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Tech Memo

Date:	September 25, 2014
To:	Bryan Gongre
Organization:	Utilities Inc. of Pennbrooke
From:	Steve Romano, P.E. and Robbie Gonzalez, P.E.
Re:	Pennbrooke Water System Water Quality Evaluation
CPH Job No.:	U07138

Introduction

The purpose of this technical memorandum is to provide Utilities Inc. of Pennbrooke with an evaluation of water quality concerns within the Pennbrooke Water System (FDEP Potable Water System #3354653) associated with iron and hardness levels. The evaluation provides potential options to consider in the short-term and long-term. The following tasks were performed for this evaluation:

- Conducted water quality testing of the source wells, treatment/storage and distribution system to determine the iron and hardness concentrations.
- Suggested economically feasible options to consider to further enhance water quality.

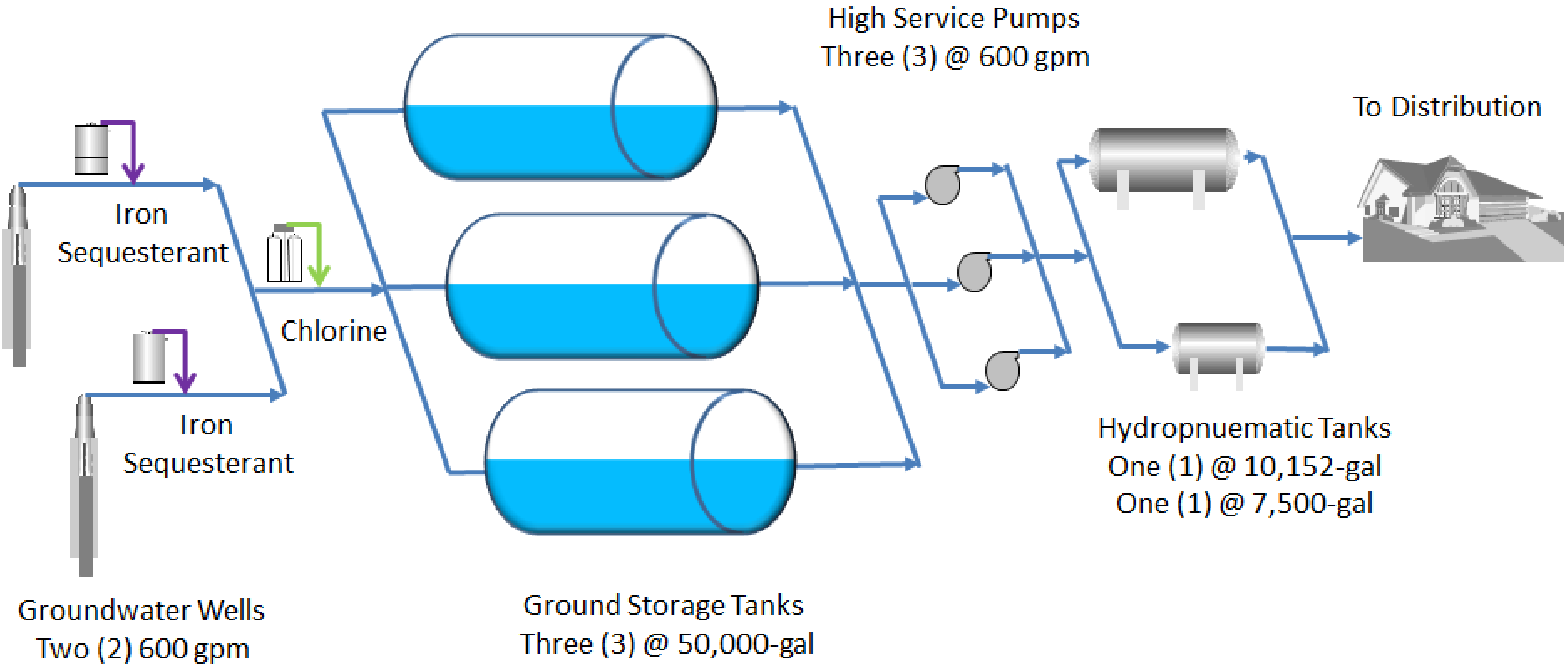
The goal of this technical memorandum is to provide context and guidance regarding potential improvements in water quality for the Pennbrooke Water System. Consumer complaints associated with water quality in the service area are frequent. According to utility staff, the water quality concerns are most commonly related to iron and hardness.

