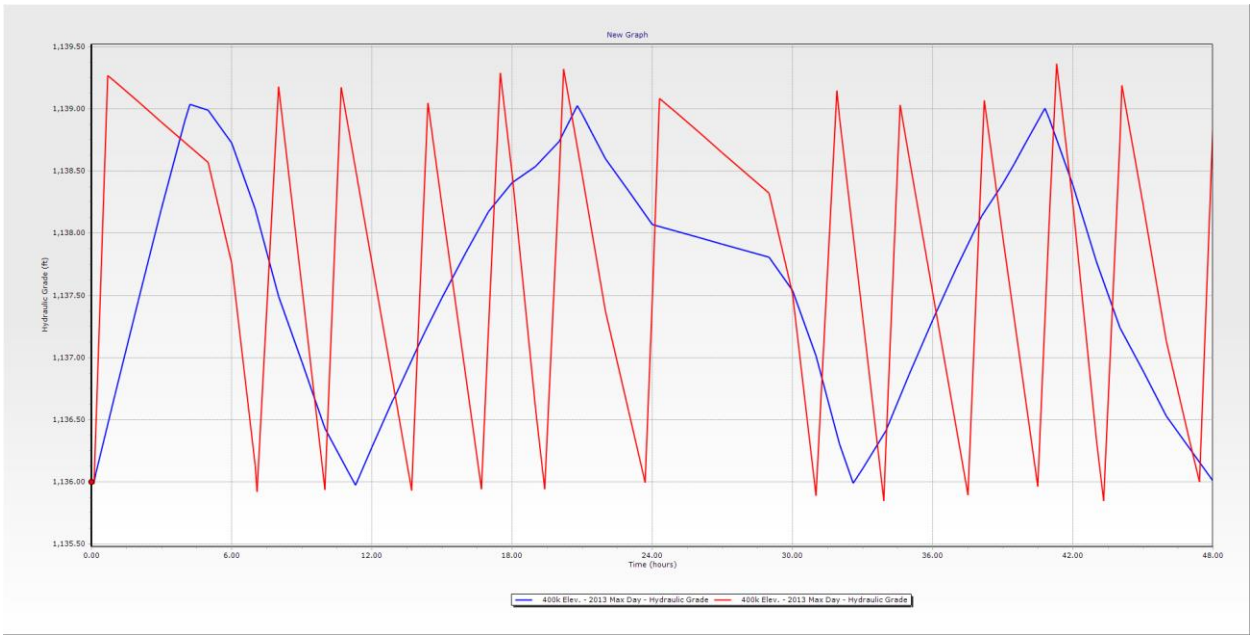
D. Kansas City, MO Hydraulics

Hydraulic analyses were performed for the same 18 scenarios identified in Section IV. To facilitate the water supply entering from a different location within the City's distribution system, check valves and gate valves forming the four pressure zones were considered open or removed. Additionally, as there was no dedicated line to the ground storage tank, it was valved off for these trials. This allowed the City to operate as one large pressure zone. Table VII.3 contains the hydraulic results for utilizing the KCMO supply and none of the improvements from Section IX.

Table VII.3 – Hydraulic Results without Improvements and KCMO Supply			
Scenario	Low Pressure (psi)	Average Pressure (psi)	High Pressure (psi)
Year 2013			
• ADF	28.1	62.9	99.5
• MDF	28.0	62.8	99.4
• PHF	27.8	62.2	99.2
Year 2018			
• ADF	28.1	62.9	99.5
• MDF	28.0	62.7	99.4
• PHF	27.7	62.1	99.1
Year 2033			
• ADF	28.0	62.8	99.4
• MDF	27.9	62.6	99.3
• PHF	27.4	61.7	98.8

The only areas that did not meet the 35 psi goal were along the 12-inch transmission main from the KCMO supply. Without these two locations, the lowest pressure in the system would increase approximately 14 to 21 psi utilizing KCMO and one pressure zone. The average pressure would increase approximately 2 to 4 with this scenario; however, the highest pressure would drop approximately 15 to 19 psi. Figure VII.1 shows the hydraulic grade within the elevated storage while utilizing the existing (blue) and KCMO (red) supplies at 2013 demands.

Figure VII.1: Elevated Storage Tank Hydraulic Grades



With the entire system receiving flow and pressure from one source, the tank drains more rapidly, however, due to the pressure gradient from the Kansas City source, the City's tank also is replenished in much less time. Table VII.4 contains the modeling results for the KCMO supply with the improvements from Section IX.

