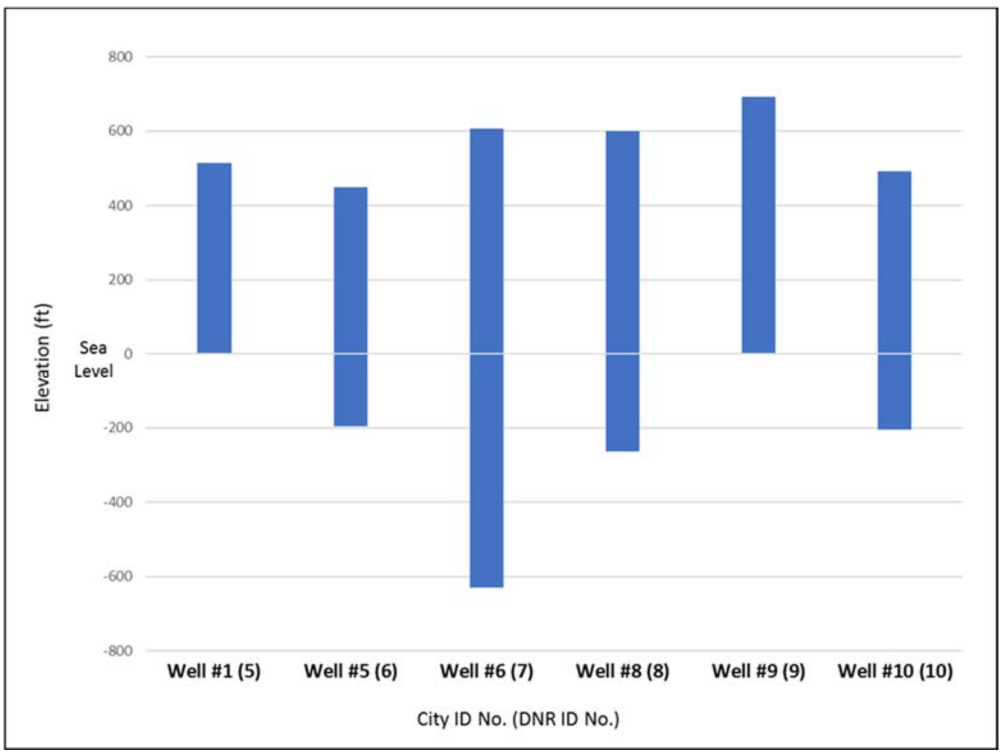
Section 1. EXECUTIVE SUMMARY

The City of Eureka, MO operates a public water system (PWS) in the greater St. Louis metropolitan area, serving a population of about 10,000 plus commercial and industrial customers. The Eureka PWS includes six (6) wells located throughout the community; each well providing groundwater for its adjoining ion exchange (IX) water treatment plant (WTP). Softened potable water is disinfected and fluoridated at each WTP before entry into the City's distribution system. The distribution system consists of eight (8) pressure zones which are maintained by eight (8) booster pump stations with seven (7) ground storage tanks. Although the PWS utilizes a decentralized treatment approach to feed various pressure zones, valving exists to interconnect adjoining pressure zones allowing uninterrupted service during maintenance of key infrastructure. The recent average water demand for the City is 1.6 million gallons per day (mgd). Customers have complained about taste, odor, and household plumbing corrosion. The PWS has also identified concerns with water age, and ineffective tank mixing, that may also be related to customer complaints.

The six wells range in pumping capacity of 600 to 1,000 gallons per minute (gpm). The wells are open bottom hard rock wells ranging in depth from 500 to 1,235 feet. The following figure presents a representation of the well head elevation and bottom of well elevation for each well.



The geological formations in the area is known to yield highly mineralized water with elevated levels of total dissolved solids (TDS), and hardness. The water distributed by the PWS meets all primary (health related) drinking water standards. However, secondary (aesthetic) parameters that are likely contributing to the taste complaints, and are related to the corrosion issue are summarized below.