Background

Figure 1 presents the process flow diagram for the 1.296-mgd Pennbrooke Water Treatment System. Source water is withdrawn from two (2) Upper Floridan Aquifer wells, each rated at 600 gpm. Iron sequesterant is applied at a dose of 1.2 mg/L to maintain iron compliance below 0.3 mg/L in the distribution system. Liquid chlorine (sodium hypochlorite) is added for disinfection in compliance with FDEP's rules and regulations.

The disinfected water is stored in three (3) 50,000-gallon storage tanks. The two (2) wells are activated when the water level in the storage tanks drop to a preset level. Finished water is pumped through two (2) hydropneumatic storage tanks, 7,500 gallons and 10,152 gallons, to maintain a stable system pressure.

FIGURE 1: Pennbrooke Water System Process Flow Diagram



Water Quality Testing Results

On June 4, 2014, water was sampled from the following locations: two (2) source wells; treated water at the point-of-entry to the distribution system (POE); and at two (2) locations in the distribution system (See **Figure 2**). **Table 1** presents water quality sampling results associated with determining typical water treatment options for water utilities in Central Florida. The water quality data are limited to duplicate samples from a 1-day sampling event of the source water, POE and distribution system. Two (2) water quality parameters of concern were identified for the Pennbrooke Water System and are summarized as follows:

1. **Iron** (See **Figure 3**) – Iron treatment is presently employed at the Pennbrooke Water System because both source water wells exceed the iron secondary water quality standard of 0.3 mg/L. Secondary water quality standards are set as guidelines to assist public water systems in managing drinking water for aesthetic considerations such as taste, color and odor. Secondary water quality standards are not considered to present a risk to human health at the secondary maximum contaminant level (SMCL).

   The iron sequesterant successfully reduces the dissolved iron at the POE to below the secondary water quality standard of 0.3 mg/L. Also, the total iron concentration is maintained in the distribution system below the secondary water quality standard. The increase in turbidity plus elevated total iron at the POE may indicate iron precipitate is accumulating at the bottom of the storage tanks.

   The dissolved iron is sequestered at the POE and then carried through the distribution system. As water ages and/or water temperature increases in the distribution system the sequestered iron has the potential to release a precipitant. The sequestration phenomenon is demonstrated by the increase in ortho-phosphate concentration whereby the polyorthophosphate dissolved iron complex converts to ortho-phosphate and releases dissolved iron. Therefore, in remote areas with high water ages or areas with increased temperature, dissolve iron may release from the sequesterant and thereby oxidize and precipitate iron when in contact with chlorine and air causing iron staining.

   Iron precipitation at the treatment plant may be forming and settling in the tanks as a result of the sequesterant application dose/type and or sequestrant application location relative to chlorine injection. This may possibly explain lower total iron concentration in the well samples when compared to the distribution system samples.

2. **Hardness** - Hardness over 120 mg/L as $CaCO_3$ is considered hard. However, there are no regulatory standards for hardness. Calcium hardness exceeds 120 mg/L as $CaCO_3$ at Pennbrooke. The Langelier Saturation Index (LSI) was calculated to identify whether the water is scale forming relative to hardness and pH. Based upon the pH measured, the LSI appears to be slightly scale forming. Review of regulatory sampling data collected at the POE in 2012 shows a pH value of 7.8.

   Should the pH be higher than recorded during the limited sampling event, then the groundwater may have a higher potential to form scale than predicted.

FIGURE 2: Pennbrooke Water System Sample Locations (June 4, 2014)

Distribution #1:
Lift Station @ 552 Grand Vista Tr.