Table VII.4 – Hydraulic Results with Improvements and KCMO Supply			
Scenario	Low Pressure (psi)	Average Pressure (psi)	High Pressure (psi)
Year 2013			
• ADF	28.1	62.9	99.5
• MDF	28.0	62.8	99.4
• PHF	27.8	62.5	99.2
Year 2018			
• ADF	28.1	62.8	99.5
• MDF	28.0	62.8	99.4
• PHF	27.8	62.4	99.1
Year 2033			
• ADF	28.0	62.8	99.4
• MDF	27.9	62.7	99.3
• PHF	27.5	62.1	98.9

The improvements did not make a large change on the low, average, and high pressures within the distribution system. With this water supply, the improvement to install a larger diameter waterline from Master Meter 1 can be eliminated. The rest of the improvements in Section IX should still be pursued to eliminate reduce water loss from deficient pipes and increase water quality by system looping.

Table VII.5 estimates rates and future water costs from the District and KCMO based upon the following assumptions:

- $3,772,389 SRF Loan as described in Section XI below
- Water rate increases of 5% per year
- District O & M rate increases of 3% per year
- 1 repump charge from KCMO

Table VII.5 – Rate and Water Purchase Cost Opinions for future Water Suppliers

Source	Parameters	Year	
		2018	2033
Cass PWSD#2			
	Rate per 1,000 gallons* (Effective 5/1 ea. yr)	$5.57	$ 10.63
	Assumed Increase	5%/3%	5%/3%
	Cost of Water Purchased	$ 581,248	$ 1,491,786
Kansas City			
	Rate per 1,000 gallons** (Effective 5/1 ea. yr)	$ 3.31	$6.89
	Repumping fee per 1,000 gallons	$ 0.30	$0.63
	Assumed Increase	5.0%	5.0%
	Cost of Water Purchased	$ 377,416	$ 1,055,996
	Loan Repayment	$ 241,988	$ 241,988
	Total	$ 619,404	$ 1,297,984

*Water rate from Cass 2 consists of three components: Water cost from Kansas City, Cass 2 O&M cost, and Cass 2 debt service on shared facilities per Water Purchase Agreement (Annual rate increase is assumed at 5% for KC rate and 3% for O&M)
**Includes Kansas City as a direct water wholesaler at their wholesale restricted rate plus 1 repump charge (Annual rate increase is assumed at 5%)

VIII. Historical Operating & Maintenance Costs

The City prepares an annual budget and maintains records of revenues and expenses. A summary of the City's water department finances for the last two years is included in Table VIII.I.

Table VIII.1: Summary of Revenues and Expenses

	2011	2012	2013
Beginning Balance	$1,266,286.79	$1,161,548.79	$1,236,239.00
Revenues			
Revenue from water sales			
Water Operating Revenues	$744,362.00	$798,257.36	$922,402.00
Water Connection Fees	$1,900.00	$0.00	$1,600.00
Non-Operating Revenue			
Interest Income	$69,500.00	$58,500.00	$62,769.00
Penalties	$31,000.00	$25,000.00	$0.00
Gain on sale of asset			$846.00
Tower Rental	$20,462.00	$21,037.34	$21,668.00
G.O. Principal	$111,000.00	$94,000.00	$51,384.00
Total Revenue	$978,224.00	$996,794.70	$1,060,669.00
Expenses			
Cost of Sales			

Cost of Water Purchased	$304,171.30	$423,765.83	$419,630.00
Pump/Line Maintenance	$5,571.00	$10,179.74	$22,718.00
Subtotal	$309,742.30	$433,945.57	$442,348.00
Operating Expenses			
Salaries/Wages	$170,371.00	$162,440.06	$166,429.00
Benefits/Payroll Taxes	$66,343.00	$62,725.77	$84,781.00
Workers Compensation	$4,000.00	$0.00	$4,250.00
Uniforms	$1,192.00	$865.85	$1,238.00
Travel and Training	$1,648.00	$2,153.32	$934.00
Employee Testing	$0.00	$0.00	$353.00
Office Supplies	$14,861.00	$16,181.97	$4,200.00
Dues and Subscriptions	$1,137.00	$2,006.94	$2,136.00
Postage	$4,985.00	$4,755.80	$3,363.00
Bankcard Fee	$0.00	$0.00	$8,568.00
Office machines	$2,147.00	$3,835.73	$4,150.00
Public hearing	$0.00	$0.00	$344.00
Audit	$3,000.00	$0.00	$3,075.00
Accounting	$13,616.00	$19,614.09	$10,446.00
Legal	$14,179.00	$15,827.59	$24,684.00
Litigation	$0.00	$3,052.56	$4,505.00
Insurance	$0.00	$7,949.41	$6,147.00
Engineering	$5,500.00	$9,351.42	$6,086.00
Contractual Payroll	$0.00	$0.00	$1,147.00
Contractual Economic Development	$0.00	$0.00	$0.00
Contractual - Water	$1,465.00	$2,397.00	$12,530.00
IT Maintenance	$9,661.00	$16,285.98	$7,512.00
Hardware Costs	$0.00	$0.00	$1,915.00
Software Costs	$0.00	$0.00	$4,904.00
Communications	$0.00	$4,832.14	$0.00
Telephone	$3,000.00	$0.00	$1,398.00
Cell Phones	$1,394.00	$0.00	$0.00
Shop Supplies	$0.00	$0.00	$0.00
Administration Building	$6,640.00	$1,093.58	$13,238.00
Public Works Building	$5,860.00	$0.00	$4,240.00
Vehicle Insurance	$1,000.00	$0.00	$2,100.00
Vehicle Maintenance	$1,171.00	$4,963.03	$1,752.00
Fuel and Oil	$6,428.00	$5,630.82	$5,170.00
Equipment Maintenance	$0.00	$2,936.09	$0.00
Tower Maintenance	$4,113.00	$0.00	$37.00
Meter Maintenance	$1,944.00	$1,773.18	$6,578.00
Utilities	$5,936.00	$11,250.21	$6,023.00