CONSTITUENT		RAW WATER RANGE		FINISHED WATER RANGE		MCL
		MIN	MAX	MIN	MAX	
Field Parameters						
pH		6.79	6.99	6.79	6.99	
Other Parameters						
Solids, Total Dissolved	mg/L	364	1430	404	1110	500
General Chemistry						
Chloride	mg/L	25	488	34	487	250
Hardness, Total as $CaCO_3$	mg/l	300	399	23	151	
Sulfate	mg/L	24.2	63.3	24.2	64.1	250
Inorganics, Metals						
Sodium, total	mg/L	29	222	147	340	

As can be seen from the data, the Ion Exchange treatment process is softening the water, as it was intended. However, an IX process will not remove dissolved solids or chlorides. A membrane treatment process such as Reverse Osmosis (RO) or electrodialysis reversal (EDR) is required. High TDS drinking water may have a salty or brackish taste, result in scale formation, and decrease the efficiency of hot water heaters and other home appliances. Chloride can contribute to taste issues and is associated with corrosion. Sulfate levels in the water are well below the secondary standard, so this constituent is unlikely to be a direct taste or odor contributor. However, even low concentrations of sulfate can become a source of taste and odor with hot water heaters. The pH is low, and is also contributing to the corrosion. There is no drinking water standard for sodium although it can contribute to taste, and may be of concern to people with heart related issues. The water quality parameters were examined for corrosive indexes, and found to be aggressive (corrosive).

The Eureka PWS already implements a water main flushing program, but is planning a more comprehensive program. It is recommended the City develop a hydraulic model of the system to help in calculating water age, and determine the best approach to flushing. If is also recommended that water quality parameters be monitored to further understand the results of the flushing.

There are various methods and equipment available to enhance mixing in tanks to prevent water stagnation in the upper portions of the tanks. In the City's case incorporating drop-in mechanical mixers will likely be the simplest and most cost effective. It is anticipated the cost will be in the range of $10,000 to $12,000 per tank for the mixer equipment, electrical wiring and conduit, and installation. The mixer motors are small, so there will be a minimal ongoing electrical cost, but it will be relatively small at around a couple hundred dollars per year per tank.

Softening the water makes it more aggressive. It is recommended that a finished water hardness of 170 mg/I (10 grains) be targeted to help reduce the aggressiveness, and reduce the amount of chemical need to stabilize the water.

To produce a slightly scale forming water (non-corrosive) will require pH adjustment to near 8.0 for each well site. One option is to feed sodium hydroxide (caustic soda). The dosages required are quite high and range from 45 to 90 mg/l. This will require approximately 5,000 gallons of chemical per month with an overall annual cost of around $275,000 (purchased at 50% solution). If aeration is also implement, as discussed below, the projected chemical use is reduced to around 2,100 gallons per month with an annual cost of around $137,000. A high-level cost estimate for a small building to house the chemical storage tanks and feed pumps and associated facilities is $1.1M for all six plant sites.

To help reduce the amount of caustic soda required an option is to aerate the water to allow a portion of the dissolved carbon dioxide to be removed. Removing the carbon dioxide will result in a raising of the pH. Aeration alone will most likely not raise the pH enough, so feeding caustic soda will still be required, but at a lesser amount. There are various forms of equipment that could be implemented for aeration. An option that would have merit for those plant sites will on-site storage tanks is an in-tank floating aeration system. For the three plant sites without on-site tanks adding aeration is more costly. High level costs to implement aeration for just the three sites with on-site tanks is $1.05M, and for the other three sites $1.63M for an overall total of $2.68M.

The table below presents the capital cost, annual chemical cost, and present worth over various time periods. The present worth analysis indicates the following:

- Investing in aeration provides a long-term cost reduction.
- It will take between 10 and 15 years to see the capital investment in aeration to pay off.