WTP
- Well #1
- Well #2
- POE

Distribution #2:
Lift Station @ 32302 Oak Park Dr.

:

TABLE 1: Water Quality Sampling Investigation (June 4, 2014)

PARAMETER		Well #1	Well #2	POE	Distribution #1	Distribution #2	Standard/Goal
Field	pH	7.2	7.4	7.45	7.25	7.25	**6.5 to 8.5**
	Temperature (^{o}C)	23.9	24.1	25.1	26.3	27.8	**---**
	Dissolved Oxygen (mg/L)	0.3	0.1	5.5	5.9	3.2	**<0.2 at wells**
	Turbidity (NTU)	0.4	0.3	0.8	0.5	1.5	**<0.3 at POE**
	Sulfide (mg/L)	0.05	0.06	---	---	---	**<0.3**
	Chlorine Dose (mg/L)	---	---	5.5	0	0	**---**
	Chlorine Residual (mg/L)	---	---	1.8	0.6	0.6	**0.5 to 4 mg/L**
	Inhibitor Dose (mg/L)	1.2	1.2	---	---	---	**---**
Laboratory	Ortho Phosphate (mg/L)	---	---	---	0.14	0.40	**---**
	TDS (mg/L)	238	229	246	240	244	**<500 mg/L**
	Calcium (mg/L as $CaCO_3$)	183	172	180	181	178	**---**
	Magnesium (mg/L as $CaCO_3$)	22	23	23	23	23	**---**
	Total Hardness (mg/L as $CaCO_3$)	205	195	203	204	201	**100 to 120 mg/L as $CaCO_3$**
	Alkalinity (mg/L as $CaCO_3$)	171	160	170	169	165	**100 to 120 mg/L as $CaCO_3$**
	LSI	(0.05)	0.16	0.24	0.05	0.06	**0.10**
	Chloride (mg/L)	10	10	16	15	15	**<250 mg/L**
	Sulfate (mg/L)	0.3	0.6	0.4	0.4	0.6	**<250 mg/L**
	Sodium (mg/L)	6	6	10	9	9	**<160 mg/L**
	Total Iron (mg/L)	0.42	0.44	0.45	0.24	0.26	**<0.3 mg/L**
	Dissolved Iron (mg/L)	0.41	0.38	0.03	0.08	0.17	**---**

FIGURE 3: Iron Concentrations from Water Quality Sampling Investigation (June 4, 2014)