Equipment purchased	$0.00	$0.00	$0.00
Capital Purchases	$19,513.00	$4,059.55	$3,680.00
CIP Water	$23,938.00	$0.00	$0.00
Existing Bond Principal Payment	$172,500.00	$175,000.00	$229,313.00
Interest	$122,000.00	$120,500.00	$128,199.00
Bond Fees	$6,500.00	$2,500.00	$10,859.00
Transfers Out	$0.00	$13,500.00	$193,105.00
Amortization			$1,563.00
Subtotal	**$696,042.00**	**$677,482.09**	**$970,952.00**
Total Expenses	**$1,082,962.00**	**$1,111,427.66**	**$1,413,300.00**
Net Revenue	**($104,738.00)**	**($114,632.96)**	**($352,631.00)**
Ending Fund Balance	**$1,161,548.79**	**$1,046,915.83**	**$883,608.00**

Table VIII.2 shows the breakdown of current City water rates. According to the "Water Rate Survey Results 2012" published by the Missouri Rural Water Association, the average Missouri city customer was charged $32.14 for 5,000 gallons. The range of survey results was from $9.50 to $93.78 for 5,000 gallons. The average minimum charge for cities was $13.56 per month, with a range from $2.75 to $46.12 per month.

Table VIII.2. Current Water Rates

Unit	City of Peculiar
Surcharge (Monthly Minimum Charge) 0 to 1,000 gallons	$17.21
Each additional 1,000 gallons	$12.77
Primacy fee ($3 annual fee/meter to DNR)	$0.25
Monthly bill for 5,000 gallons	$68.54

The City's average monthly bill is greater than the average for respondents to the Missouri Rural Water Association survey. Government funding agencies consider a monthly average water bills that exceed 2% of the median household income as an eligibility factor in determining qualifications for grant funding. The US Census Bureau lists a median household income of $62,654 for the City (listed for the year 2010). Based on the City's income level, 2% of the median household income would equal $104.42 per month. This indicates that the City's water rates are not excessive.

IX. Recommended Improvements:

After reviewing the system with the updated hydraulic model and based upon consultation with operating and management staff, several key improvements were selected. Each item is ranked in priority order. See enclosed System Map for all the improvements listed. Opinions of probable construction cost

are included in Section X.

