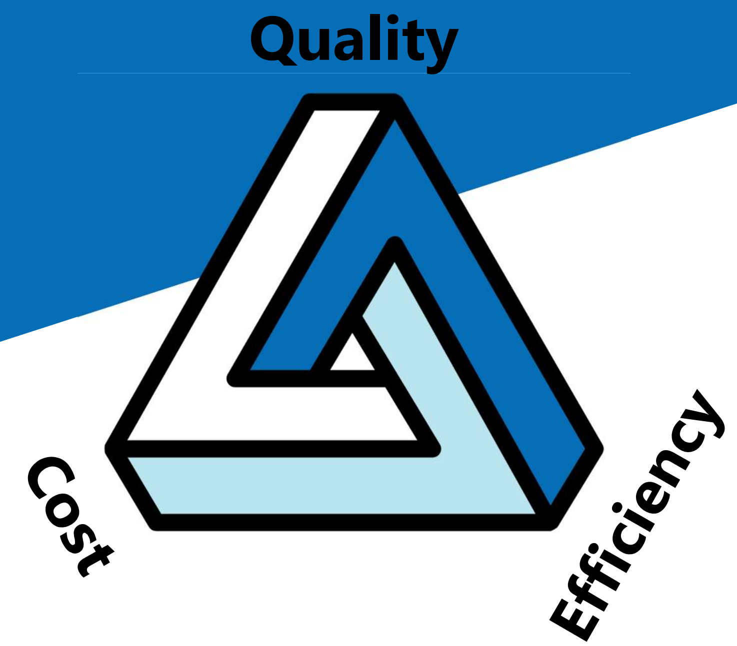
The Impossible Triangle:

Balancing Quality, Efficiency, and Cost
Can You Really Have It All?



T. Hall, Water Utility Director, Fargo
Q. Chang, Senior Advanced Technical Specialist, AE2S

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AE2S Think Big. Go Beyond.

OUTLINE

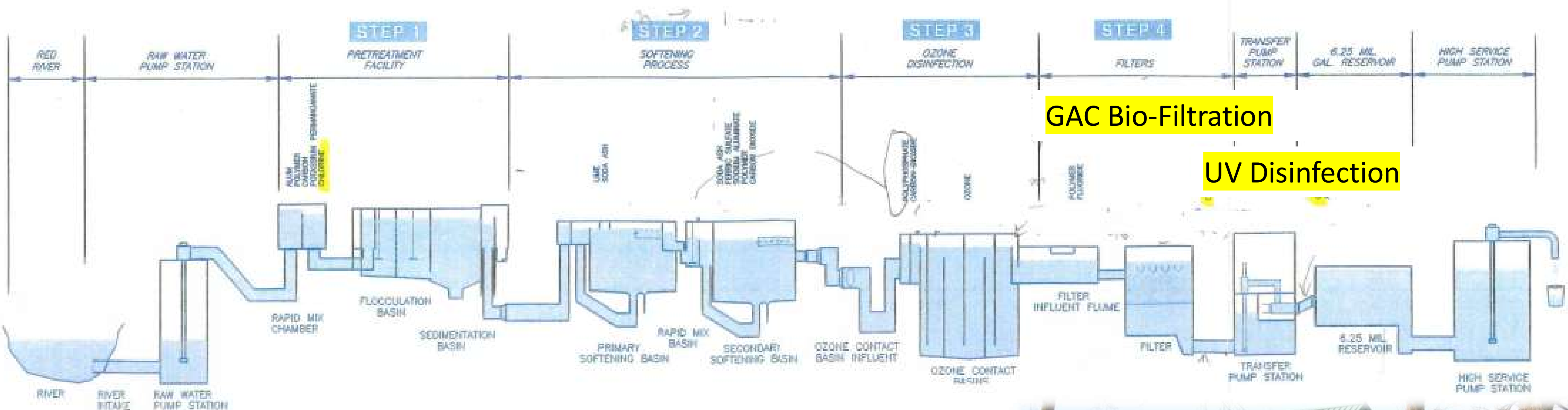
1. **Fargo Water Utility Overview**
   - Water Treatment Plant Overview
   - Raw Water
   - Plant Performance
2. **Impossible Triangle**
   - Quality
   - Efficiency
   - Cost
3. **Strategies and Innovations to Get the Job Done**

Fargo Water Utility Overview

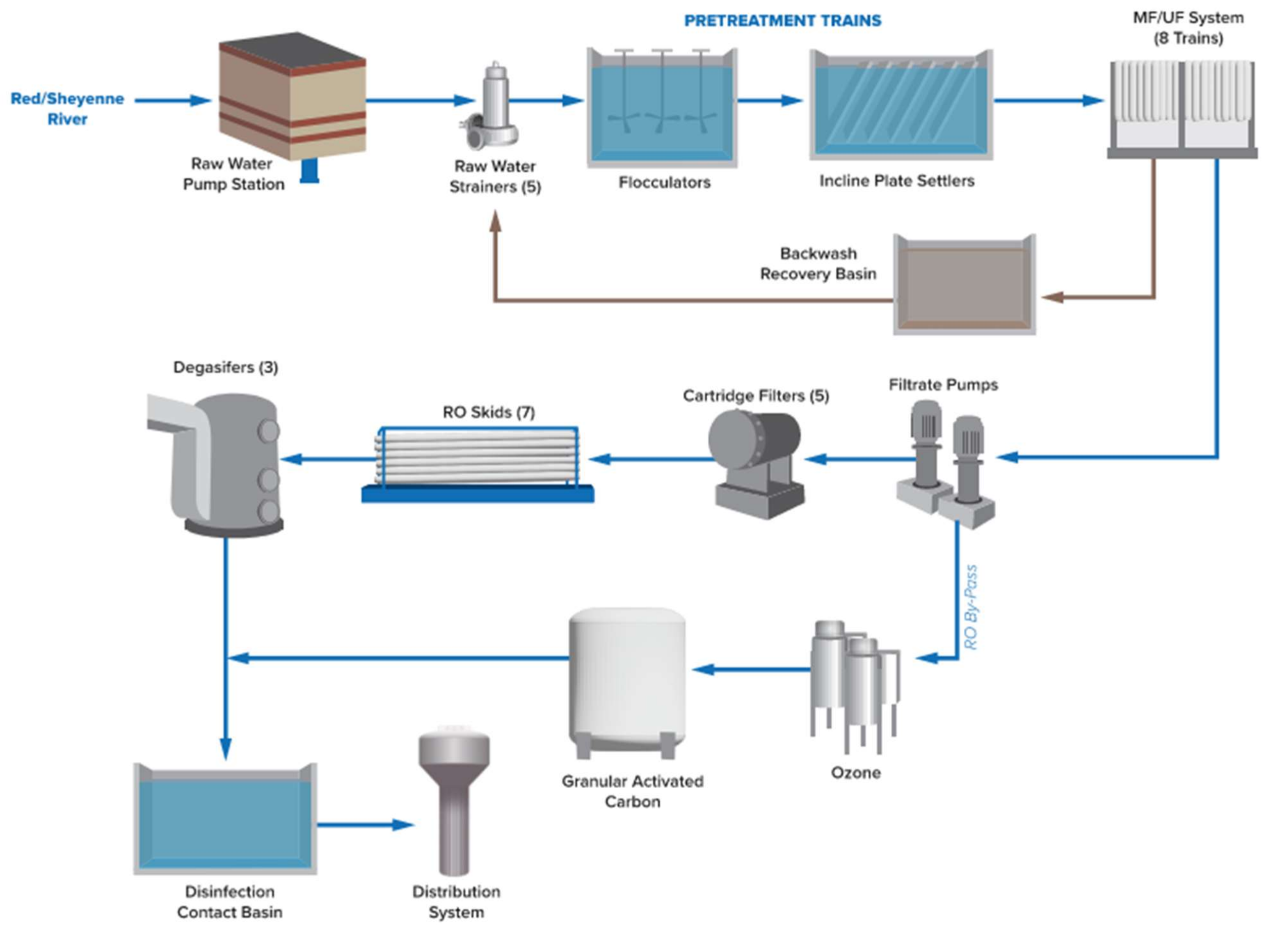
- **30 MGD Lime Softening WTP (1997)**
- **15 MGD Integrated Duo Membrane WTP (2018)**