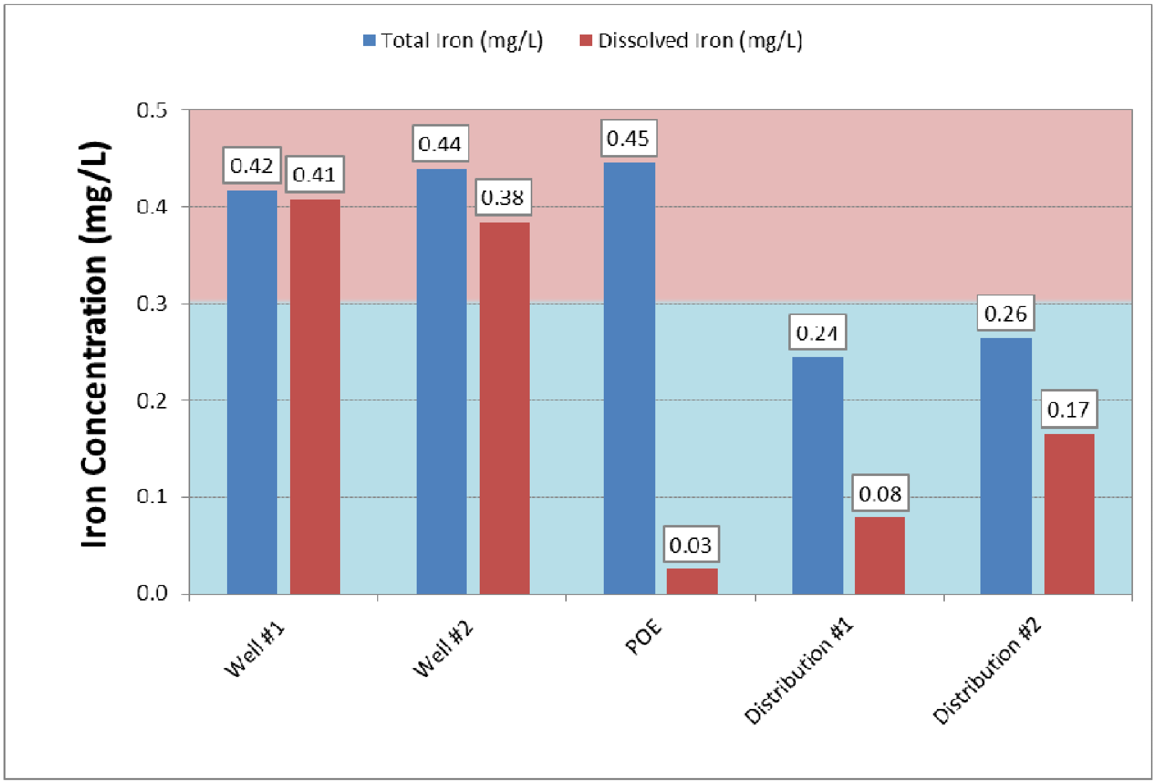


Table 2 presents potential treatment options to remove/reduce iron and hardness in an effort to address consumer water quality concerns.

1. **Iron Sequesterant**

   Water containing a dissolved iron concentration less than 1 mg/L may be treated using a food-grade polyphosphate compound. Once the sequesterant is fed into the water using a chemical feed pump, the phosphate chemical sequesters (“coats” and “ties up”) the dissolved iron ions, preventing oxidation and formation of iron colloids or particles. Sequestering prevents the staining effect but does not actually remove iron. Over time the polyphosphate reverts to ortho-phosphate releasing the sequestered dissolved iron. Also, phosphate compounds are not stable at high temperatures, and if the water is heated or boiled, the phosphates will break down and release iron. Then the released dissolved iron will react with oxygen to precipitate and cause staining.

2. **Greensand Oxidizing Filters**

   Oxidizing filters, which oxidize and filter iron in one unit, are the most widely used option for managing moderate levels of dissolved iron at concentrations up to approximately 15 mg/L. Because the units combine oxidation and filtration, the units can be used to treat raw water with both dissolved and oxidized iron.

   An oxidizing filter typically contains a filter media of natural manganese greensand or manufactured zeolite coated with manganese oxide. Greensand filter media is periodically reconditioned with potassium permanganate to reform a coating that oxidizes the dissolved iron to form iron precipitate. Then the precipitated iron is filtered out by the greensand filtering media.

   Oxidizing greensand filters require significant maintenance including frequent regeneration with a potassium permanganate solution as potassium permanganate is consumed during oxidation of the dissolved metals. In addition, the units require regular backwashing to remove the oxidized iron particles. The potassium permanganate solution used for regeneration is toxic and must be handled and stored with care. Caution must be exercised with potassium permanganate, as it is both poisonous and a skin irritant

   As an alternative compared to manganese greensand, synthetic zeolite requires less backwash water and softens the water as it removes iron.

3. **Aeration followed by Filtration with BIRM Media**

   High levels of dissolved iron concentrations up to approximately 5 mg/L can be treated with aeration followed by a filtration system. The utility has experience with BIRM media filtration systems, where, air is introduced to the hydropneumatic tank to maintain system pressure with the added benefit of imparting dissolved oxygen to react with the dissolved iron. Then water flows through a pressure filter with BIRM media to remove oxidized particles of iron.

   Periodic filter backwashing is the most important maintenance step in optimizing operational performance. Backwash water containing chlorine may be detrimental to media life. Aeration may be inefficient if the source waters contain complex organic compounds of iron or iron bacteria that may clog the aspirator and filter.