A. Storage Requirements:

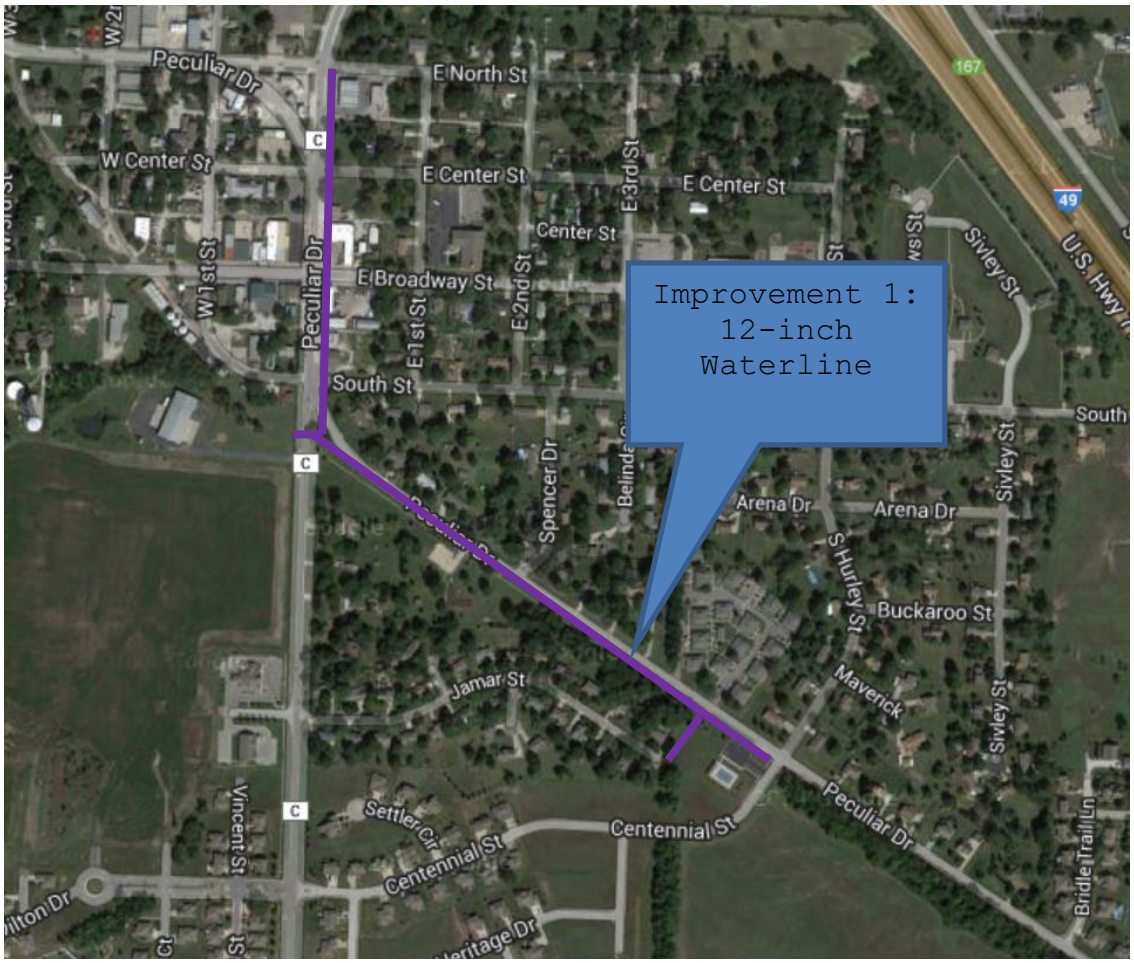
The current storage capacity of the City meets the DNR requirements; however, we recommend the City install passive mixing systems into both storage tanks. Mixing systems include separate inlets and outlets while often utilizing a single manifold pipe within a storage tank. Typically, a passive mixing system will utilize the pressure required to fill the tank to deliver water further away from where the inlet pipe penetrates the tank shell. The separate outlet will then be located apart from the inlet to avoid short-circuiting in the tank (to ensure the last water into the tank is not the first water out of the tank). Mixing systems reduce spikes is disinfection byproducts, disinfectant residual loss, and water age.

Currently, water is fed into the ground storage tank and then repumped into the elevated storage tank. The pumping facilities do not have emergency back-up power and thus the installation of a generator at this location is recommended. The generator should be connected into the City's SCADA system and include an automatic transfer switch. These options will allow the generator to turn on automatically and switch the pumps power source from its existing electrical service to generator.

B. Distribution Improvements:

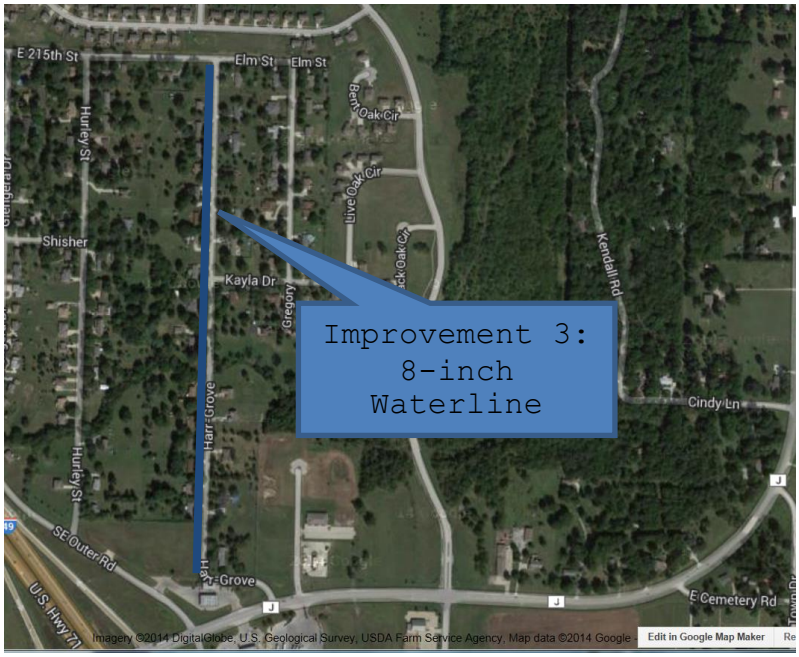
A list of recommended distribution improvements (listed in order of priority) is shown below:

1. Install an 12-inch waterline along Peculiar Drive between the existing 12-inch at the intersection of Peculiar Drive and S. Hurley St. and the waterlines at the intersection of Main St. and E. North Rd., replacing the existing waterlines. This will loop part of the distribution system and replace smaller diameter waterlines.