Fargo Lime Softening WTP

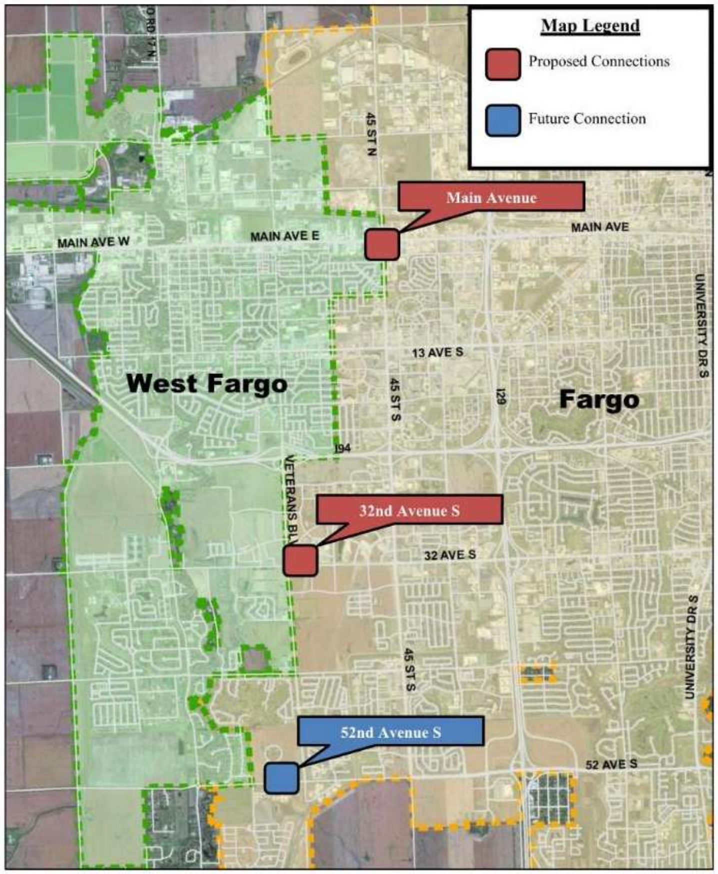
- **Fargo Water Treatment Plant (WTP) in operation since 1912**
- **Current WTP completed in 1997 with a capacity of 30 million gallons per day (mgd)**



Fargo 15 MGD Integrated Duo Membrane WTP



Regional Water System

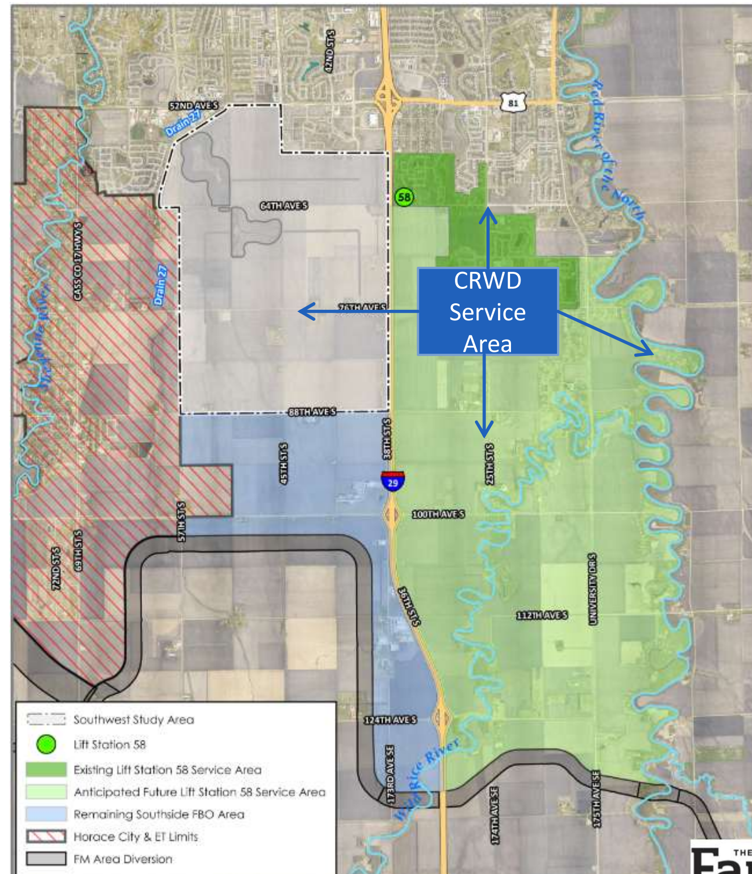


Fargo Population

137,989

Regional Population

~200,000



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Fargo Raw Water Overview

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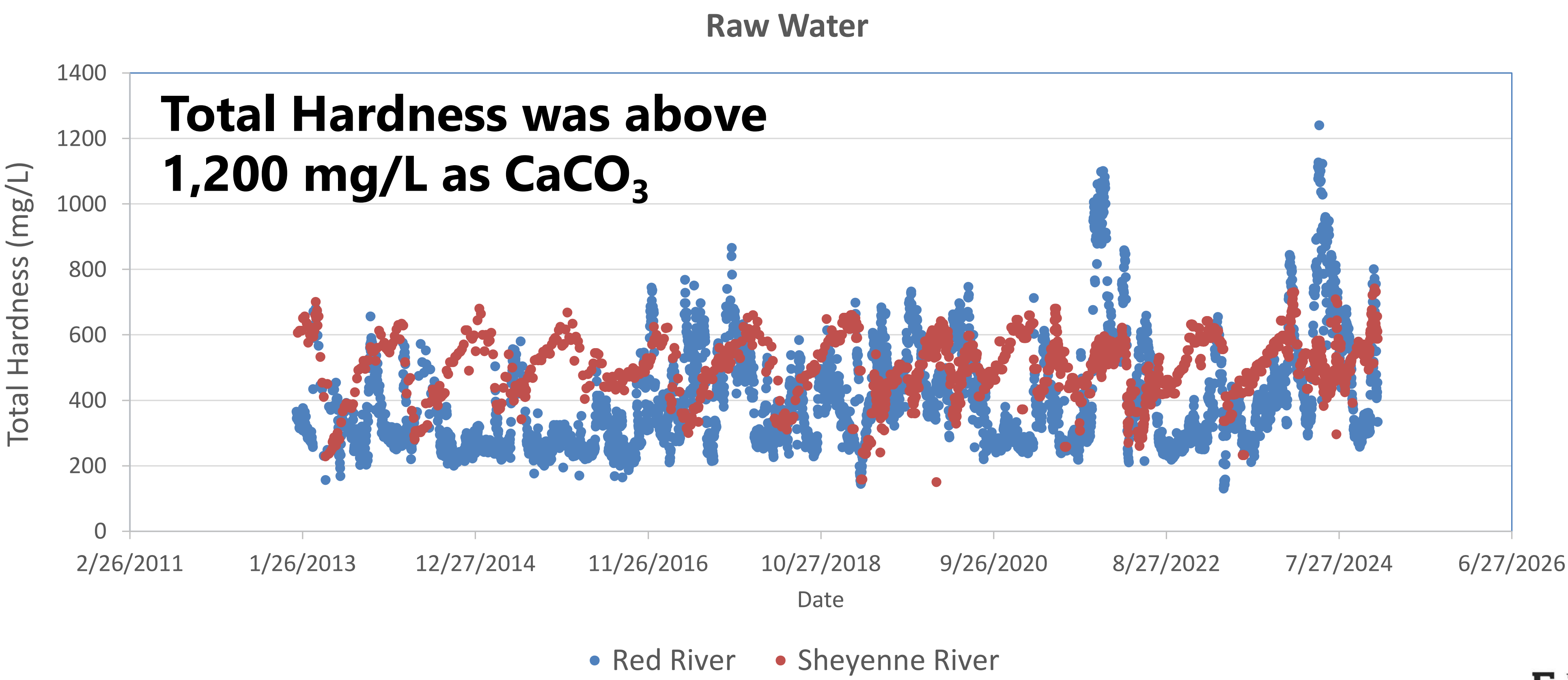
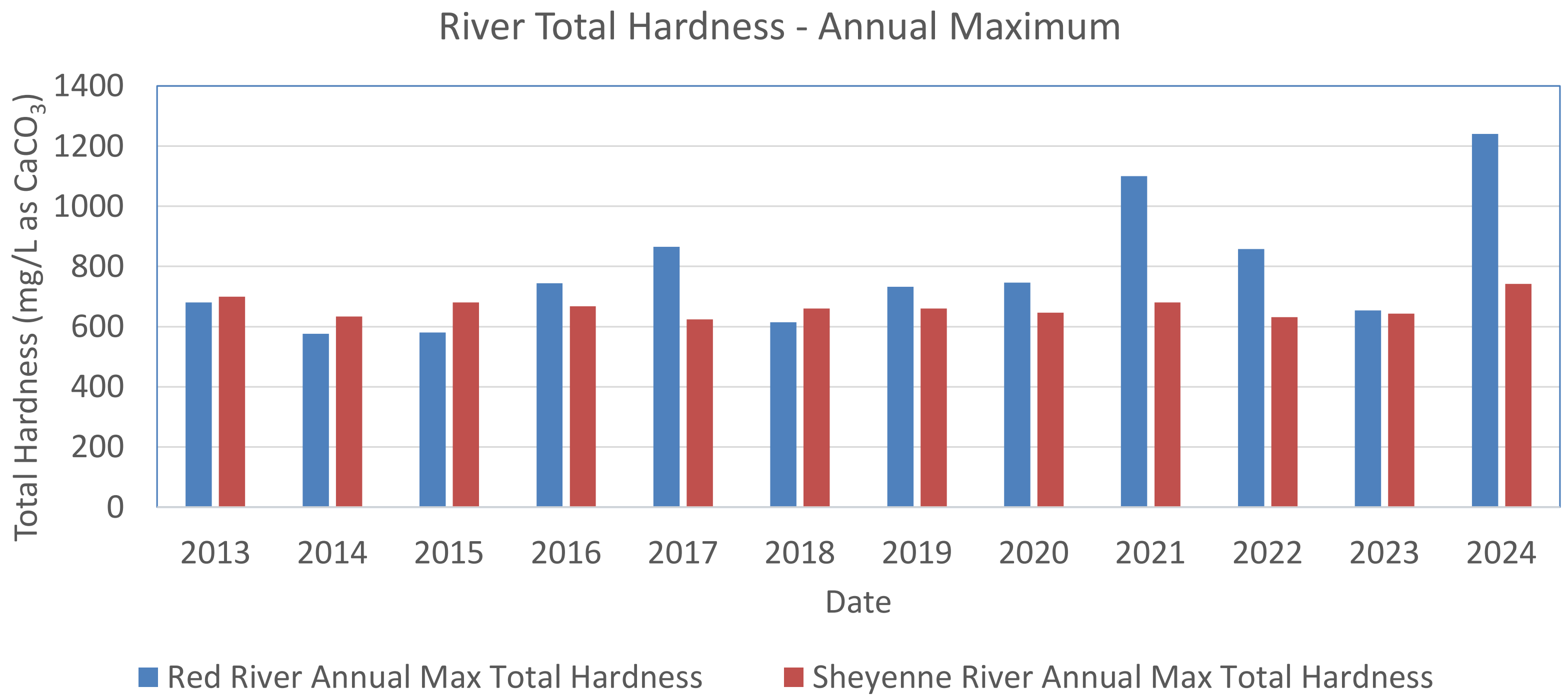
Fargo WTP Raw Water Total Hardness