4. **Chemical Oxidation followed by Sand Filtration**

   High levels of dissolved or oxidized iron greater than 10 mg/L can be treated by chemical oxidation followed by a sand trap filter to remove the precipitated particles. This treatment is particularly useful when iron is combined with organic matter or when iron bacteria are present.

First, water is treated with an oxidizing agent such as ozone, chlorine, or potassium permanganate to convert dissolved iron into solid oxidized forms that can then be filtered through a sand trap filter. Significant retention or contact time is required to allow oxidation to take place. For this reason, a storage tank may be used. If chlorine is used as the oxidizing agent, it may be necessary to install an activated carbon filter to remove taste and odor from residual chlorine left in water after oxidation.

Regular maintenance of this system is required. Solution tanks must be routinely refilled and mechanical filters need to be backwashed to remove accumulated iron particles. If a carbon filter was also installed, the carbon needs to be replaced occasionally as it becomes exhausted. The frequency of maintenance is primarily determined by the concentration of the metals in the raw water and the volume of water treated. If potassium permanganate is used, careful calibration, maintenance, and monitoring of the water treatment equipment is necessary. Caution must be exercised with potassium permanganate, as it is both poisonous and a skin irritant.

5. Ion-Exchange Water Softening

Conventional water softeners are sometimes effective for removing dissolved iron at concentrations up to 5 mg/L. Iron removal is accomplished in the same way as hardness removal in water by an ion exchange process. Iron and hardness are exchanged with sodium using a cationic ion-exchange resin.

Then iron and hardness are removed from the softener resin bed through backwashing and salt regeneration. The efficiency of softeners in removing iron varies depending on the iron concentration, water hardness, and pH. It is important to check the resin manufacturer’s maximum iron removal level recommendations, which typically range from 1 to 5 mg/L, before purchasing the resin. Softeners can clog if levels of oxidized or dissolved iron exceed the manufacturer’s recommended level. Some vendors recommend using special softener salts that contains additives to remove accumulated iron from the resin during regeneration.

One of the major difficulties with ion exchange for controlling iron is that if any oxidation occurs during the process, the resulting precipitate can coat and foul the ion exchange media. Hence, the raw water should not come in contact with any oxidizing agent like air or chlorine before entering the softener. Ion exchange treatment requires an enhanced level of expertise and manpower.

6. Nanofiltration (Membrane Softening)

Membrane softening is used to partially soften water, allowing some minerals to pass into the product water and thus increase the stability of the water. Providing a partial bypass of raw water allows for a more stable buffered water to and prevent aggressive water to the distribution piping material.

Membrane softening can effectively remove hardness and dissolved iron. However, iron oxidized to elemental iron can be detrimental to membrane life. Also, membrane softening continually produces a concentrate waste stream that must be disposed of and can be limited by permitted groundwater withdrawal limits. However, NF concentrate has been proven to be acceptable when blended downstream of reclaimed water supplies as a source of an alternative water supply (AWS).

Membrane softening requires a significantly elevated level of operational expertise compared to all of the alternative treatment options described above.

TABLE 2: Potential Treatment Options to Address Iron and Hardness Control

PARAMETERS		**Treatment**		**Cost Opinion for 1.296 -mgd**		**Operator Skill**	**Residuals Handling**	**Central Florida Utilities**	**Comments**
Treatment Options		**Iron**	**Hardness**	**Capital**	**O&M**	**(1=low, 5=high)**			
1	Iron Sequestrant	🟦 ↓	---	---	$	1	No	Pennbrooke Water System & Seminole County (Apple Valley WTP)	Current treatment for Pennbrooke Water System
2	Oxidizing Greensand Filtration	🟦 ↓	---	$1.1 Mil	$$	2	Yes	Polk County Imperial Lakes	Regengerate Chemical Handling Saftey Issues.
3	Aeration followed by Birm Media Filtration	🟦 ↓	---	$1.0 Mil	$$	2	Yes	Utilities Inc of Florida - Lake Saunders	Utilities Inc familiar with Birm Media
4	Ozone Oxidation followed by Sand Filtration	🟦 ↓	---	$3.2 Mil	$$$	2	Yes	Chlorine Oxidation Previously at Pennbrooke	Assumes ozone instead of Chlorine oxidation
5	Ion-Exchange Softening (50% to 100%)	🟩 ↓	🟦 ↓	$0.7 to 1.1 Mil	$$	2	Yes	Arcadia	IX Regenerate brine disposal needs to be addressed.
6	Nanofiltration (50% to 100%)	▨ ↓	🟦 ↓	$8.8 Mil to $10.3 Mil	$$$$	5	Yes	Pending at Polk County new Central Regional WTP	Concentrate disposal and CUP limitations need to be addressed. Concentrate can be used to supplement Reclaimed Water