2. Install 8-inch waterlines within the Spencer Addition along Clairmont St, Soryl Ave, and Hillcrest Drive. These will replace smaller diameter lines and relocate potable water lines greater than 10' from existing sewer lines as required by the DNR.

3. Install an 8-inch waterline along Harr-Grove Rd between Elm St. and Highway J, replacing the existing smaller diameter waterlines that are prone to breaks.

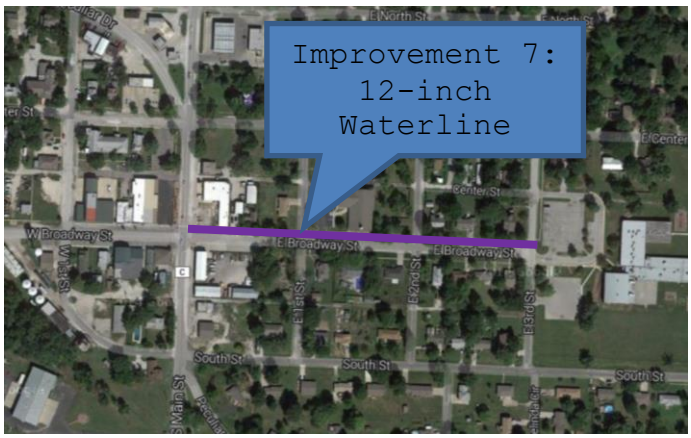


4. Install an 8-inch waterline along Elm St. between Gregory and School Rd, replacing the existing smaller diameter waterlines that are prone to breaks.

5. Install an 8-inch waterline along Gregory between Elm St. and Harr Grove Rd, replacing the existing smaller diameter waterlines that are prone to breaks.

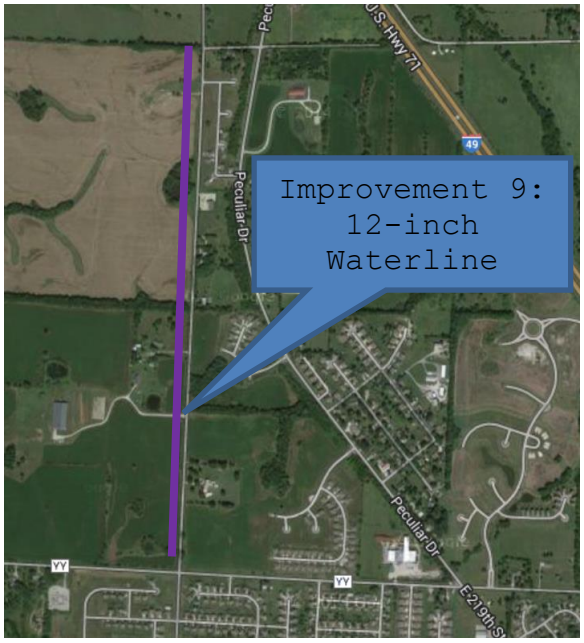
6. Install a 12-inch waterline along Peculiar Dr. between Maple Ave. and Willow St., replacing the existing smaller diameter waterlines and increasing flow to the subdivisions in the north area of Pressure Zone 3.

7. Install a 12-inch waterline on along E. Broadway St between E. 3rd St. and N. Main St., replacing the existing smaller diameter waterline.



8. Install a 12-inch waterline along E. 3rd St. between E. South St. and Legend Ln., replacing the existing smaller diameter waterline.

9. Install a 12-inch waterline along Harper Rd. between Master Meter No. 1 and the existing 12-inch waterline north of State Route YY. This waterline will increase the pressures in Pressure Zone 1 so that the minimum available is above 35 psi. The pressure loss in the supply line will decrease to 19 psi from 38 psi. This improvement is not necessary if the City opts for the direct KCMO water supply source.



All improvements are also shown on the enclosed distribution system map.

Per the DNR *Minimum Design Standards for Missouri Community Water Systems* effective December 10, 2013, Section 8.1.4c states "In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-ins whenever practical."

The following improvements will increase system looping and should be made as City funds allow or when other projects occur in the area.