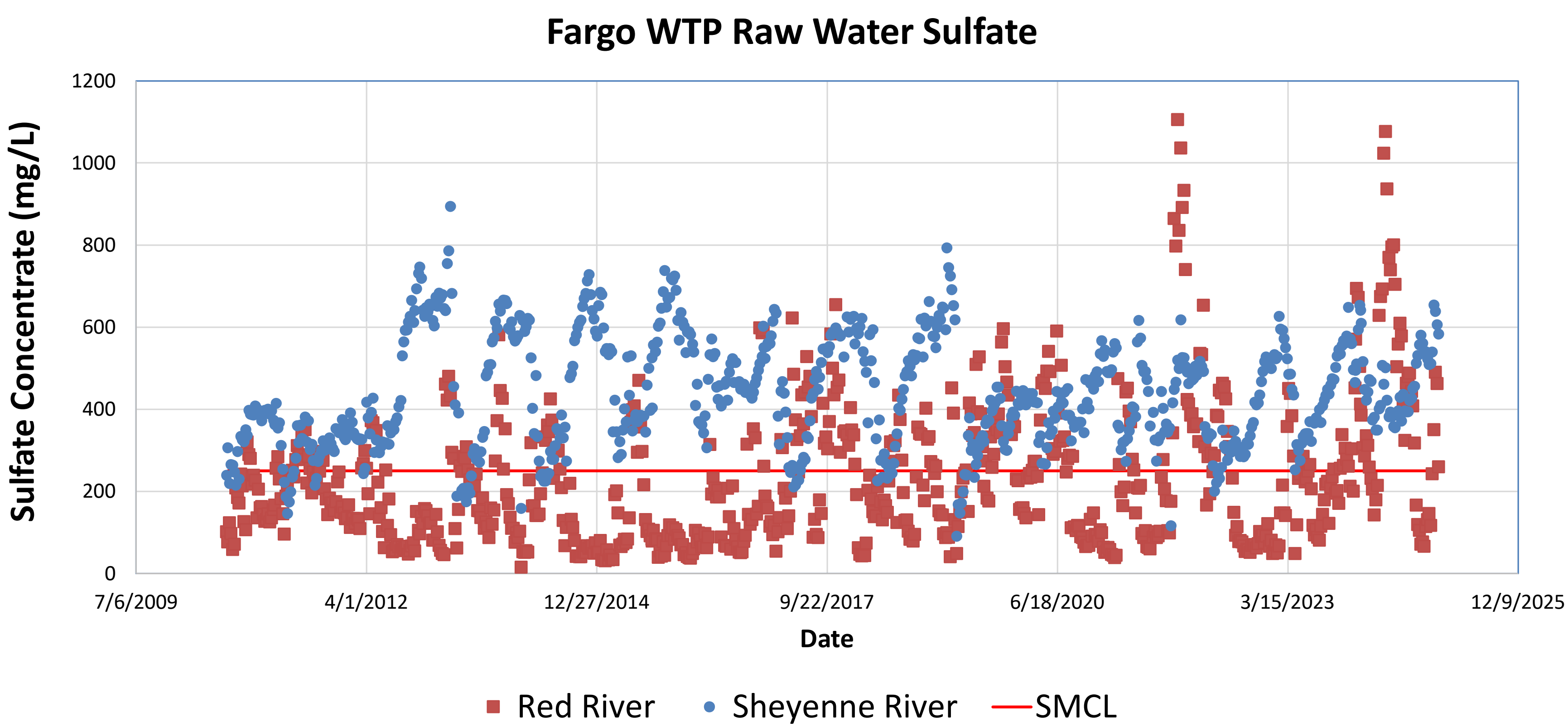


Fargo WTP Raw Water Total Hardness

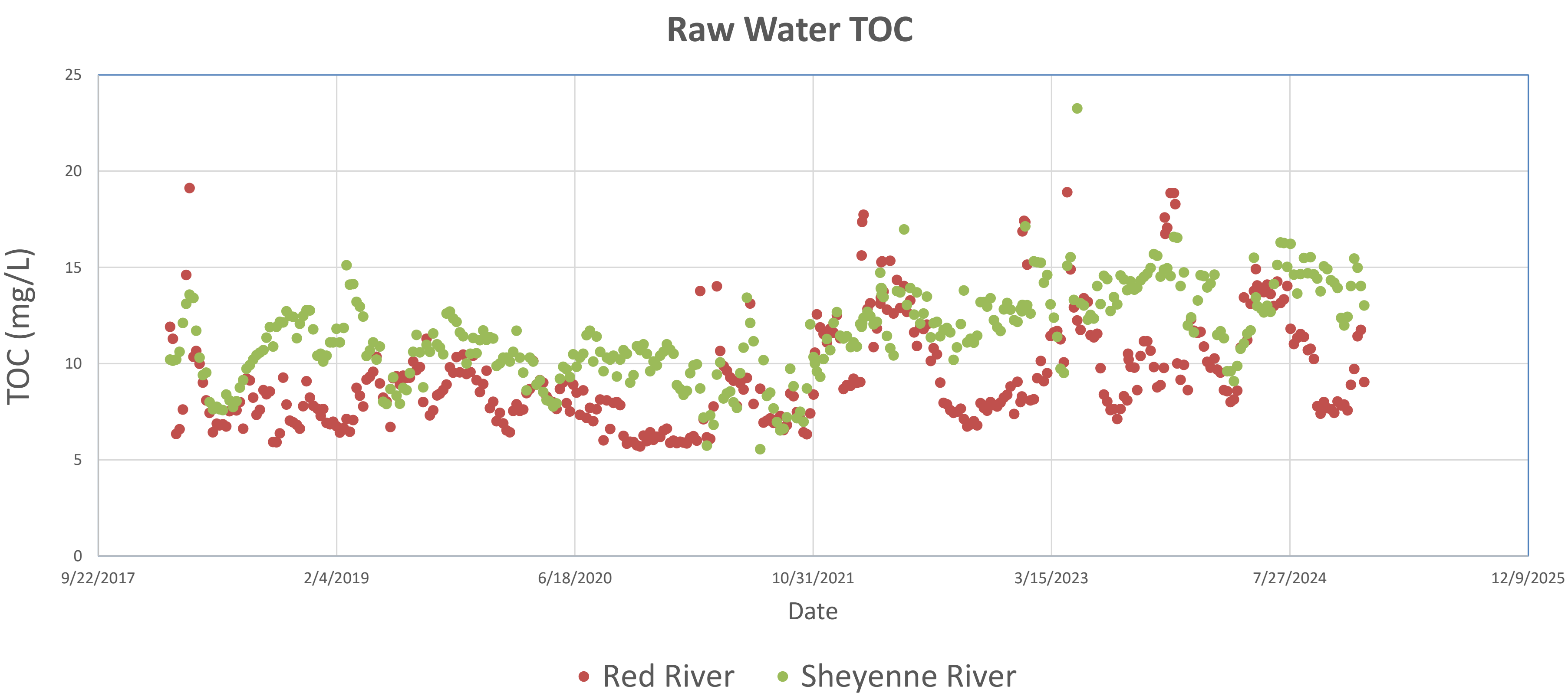


Rivers are increasingly exhibiting more extreme variations in water quality.