Legend:

Treatment Effectiveness:

---	No Change
🟨 ↓	Slightly Effective Reduction
🟩 ↓	Effective Reduction
🟦 ↓	Very Effective Reduction
🟥	Detrimental

Cost:

$	Low
$$	Moderate
$$$	High
$$$$	Very High

Operator Skill: Rule 62-699, F.A.C.

1	Category 5 / Class C
2	Category 4&5 / Class C
3	Category 3 / Class B
4	Category 3&4 / Class B&C
5	Category 2&4 / Class B&C

Cost Opinion

Three (3) potential treatment options were explored in order to generate an opinion of probable construction cost and potential impact to customer rates. Processes further explored include:

a) BIRM Media Pressure Filter (*Iron Removal*)
b) Greensand Filter (*Iron Removal*)
c) Ion-Exchange (*Hardness & Iron Removal*)

Also, additional process upgrades were included which FDEP may include should the permit be opened to meet current rules. Additional ground storage, high service pumping and electrical upgrades were included in the cost opinion to meet the requirements of the rule

Table 3 presents the potential cost opinion for the treatment options explored. Assumptions used to develop the cost opinion can be found in **Appendix A**. Construction costs ranged from $2.1 Mil to $2.4 Mil with an annual cost impact of $479,000 to $598,000, which results in an additional impact cost of $32 to $40 per month to each of the 1,244 connections.

TABLE 3: Cost Opinion of Potential Treatment Options

CONSTRUCTION COST	BIRM Pressure Filter	Green Sand Filter	Ion-Exchange
Ancillary Equipment	$15,000	$52,000	---
Booster Pump Station	$117,000	$117,000	$117,000
Pressure Filters	$963,000	$963,000	$860,000
Media	$50,000	$61,000	$72,000
Backwash Pumping Facilities	$224,000	$224,000	$138,000
Storage & HSP Improvements	$365,000	$365,000	$365,000
Associated Electrical Improvements	$125,000	$125,000	$125,000
Yard Piping (10%)	$173,000	$178,000	$155,000
Contingency (15%)	$305,000	$313,000	$275,000
Engineering (10%)	$234,000	$240,000	$211,000
CONSTRUCTION COST ($)	**$2,337,000**	**$2,398,000**	**$2,107,000**
ANNUAL CONSTRUCTION COST ($/yr)	**$373,000**	**$383,000**	**$337,000**
O&M COST			
Chemicals ($/yr)	---	$94,000	---
Maintenance Materials ($/yr)	$11,000	$13,000	$36,000
Building Energy ($/yr)	$16,000	$16,000	$6,000
Process Energy ($/yr)	$14,000	$14,000	$8,000
Labor ($/yr)	$78,000	$78,000	$92,000
Annual O&M Cost ($/yr)	**$119,000**	**$215,000**	**$142,000**
TOTAL COST			
TOTAL ANNUAL COST ($/yr)	**$492,000**	**$598,000**	**$479,000**
Number of Connections	1,244	1,244	1,244
Cost per Year per connection ($/yr)	$395	$481	$385
Additional Cost per Month Per Connection ($/month)	$33	$40	$32

Suggested Action Items

Based on summary of the water quality and operational aspects of the water system, the following action items were suggested for Utilities Inc. of Pennbrooke to consider when addressing iron and hardness concerns.