10. Looping Improvements to remove dead-end lines from distribution system and improve water loss:

a. 1st St. south of Elm St. – 8” Loop

b. Cindy Lane, west of Highway J –8” Loop

c. Centennial Farms as subdivision grows (Centennial Circle, Pioneer Dr. and Legacy Drive) – 8” Loop

d. Alley south of W. Broadway St. and west of N. Main St. – 8” Loop

e. Alley north of W. Broadway St. and west of N. Main St. – 8” Loop

f. W. 2nd St. , north of W. Center St. – 6” Loop

g. E. 2nd St., north of E. Broadway St. – 6” Loop

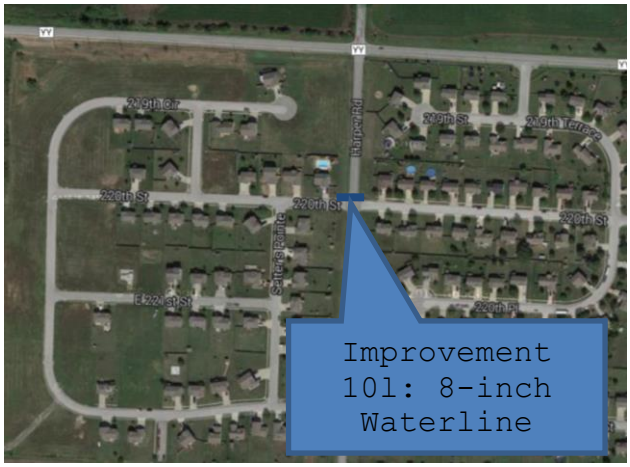
h. W. 2nd St. , north of W. Broadway St. – 6” Loop

i. Cross W. North St. at W. 1st St. – 6” Loop

j. Cross Schug Ave. to 6” waterline, south of Summerskill Rd – 8” Loop

k. Cross State Route YY at Quail Ridge Rd – 8” Loop

l. 220th St, across S. Harper Rd – 8” Loop



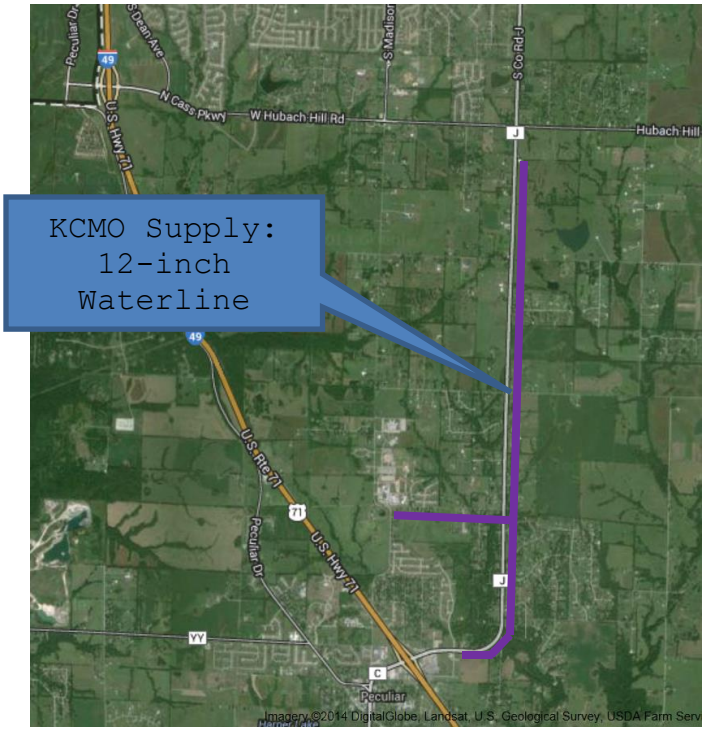
m. Cross S. Harper Rd north of State Route YY at existing 2” waterline – 6” Loop

Cost opinions for these improvements are located in Appendix C.

None of the waterline improvements will increase the operating and maintenance costs for the City. Many of them will reduce the line breaks and water loss experienced within the City and may thus lower water purchase costs and repair costs. Distribution system water quality will be enhanced by looping dead end mains.

C. Supply Improvement:

Based upon discussions the City had with potential water suppliers, the direct KCMO source is the best long term option for the City. This will provide the City with a reliable source of water for the foreseeable future and remove the potential for being charged to replace and upgrade shared facilities within the Cass PWSD No. 2 system. If Kansas City makes internal improvements to facilities that serve the wholesale customers, the cost is shared by all customers of the system. Changing water supply supplier from Cass 2 to KCMO (direct) should not increase the City’s operating and maintenance budget.



D. Emergency Interconnect:

Currently, the City has two emergency connections to water suppliers (Cass County PWSD No. 10 and No. 7). If the City connects directly to KCMO, the City should maintain its connections with Cass County PWSD No. 2 and begin negotiations on an emergency supply contract. This would be to the mutual benefit of both utilities.