Fargo WTP Raw Water - Sulfate



Fargo WTP Raw Water - TOC



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Fargo WTP Finished Water Goals

1. Meet EPA Primary Drinking Water Standards
2. Total Hardness: 115-130 (120) mg/L as $CaCO_3$
3. TDS: < 500 mg/L
4. Sulfate: <250 mg/L
5. Taste and Odor: no complaints

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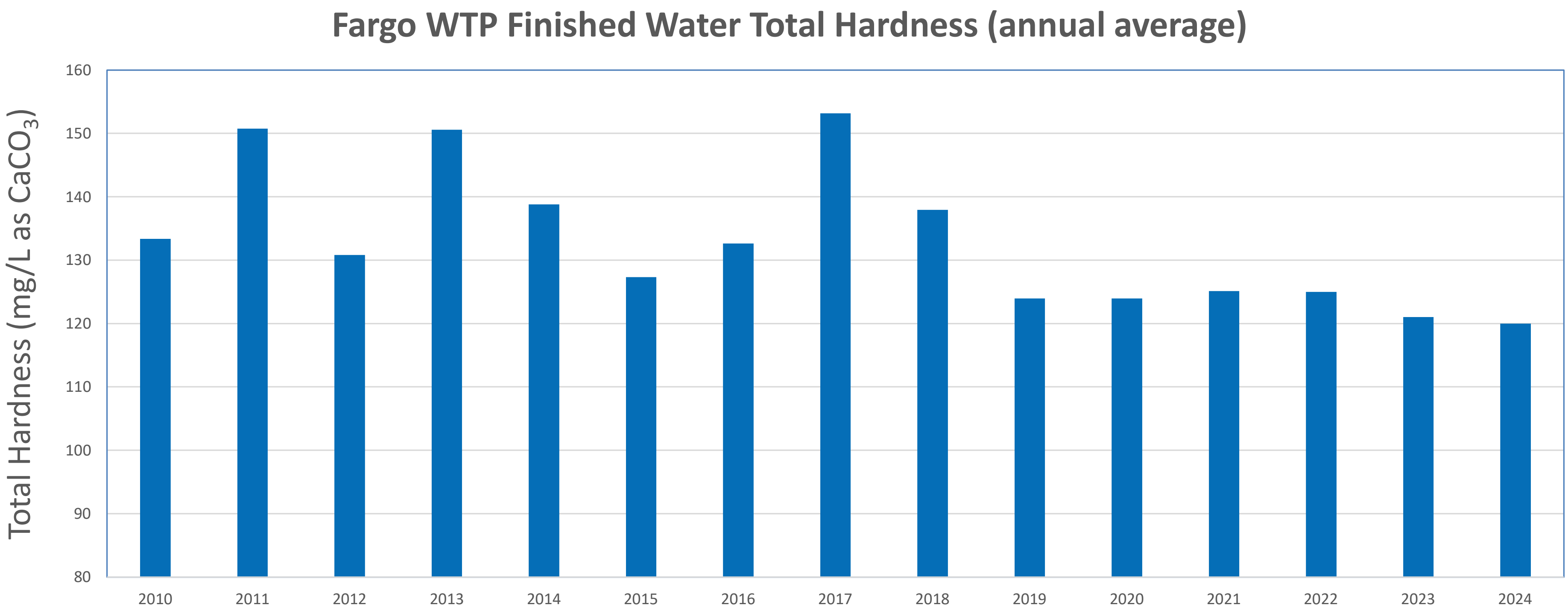
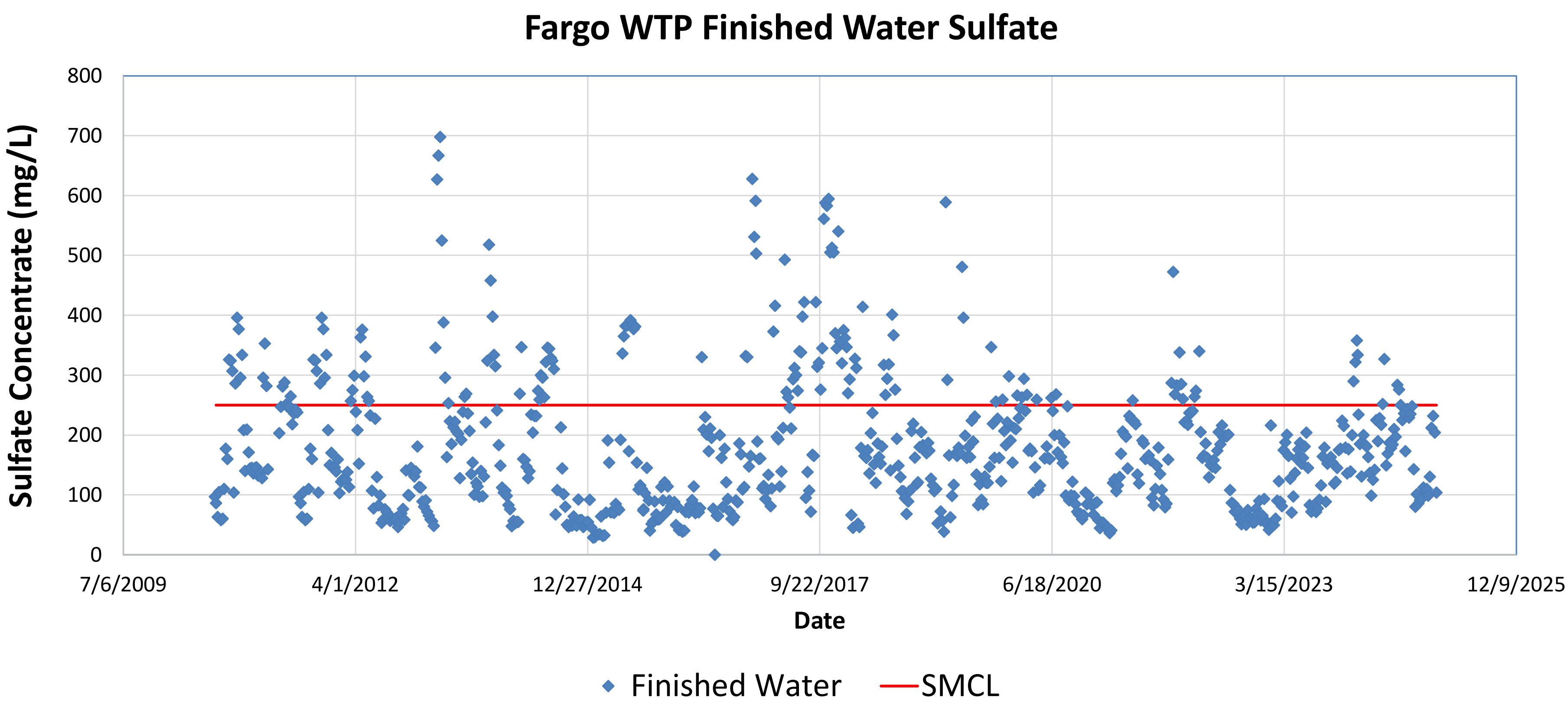
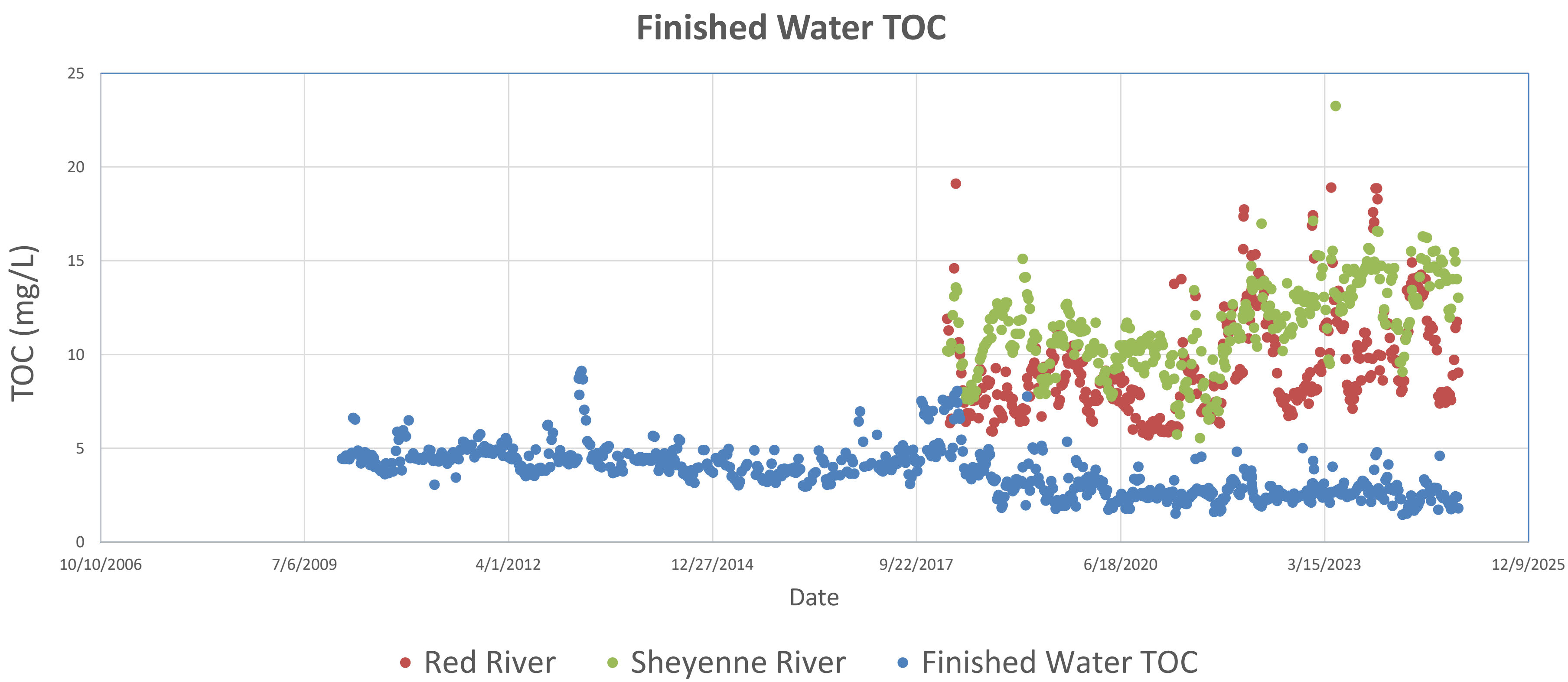
Fargo WTP Finished Water – Total Hardness