Recommendations	Advantage	Disadvantage	Relative Cost	Likelihood of Concern
SOURCE WATER				
• Investigate chemical dosing relative to water quality and well rotation trends.	• Identifies low cost operational changes	• None	Minimal	Low
• Refurbish wells to provide lower iron concentrations while maintaining production capacity.	• Provide higher water quality without major capital improvement	• Hydrogeological formation behavior unpredictability	Moderate	Low
• Replace high iron wells with new wells.	• New wells	• Permitting • New wells and locations may prove not to be suitable	High	High
TREATMENT				
• Establish water quality policy to set goals for Iron and Hardness: ○ Iron < 0.3 mg/L ○ Hardness 100 to 120 mg/L as $CaCO_3$	• Helps set stage for treatment decisions	• None	Minimal	Low
• Review iron sequesterant specification and application relative to chlorine addition	• Identifies treatment efficiency	• None	Minimal	Moderate
• Establish a routine storage tank flushing program to remove oxidized iron precipitate	• Improves on-site water quality	• None	Minimal	Moderate
• Provide advanced treatment to remove iron and hardness with cationic ion-exchange	• Results in reduced iron and hardness	• Residual disposal salt loadings to WWTF after regeneration	Moderate to High	High
• If hardness removal not pursued, provide aerator with BIRM filter media to remove iron	• Lower capital cost compared to cationic ion-exchange.	• Backwash waste disposal	Higher	High
DISTRIBUTION SYSTEM				
• Conduct unidirectional pigging program for areas with unlined cast iron	• Reduces iron release in distribution resulting in higher consumer confidence	• None	Low	Moderate

Recommendations

The following recommendations identify a strategy to improve water quality by addressing iron and hardness concerns.

1. **Establish a water quality policy**. Utility, Inc. of Pennbrooke's water policy goal is to select the most cost effective treatment method to enhance water quality while remaining compliant with regulations. Source water, treatment enhancements and distribution system optimization strategies will be employed to meet the water policy goals.
    a. **Maintain 0.3 mg/L iron standard**. Current treatment meets iron standard.
    b. **Set a target hardness goal of 120 mg/L as $CaCO_3$.** Maintaining a target goal will help prioritize cost effective methods to treat hardness with the potential to also remove iron.
2. **Investigate Iron Sequestering Chemical**:
    a. Dose concentration
    b. Chemical makeup specification
    c. Application location relative to chlorine feed site
3. **Establish routine flushing program for On-site Storage Tanks** to remove oxidized iron precipitates.
4. **Design a BIRM Media Filtration Treatment System to remove Iron.**
    - If hardness removal is pursued, design cationic ion-exchange to remove both iron and hardness.

Closing

With this preliminary evaluation now completed, we recommend the evaluation be presented to the Pennbrooke Home Owners Association (HOA) regarding the following:

- Provide an opportunity to discuss the context of the investigation performed to date relative to iron and hardness water quality.

- Answer questions the utility's customers may have regarding the water quality evaluation.

- Determine a path forward, as well as goals and objectives for addressing iron and hardness water quality.

- Prescribe a treatment strategy and methodology to address iron and hardness water quality.

Should you have questions regarding this evaluation, please contact either Steve Romano or Robbie Gonzalez at (407) 425-0452.

APPENDIX A: Potential Treatment Option Cost Opinion Assumptions

Pennbrook Utities Inc.
BIRM Pressure Filter

Construction Cost (USEPA Cost Curves)

				Assumptions
Air Compressor		$	15,000	78 cfm
Booster Pump Station		$	117,000	1200 gpm
Pressure Filters		$	963,000	1200 gpm @ 5 gpm/sf
BIRM Filter Media	$70	$	50,000	$70 per cf
Backwash Pumping Facilities		$	224,000	15 gpm/sf
Storage & HSP Improvements		$	365,000	250 kgal GST
Associated Electrical Improvements		$	125,000	
Yard Piping (10%)	10%	$	173,000	
Contingency (15%)	15%	$	305,000	
Engineering (10%)	10%	$	234,000	
CONSTRUCTION COST ($)		**$**	**2,337,000**	
ANNUAL CONSTRUCTION COST ($/yr)		**$**	**373,000**	20 yr @ 15%