E. Valves and Flushing Hydrants:

Currently the City has many water mains that cannot be isolated during main breaks or other emergencies. The enclosed Improvement Map details where additional valves should be installed as the City can. The map also indicates a few places where additional fire hydrants should be installed to allow areas to be flushed. These are also improvements that should be made as City funds allow, or when other projects occur in the area.

F. Security

Currently the altitude valve located at the ground storage tank and elevated storage tank site is located outside of the fencing, near the access road. To increase security, the valve can be relocated to a site that is fenced-in or where a fence can be added.

Unauthorized entry alarms at the master meter vaults currently only alert Cass PWSD No. 2. With SCADA modifications, these alarms could be added to the City's SCADA system, as well as an

unauthorized entry alarm at the City's pump station.

X. Opinions of Probable Cost

A summary of the opinions of cost for the system improvements outlined in Section IX (except looping improvements) is shown below in Table X.1. These recommended improvements have been prioritized according to the hydraulic analyses in Section IV. As development occurs, the timing of all or part of these improvements may be altered according to system requirements. A detailed opinion of probable cost for each improvement is included in Appendix C of this report.

Table X.1 - Cost Opinion of Recommended Improvements

Improvement	**Probably Cost**
Supply Improvement	$3,772,389
Improvement 1	$640,393
Improvement 2	$369,941
Improvement 3	$292,059
Improvement 4	$261,482
Improvement 5	$184,248
Improvement 6	$452,156
Improvement 7	$184,046
Improvement 8	$278,154
Tank Mixing Systems (2)	$100,000
Emergency Generator	$35,000
Total	$6,569,868

XI Funding Options

USDA – Rural Development

Rural Development Water and Wastewater loan and grant funds may be used to construct, enlarge, extend, or improve water and waste water systems in communities with a population of 10,000 or less. Funds are available to public entities such as municipalities, counties, special-purpose districts and Indian tribes. In addition, funds may be made available to corporations operated on a not-for-profit basis. Priority is given to public entities in areas with less than 5,500 population to restore a deteriorating water supply, or to improve, enlarge, or modify a water facility or inadequate waste facility. Also, preference is given for projects that merge small utilities and projects serving low-income communities. Eligibility for grant and loan funding is based on median household income (MHI), project costs and current rates.

Rural Development offers up to 75 percent grant funds in combination with loan funds for entities that qualify. Interest rates depend upon the MHI of the project area. These are market rate, intermediate rate, or poverty rate. The 2000 median household income (MHI) for Peculiar was $44,768 according to U.S. Census Bureau information. RD is still using 2000 MHI figures in funding determinations. Since the State MHI exceeded the State Amended 2000 census figure of $39,043, the City would only be eligible for 100% loan, at the current market interest rate of 4.375%. When RD adopts the 2010 data, the City's eligibility will not improve (City 2010 MHI $62,654 to State's 2010 MHI of $47,333). The 33-year loan amortization, with first two years interest only, results in lower annual payments when compared to other bond financing options. Security for a RD loan is normally provided by a revenue bond passed by a simple majority of votes cast.

State Revolving Fund and Rural Water Grant Program

This program is available through the DNR for both water and wastewater projects. The market interest rate is subsidized and the loan term is limited to a maximum of 20 years. Applicants are scored based on need. The annual application deadline is generally November 15th. Treatment and distribution projects are eligible, but reservoir projects are not. The current SRF drinking water loan fund interest rate is approximately 2.5% with fees included. Security for an SRF loan is also provided by voter approved revenue bonds. The City is currently on the list for this funding source for the direct KCMO source project (See Appendix D). City will need to advertise, conduct, and document an environmental assessment public hearing for this funding source.

Private Financing/Bond Issue

This is a common method of obtaining long term financing for projects. These bonds are retired from water revenues generated by the rate structure. Current bond rates for 20-year bonds are in the range 3.75-4.50%. The interest rates are low enough to be competitive with funding agencies such as Rural Development; however, the shorter term will result in higher annual payments. Again, a revenue bond issue must be approved by a majority of the votes cast in an election. The private market also requires higher reserve requirements to be generated by the rate structure. Using private financing may streamline project development by minimizing the number of review agencies before the project is approved for construction.

Table XI.1 details the effects these loans would have on the City's current water rates if all improvements were constructed and all 1,537 current customers purchased 5,000 gallons for the course of the loan. The last two columns represent a $1.71 reduction in price per 1,000 gallon ($8.85 decrease for 5,000 gallons) if the City were not paying the Cass No. 2 rate and only the Kansas City rate per 1,000 gallons.