Fargo WTP Finished Water – Sulfate



Finished Water TOC vs Raw Water Natural Organics



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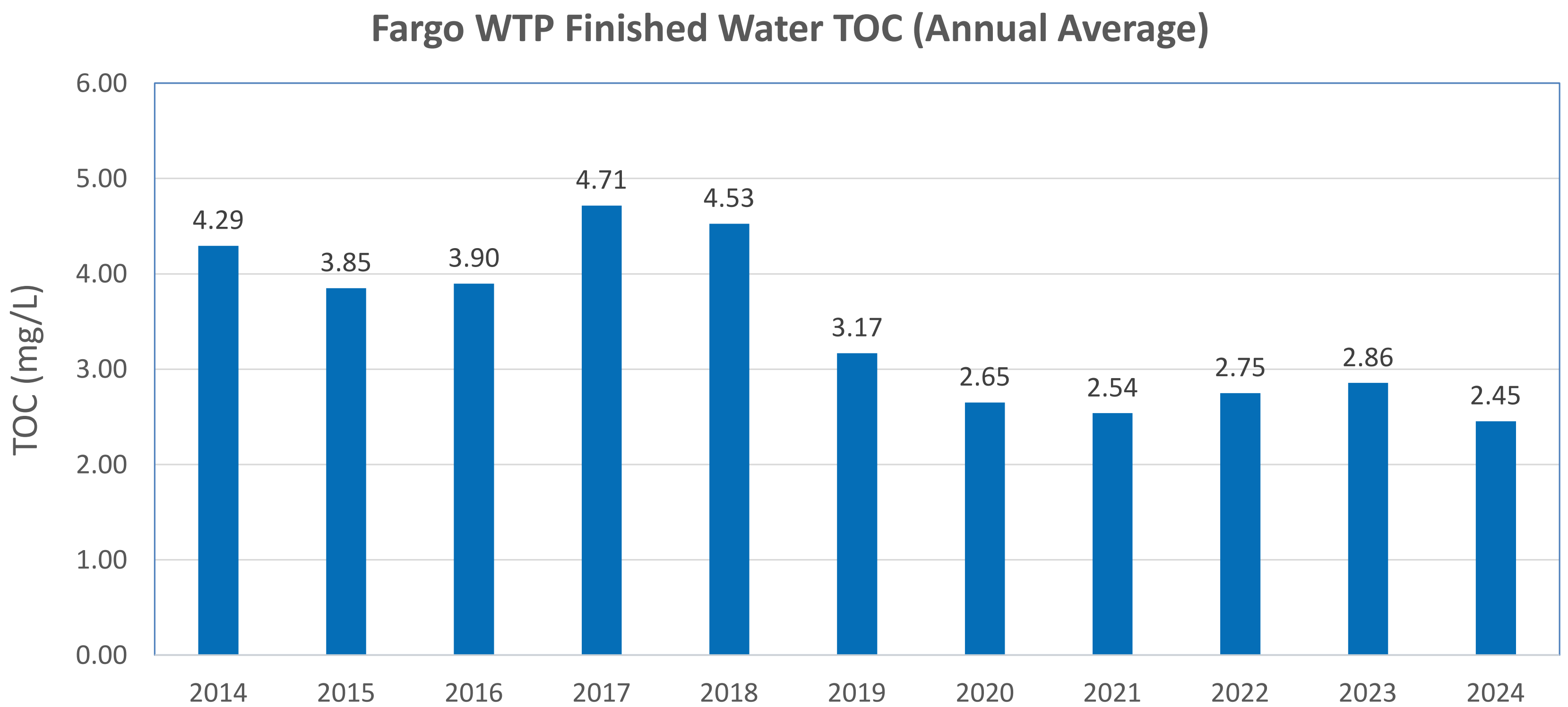
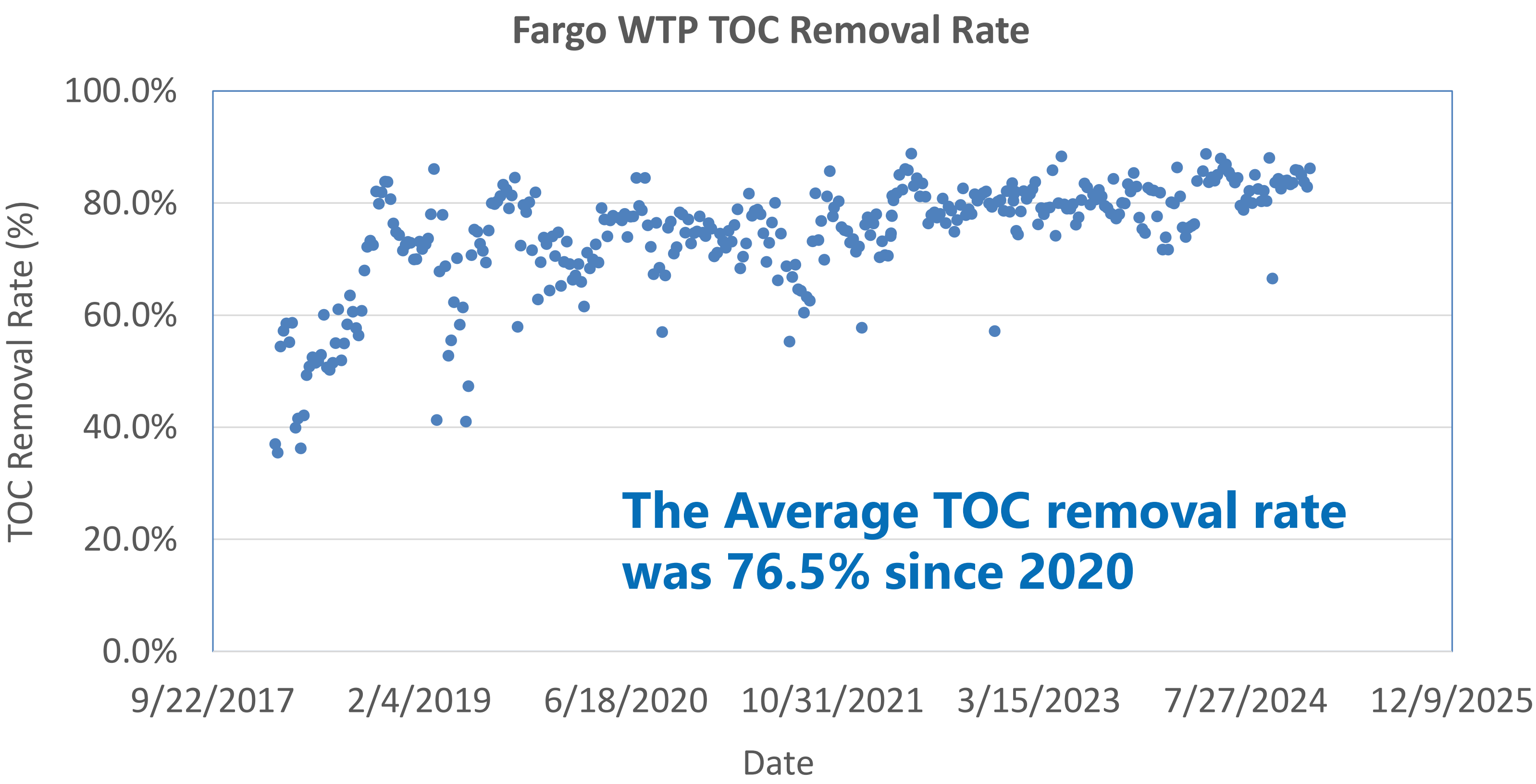
Far More