O&M Cost (USEPA Cost Curves)

Air ($/yr)			0	
Maintenance Materials ($/yr)			$11,000	
Building Energy ($/yr)	$	0.075	$16,000	$0.075/kw-hr
Process Energy ($/yr)	$	0.075	$14,000	$0.075/kw-hr
Labor ($/yr)	$35		$78,000	$35/hr
Annual O&M Cost ($/yr)			**$119,000**	

TOTAL COST

TOTAL ANNUAL COST ($/yr)	**$**	**492,000**	
Number of Connections		1,244	FDEP
Cost per Year per connection ($/yr)	**$**	**395**	
Cost per Month Per Connection ($/month)	**$**	**33**	

Construction Cost (USEPA Cost Curves)

				Assumptions
Potassium Permanganate Feed System		$	52,000	2 oz per cf = 90 lbs per regeneration
Booster Pump Station		$	117,000	1200 gpm
Pressure Filters		$	963,000	1200 gpm @ 5 gpm/sf
Greensand Media	$85	$	61,000	$85 per cf
Backwash Pumping Facilities		$	224,000	15 gpm/sf
Storage & HSP Improvements		$	365,000	250 kgal GST
Associated Electrical Improvements		$	125,000	
Yard Piping (10%)	10%	$	178,000	
Contingency (15%)	15%	$	313,000	
Engineering (10%)	10%	$	240,000	
CONSTRUCTION COST ($)		**$**	**2,398,000**	
ANNUAL CONSTRUCTION COST ($/yr)		**$**	**383,000**	20 yr @ 15%

O&M Cost (USEPA Cost Curves)

Potassium Permanganate ($/yr)			$94,000	1 regeneration per week
Maintenance Materials ($/yr)			$13,000	
Building Energy ($/yr)	$	0.075	$16,000	$0.075/kw-hr
Process Energy ($/yr)	$	0.075	$14,000	$0.075/kw-hr
Labor ($/yr)	$35		$78,000	$35/hr
Annual O&M Cost ($/yr)			**$215,000**	

TOTAL COST

TOTAL ANNUAL COST ($/yr)	**$**	**598,000**	
Number of Connections		1,244	FDEP
Cost per Year per connection ($/yr)	**$**	**481**	
Cost per Month Per Connection ($/month)	**$**	**40**	

Construction Cost (USEPA Cost Curves)

				Assumptions
Booster Pump Station		$	117,000	1200 gpm
Pressure Filters		$	860,000	1200 gpm @ 5 gpm/sf
Cationic Resin	$100	$	72,000	$100 per cf
Spent Brine Disposal Storage & Transfer Pump		$	138,000	6000 gal storage for 4 vessels plus 600 gpm pumping
Storage & HSP Improvements		$	365,000	250 kgal GST
Associated Electrical Improvements		$	125,000	
Yard Piping (10%)	10%	$	155,000	
Contingency (15%)	15%	$	275,000	
Engineering (10%)	10%	$	211,000	
CONSTRUCTION COST ($)		**$**	**2,107,000**	
ANNUAL CONSTRUCTION COST ($/yr)		**$**	**337,000**	20 yr @ 15%

O&M Cost (USEPA Cost Curves)

Salt ($/yr)				
Maintenance Materials ($/yr)			$36,000	
Building Energy ($/yr)	$	0.075	$6,000	$0.075/kw-hr
Process Energy ($/yr)	$	0.075	$8,000	$0.075/kw-hr
Labor ($/yr)		$35	$92,000	$35/hr
Annual O&M Cost ($/yr)			**$142,000**	

TOTAL COST

TOTAL ANNUAL COST ($/yr)	**$**	**479,000**	
Number of Connections		1,244	FDEP
Cost per Year per connection ($/yr)	**$**	**385**	
Cost per Month Per Connection ($/month)	**$**	**32**	