Table XI.1 - Current Rates and Required Rate Adjustments

Current Avg. Water Usage per month per meter (gallons)	Average Residential Bill	Current Number of Residential Meters				Average Residential Bill minus current Cass 2 charges	
5,000	**$ 68.54**	**1,537**					
USDA RD Loan/No Grants - Amount Funded	Interest Rate	Loan Period (Years)	Yearly Payment	Adjusted Average Residential Bill	% Increase 5,000 gallon bill	Adjusted Average Residential Bill with $1.71 per 1,000 gallon reduction	% Increase 5,000 gallon bill
$6,569,868	4.375%	33	**$379,898**	**$ 89.14**	30%	**$ 80.59**	18%
SRF Loan/No Grants - Amount Funded	Interest Rate	Loan Period (Years)	Yearly Payment	Adjusted Average Residential Bill	% Increase 5,000 gallon bill	Adjusted Average Residential Bill with $1.71 per 1,000 gallon reduction	% Increase 5,000 gallon bill
$6,569,868	2.50%	20	**$421,438**	**$ 91.39**	33%	**$ 82.84**	21%
SRF Loan/ with $500,000 Grant - Amount Funded	Interest Rate	Loan Period (Years)	Yearly Payment	Adjusted Average Residential Bill	% Increase 5,000 gallon bill	Adjusted Average Residential Bill with $1.71 per 1,000 gallon reduction	% Increase 5,000 gallon bill
$6,069,868	2.50%	20	**$389,365**	**$ 89.65**	31%	**$ 81.10**	18%
Private Financing	Interest Rate	Loan Period (Years)	Yearly Payment	Adjusted Average Residential Bill	% Increase 5,000 gallon bill	Adjusted Average Residential Bill with $1.71 per 1,000 gallon reduction	% Increase 5,000 gallon bill
$6,569,868	4.25%	20	**$494,184**	**$ 95.33**	39%	**$ 86.78**	27%

XII. Conclusion

Sections VI and VII discussed the City's future water supply options which included continuing with their current source (Cass #2) or purchasing water from a new source directly (Kansas City, Tri-County Water Authority, or WaterOne of Johnson County, KS). A weighted decision matrix was developed to help determine the best option for the City's water needs going forward. The matrix showed that purchasing water directly from Kansas City would be the best option for the City's water needs moving forward. Kansas City was the highest rank supplier based in the following criteria of the matrix:

- Lowest costs for 20-year life cycle analysis
- Lowest water rates

Hydraulic modeling showed that converting to a KCMO direct supply and utilizing one pressure zone (instead of the current four) would increase the low and average pressures within the distribution system but would reduce the highest pressures (down to approximately 99 psi from approximately 115 psi). All pressures would be within MDNR recommendations.

A yearly water cost opinion was then developed to compare KCMO to Cass 2 for the years 2018 and 2033. The Cass 2 water costs included yearly increases of 5% for the water rate and 3% for operating and maintenance costs. KCMO costs included an annual rate increase of 5% and a loan repayment of $241,988 per year. Initially KCMO annual water costs were higher than Cass 2; however, during the year 2033 the KCMO water cost was approximately $200,000 less than those from Cass 2.

With the City already on the SRF funding list, we recommend the City continuing talks with KCMO to get an acceptable water purchase agreement agreed upon.

Distribution system improvements were discussed in Section IX. These distribution system improvements initially focused on replacing deficient waterlines, followed by replacing small diameter waterlines, and finally looping and removing dead-ends. The City should prioritize the following five projects and strive to complete them as available funds and governmental assistance allows:

- Install a 12-inch waterline along Peculiar Drive from Hurley St. to Main St. and then north to E. North St.
- Installing 8-inch waterlines within the Spencer Addition Subdivision

- Replace the existing waterline on Harr Grove Rd.
- Replace the existing waterline on Elm St.
- Replace the waterlines on Gregory St. and Kayla Dr.

We recommend the City begin the application process for both SRF and RD funding for these projects.

Future waterlines that are not a part of the recommended improvements, but that are constructed inside the City, should be a minimum of 8-inches diameter in size. Also, as improvements and upgrades are constructed on the system, any lines 2 or 3-inches in diameter should be evaluated for replacement. Also, dead end mains should be looped to reduce water consumed by excessive flushing.

While this report evaluated the potential for system growth in the next twenty years, individual impacts of new subdivisions, industrial customers, and other large scale demands or system improvements should be reviewed on a case-by-case basis and compared with this report and previous studies to determine what improvements are necessary.

APPENDIX A

Water Purchase and Sales Contracts

APPENDIX B

Hydraulic Analysis Reports

APPENDIX C

Opinions of Probable Cost

APPENDIX D

SRF Intended Use Planning List Letter