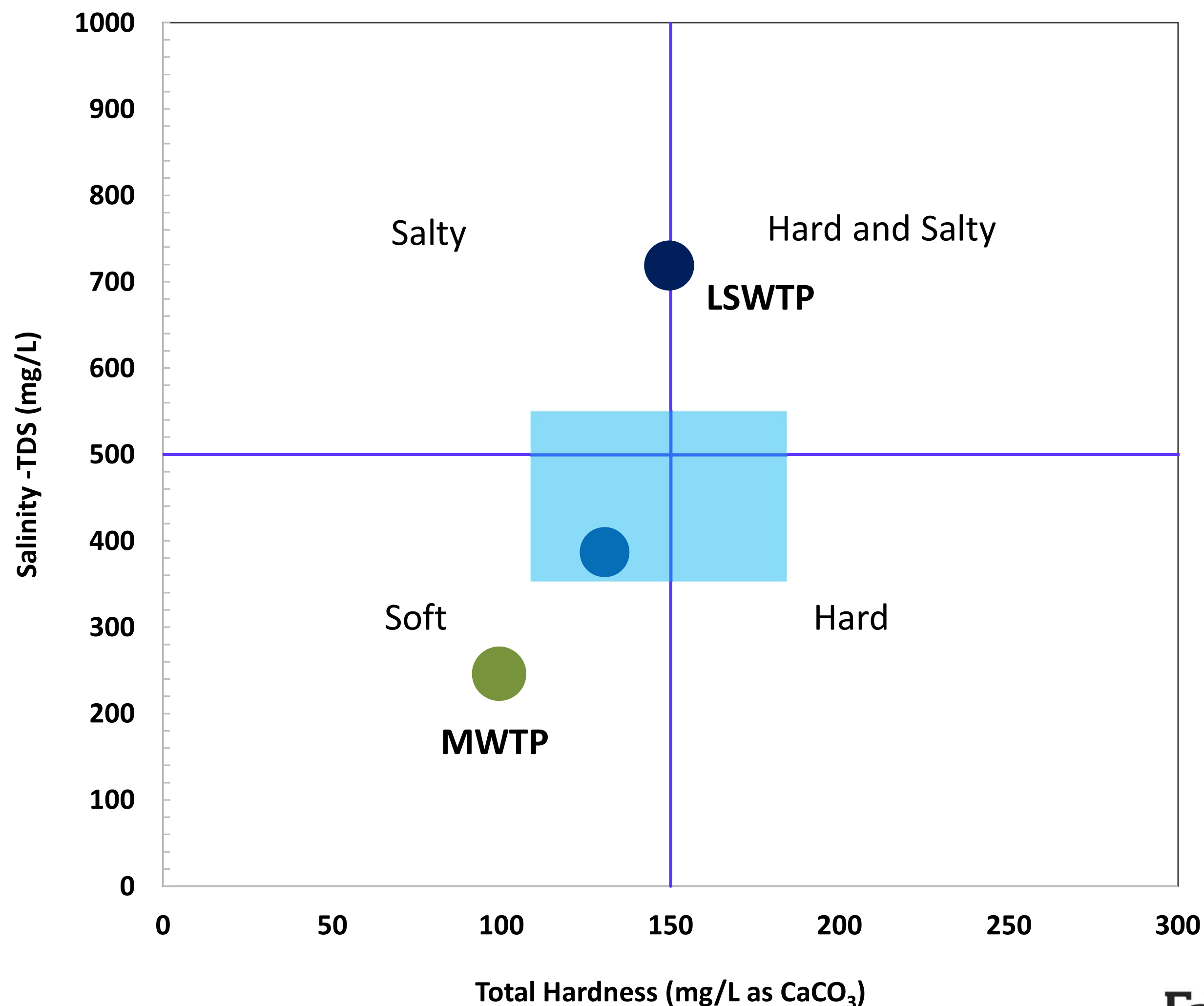
Finished Water TOC (Annual Average)



Finished Water TOC (Annual Average)



Water Quality Quadra



Fargo WTP Community Engagement and Recognitions

Public Education

Plant tours to K-12 students, college students, and professionals.

TPO. November 2024

Editorial > In Fargo: Award for Good Taste. Reputation for Quality.

In Fargo: Award for Good Taste. Reputation for Quality.

The North Dakota city of Fargo turned to membrane filtration to deal with significant changes and variability in source water

Appeared in print as *"Tastes Great. Best Filtered."*

By **James Careless**

December 2024

Top Performer - Plant

Jessey Pederson, left, membrane plant specialist, and Dan Portlock, water utility engineer, in the treatment plant's lobby.

Want tap water that tastes really great? Then go to Fargo.

For two years in a row, 2022 and 2023, the output from the Fargo Water Treatment Plant was named the Best Tasting in the state at the North Dakota Water & Pollution Control Conference. To date, Fargo is the only city to...

https://www.tpomag.com/editorial/2024/12/in-fargo-award-for-good-taste-reputation-for-quality

Top-Tier Operation Staff

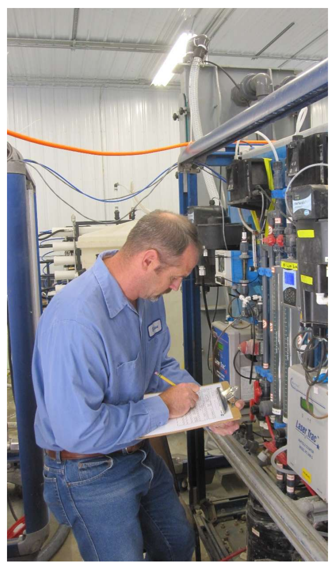
AMTA and AWWA announce awardees at the Membrane Technology Conference & Exposition

February 25, 2022

Press Releases

The American Membrane Technology Association (AMTA) and the American Water Works Association (AWWA) announced awardees at the 2022 Membrane Technology Conference & Exposition (MTC) in Las Vegas.

Brian Ward of the City of Fargo Water Treatment Plant in Fargo, N.D., was presented with this year's Robert O. Vernon Operator of the Year Award. The award recognizes outstanding contributions by a plant operator working at a membrane filtration, desalination or water reuse facility that resulted in significant, long-term improvement in water production and/or water reuse.



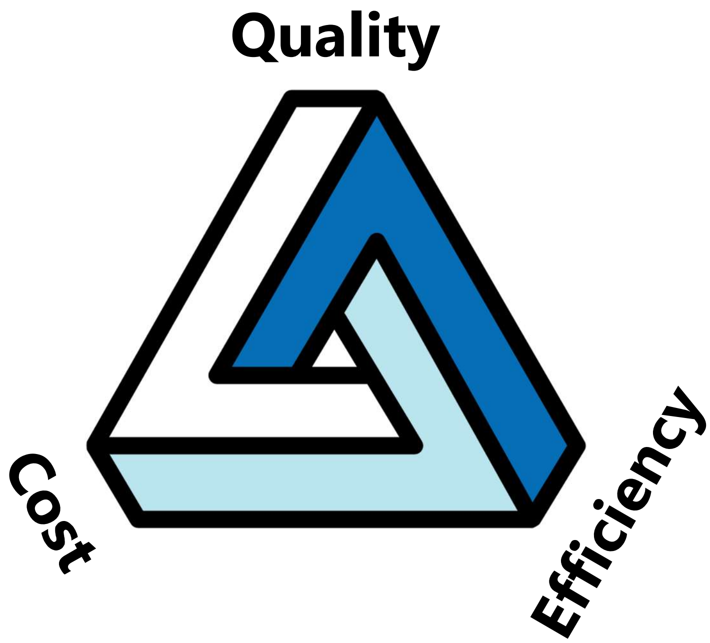
We Care About Water Quality

2024 Membrane Facility of the Year Award

Impossible Triangle

Quality, Efficiency, Cost

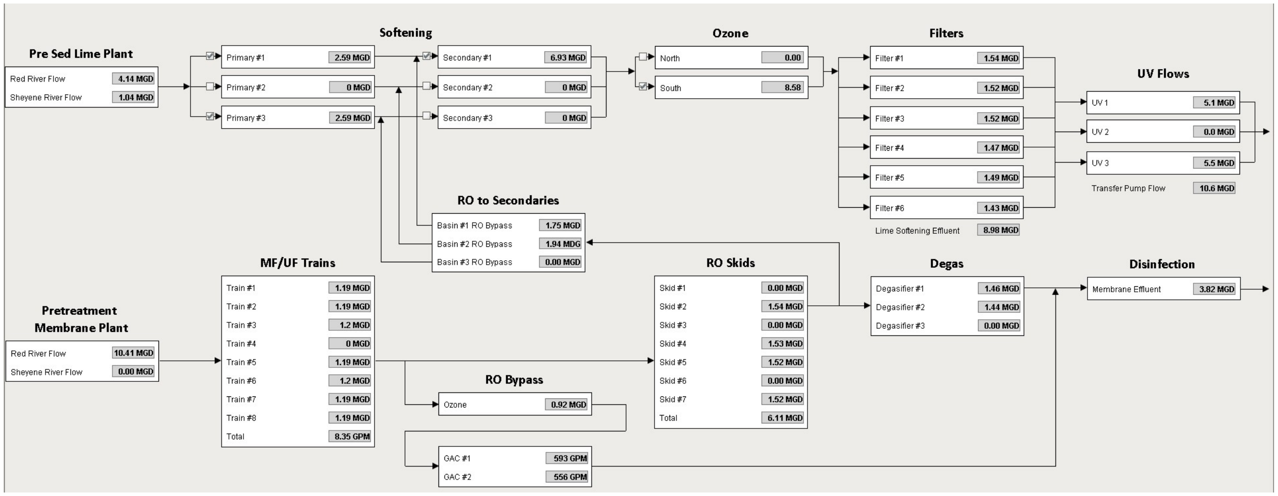
Win Them All



How to operate two plants in a way to achieve:

1. Great Water Quality
2. High Efficiency
3. Low Cost

Operation Strategies



Operation Scenarios

	LSWTP		MWTP		RO Transfer
Scenario No.	RED	Sheyenne	RED	Sheyenne	
1	x		x		
2	x		x		x
3	x			x	
4	x			x	x
5		x	x		
6		x	x		x
7		x		x	
8		x		x	x
9	x	x	x		
10	x	x	x		x
11	x	x		x	
12	x	x		x	x
13	x	x	x	x	
14	x	x	x	x	x

Operation Strategies

Operation variables:

1. Raw water selection: two rivers
2. Flow split between two WTPs
3. Intermediate RO permeate transfer between two WTPs
4. Finished water quality from each plant
5. 13 chemicals

Production Cost Model: A real time chemical cost estimate based upon real-time water quality monitoring

Team Approaches

Fargo WTP has been working closely with NDDEQ, ND PFA, and DWR on various projects aimed at improving finished water quality and enhancing overall plant efficiency.

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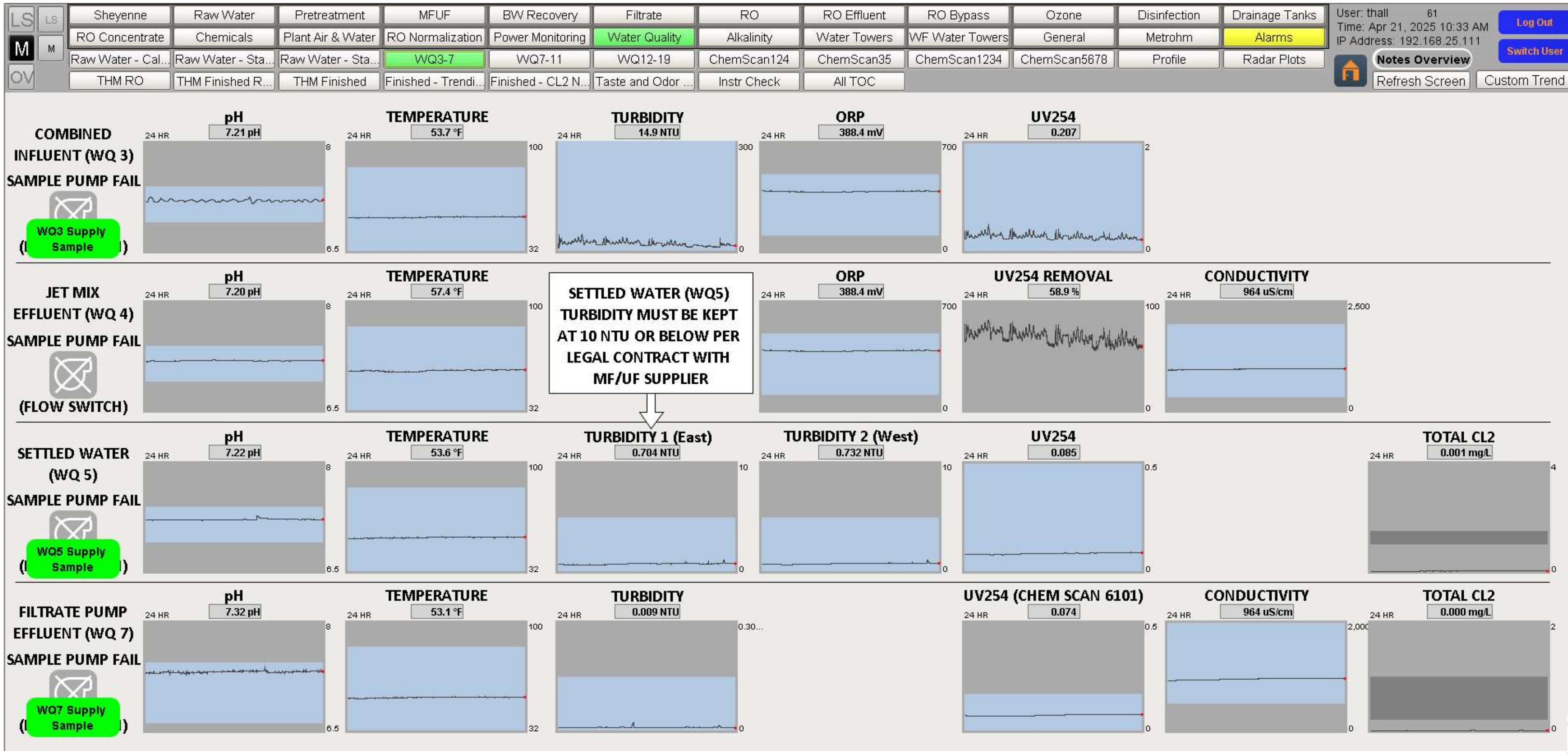
Tools in Place for Operational Improvement

A New SCADA System



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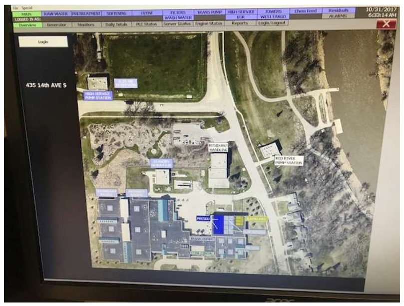
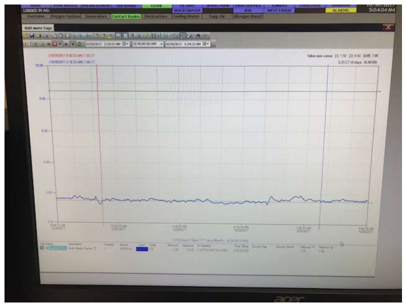
Information Speed with New SCADA System

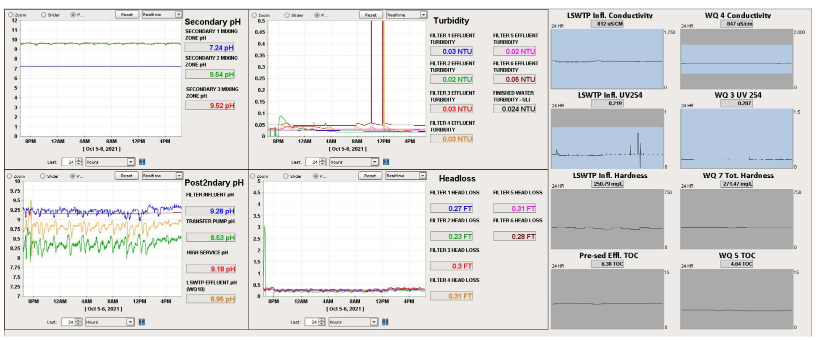
Over 100x Faster for Operations Personnel





Past Fargo WTP SCADA System

- 4 mouse clicks to get trend of single data point
- Slight data Retrieval delay
- **Data point not trended with other related data**
- Limited performance 'information'



New Fargo WTP SCADA System

- Each mouse click 4 to 6 different trend graphics
- Multiple related data point on each screen
- Graphic load quickly (minimum delay)
- **Example screen has 27 trended data points**
- **4 mouse clicks get roughly 108 data points trended**

Times about 15 end users → 1,500 times faster plant-wide!