50% Caustic Soda Purchase						
Description	**Construction Project Cost**	**Annual Chem. Cost**	**Present Worth 5 Years**	**Present Worth 10 Years**	**Present Worth 15 Years**	**Present Worth 20 Years**
Equation Factor[1]			4.7135	8.9826	12.8493	16.3514
No Aeration – Chem. Feed Only	$1,066,610.00	$275,023	$2,362,932	$3,537,035	$4,600,467	$5,563,626
With Aeration + Chem. Feed	$2,685,070.00	$137,512	$3,333,231	$3,920,282	$4,451,999	$4,933,578

If reduction in TDS, and chlorides is a path the City would like to go down, very high-level cost estimates for the RO equipment at each plant site is in the range of $300,000 to $600,000 per site depending on the processing capacity and water quality at each site. In addition to the RO equipment cost for removal of the existing IX equipment, piping and electrical modifications, and other required changes needs to be included. An overall cost to implement RO treatment was not developed. In addition, aeration and a lesser amount of caustic soda feed would still be required.

See Section 6 of the report for Recommendations and Time Frames.

Section 6. RECOMMENDATION

6.1. Recommendations

The following recommendations are provided:

1. Conduct field jar testing to confirm the calculated dosages of caustic soda are correct.

2. Conduct field testing with SolarBee to confirm the pH change noted through aeration.

3. After steps 1 and 2 are complete, adjust cost estimates as appropriate.

4. Concurrently with recommendations 1 through 3, it is recommended the City engage with a consultant and the Missouri Geological Survey to review details of the water producing formation, well construction information, and any water quality and water quantity testing completed on each well from various depths. It may be prudent to compete quality testing of some, if not all, of the wells at various depths. This testing will come at a cost, so estimates from a well driller will be required. An option may be to blank off sections of a well contributing the poorest water quality. However, the blanking off a section, could impact the well production rate. Well 6, should be of particular focus, since it has a substantially lower bottom elevation than the other wells.

5. The City has obtained a MO-DNR permit to add caustic soda feed equipment at each plant location. It is recommended that a caustic soda feed system be installed at one of the plants. Operate for several months, and summarize both effect on finished water quality, and customer comments. Feeding 30% caustic soda without aeration to Well 6 will have an estimated monthly cost of $5,200+.

6. Pending the outcome of the prior recommendations it may be necessary to modify the caustic soda construction permit to accommodate greater feed quantities than may have been anticipated previously. An in-depth preliminary design for caustic soda feed at each plant site would be completed. This preliminary design will establish if a separate building is required at each site, what site modifications will be required to accommodate the chemical feed building, and preliminary electrical design. Updated cost estimates would need to be developed based on the preliminary design.

7. Develop aeration options to a preliminary design level. Updated cost estimates would need to be developed based on the preliminary design.

8. City decides what treatment processes, and which sites to move forward to full final design and construction. A phased approach may be appropriate

9. Maintain closer control over the hardness level being distributed. Target 170 mg/l (10 grains).

10. Continue with and enhance the flushing program throughout the distribution system. It is recommended the City develop a hydraulic model of the system to help in calculating water age, and determine the best approach to flushing. If is also recommended that water quality parameters be monitored to further understand the results of the flushing.

11. Conduct depth temperature profiling of storage tanks. Install mechanical mixers in any tanks showing signs of insufficient mixing. Conduct depth temperature profiling of storage tanks following installation of the mixers.

12. Provide periodic public education in relation to use of in-home water softeners to have them properly set, given the incoming hardness from the PWS.

6.2. Time Frame

The following general time frame is anticipated.

Recommendations 1, 2, and 3: Within 45 days.

Recommendation 4: Concurrent with 1 through 3. If field testing is complete this step could take more time. Anticipated time frame of 45 to 75 days.

Recommendation 5: Accounting for planning, installation, and completing the trial, and summary of results, 4 to 6 months.

Recommendations 6 and 7: Within 2 months

Recommendation 8: 6 months to design and permit, 2 months for bidding and executing contract documents, and 6 to 12 months for construction depending on the final improvements and number of sites involved.

Recommendations 9, 10, and 12: Ongoing

Recommendation 11: To account for planning, obtaining a construction permit, and installation the anticipated time frame is within 12 months.