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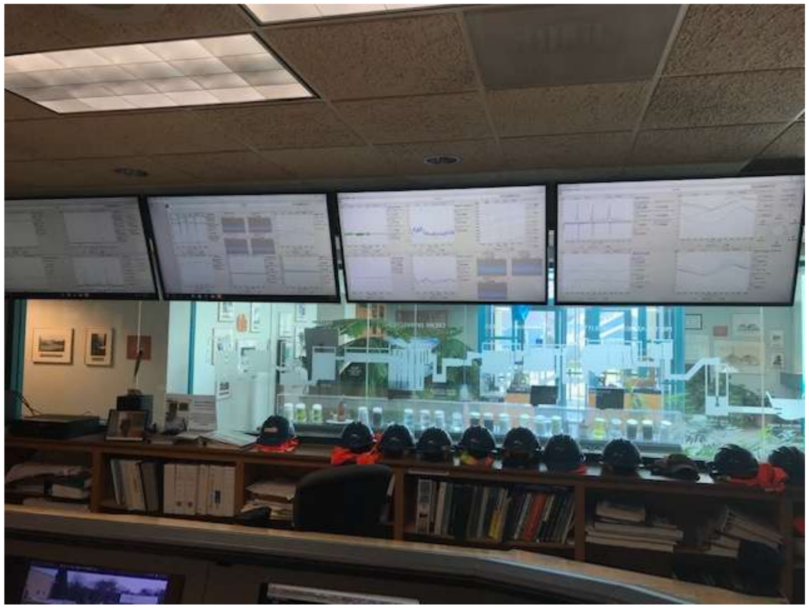
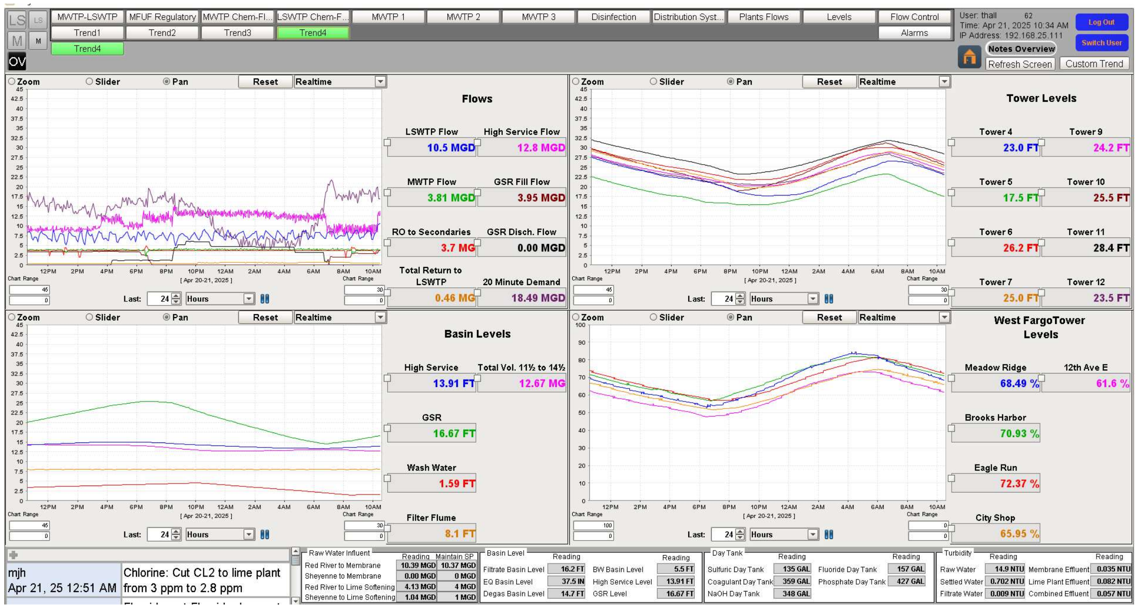
Full WTP Assessment in Seconds to Minutes





Tools in Place for Operational Improvement

Chemical Cost Calculator

LS LS M M OV

Sheyenne | Raw Water | Pretreatment | MFUF | BW Recovery | Filtrate | RO | RO Effluent | RO Bypass | Ozone | Disinfection | Drainage Tanks
RO Concentrate | Chemicals | Plant Air & Water | RO Normalization | Power Monitoring | Water Quality | Alkalinity | Water Towers | WF Water Towers | General | Metrohm | Alarms
Ambient Gas | Sulfuic-PACL-Bi... | Citric-Anti-H2O2 | Fluoride-Phosph... | Sodium Hydroxide | Copper Sulfate | Dosing | Transfer | Chlorine | Ammonia | Digital Alarms | Level and Press...
Cost Calculations

User: thall 1
Time: Apr 17, 2025 01:01 PM
IP Address: 192.168.25.111

Log Out | Switch User | Notes Overview | Refresh Screen | Custom Trend

Refresh Live Value: OFF

Chemical Name	Chemical Pump Tag Name	Description	Feed Point	Chemical Cost ($ / lb)	Dosage	$ / Day	$ / 1,000 Finished	Calculated Flow	Calculated Dosage	Calculated $ / Day	Calculated $ / 1,000	Cost/Day Difference	Cost/1,000 Difference
PACl	16_CMP_2103	COAGULANT METERING PUMP NO. 1	Coagulant-PACL	$0.28	55 PPM	0 $	0.00 $		35 mg/L	0 $	0.00 $	0 $	0.00 $
PACl	16_CMP_2203	COAGULANT METERING PUMP NO. 2	Coagulant-PACL	$0.28	55 PPM	2,438 $	0.18 $		35 mg/L	825 $	0.16 $	-1,613 $	-0.02 $
Sulfuric Acid -93%	16_CMP_1103	SULFURIC ACID METERING PUMP NO. 1	Sulfuric Acid 1	$0.1023	34.68 PPM	562 $	0.04 $		22.42 mg/L	193 $	0.04 $	-368 $	0.00 $
Sulfuric Acid -93%	16_CMP_1203	SULFURIC ACID METERING PUMP NO. 2	Sulfuric Acid 1	$0.1023	34.68 PPM	0 $	0.00 $		22.42 mg/L	0 $	0.00 $	0 $	0.00 $
Sulfuric Acid -93%	16_CMP_1303	SULFURIC ACID METERING PUMP NO. 3	Sulfuric Acid 1	$0.1023	34.68 PPM	0 $	0.00 $		22.42 mg/L	0 $	0.00 $	0 $	0.00 $
			Pretreatment Totals			3,002 $	0.22 $	10.1 MGD		1,019 $	0.20 $	-1,983 $	0.02 $
Anti-scalant	16_CMP_4103	ANTISCALANT METERING PUMP NO. 1	Antiscalant	$3.35	2 PPM	0 $	0.00 $		1.48 mg/L	0 $	0.00 $	0 $	0.00 $
Anti-scalant	16_CMP_4203	ANTISCALANT METERING PUMP NO. 2	Antiscalant	$3.35	2 PPM	660 $	0.05 $		1.48 mg/L	254 $	0.05 $	-406 $	0.00 $
			Antiscalant/RO Totals			660 $	0.05 $	6.13 MGD		254 $	0.05 $	-406 $	0.00 $
Fluoride	15_CMP_6103	FLUORIDE METERING PUMP NO. 1	Fluoride	$0.22	0.65 PPM	16 $	0.00 $		0.7 mg/L	7 $	0.00 $	-10 $	0.00 $
Fluoride	15_CMP_6203	FLUORIDE METERING PUMP NO. 2	Fluoride	$0.22	0.65 PPM	0 $	0.00 $		0.7 mg/L	0 $	0.00 $	0 $	0.00 $
Phosphate	15_CMP_7103	PHOSPHATE METERING PUMP NO. 1	Phosphate	$1.13	0.5 PPM	0 $	0.00 $		0.5 mg/L	0 $	0.00 $	0 $	0.00 $
Phosphate	15_CMP_7203	PHOSPHATE METERING PUMP NO. 2	Phosphate	$1.13	2.5 PPM	319 $	0.00 $		2.3 mg/L	111 $	0.02 $	-207 $	0.02 $
			Phosphate 1 Totals			319 $	0.00 $			111 $	0.02 $	-207 $	0.02 $
Sodium Hydroxide	16_CMP_3103	SODIUM HYDROXIDE METERING PUMP NO. 1	Sodium Hydroxide 1	$0.1985	16.67 PPM	0 $	0.00 $		0 mg/L	0 $	0.00 $	0 $	0.00 $
Sodium Hydroxide	16_CMP_3203	SODIUM HYDROXIDE METERING PUMP NO. 2	Sodium Hydroxide 1	$0.1985	16.67 PPM	373 $	0.03 $		0 mg/L	0 $	0.00 $	-373 $	-0.03 $
Chlorine	CF_4XX	CHLORINE FEEDER SELECTED	Chlorine 2	$0.2685	3.75 mg/L	114 $	0.00 $		3.5 mg/L	40 $	0.01 $	-73 $	0.01 $
Chlorine	CF_4XX	CHLORINE FEEDER SELECTED	Chlorine 3	$0.2685	0 mg/L	0 $	0.00 $		0 mg/L	0 $	0.00 $	0 $	0.00 $
			Chlorine Totals			114 $	0.00 $			40 $	0.01 $	-73 $	-0.01 $
Ammonia	AM_CF_4XX	AMMONIA FEEDER SELECTED	Ammonia 3	$2.06	1.05 mg/L	244 $	0.00 $		1.01 mg/L	89 $	0.02 $	-154 $	0.02 $
			Ammonia Totals			244 $	0.00 $			89 $	0.02 $	-154 $	0.02 $
			Finished Totals			1,066 $	0.03 $	5.13 MGD		247 $	0.05 $	-818 $	0.02 $
			Plant Chemical Totals			4,728 $	0.30 $			1,520 $	0.30 $	-3,207 $	0.00 $
			Plant Power Totals			1,263 $	0.09 $						
			Plant Combined Totals			5,987 $	0.39 $						

Cost/ 30-Day Difference	Cost/ Year Difference
-96,129 $	[illegible]

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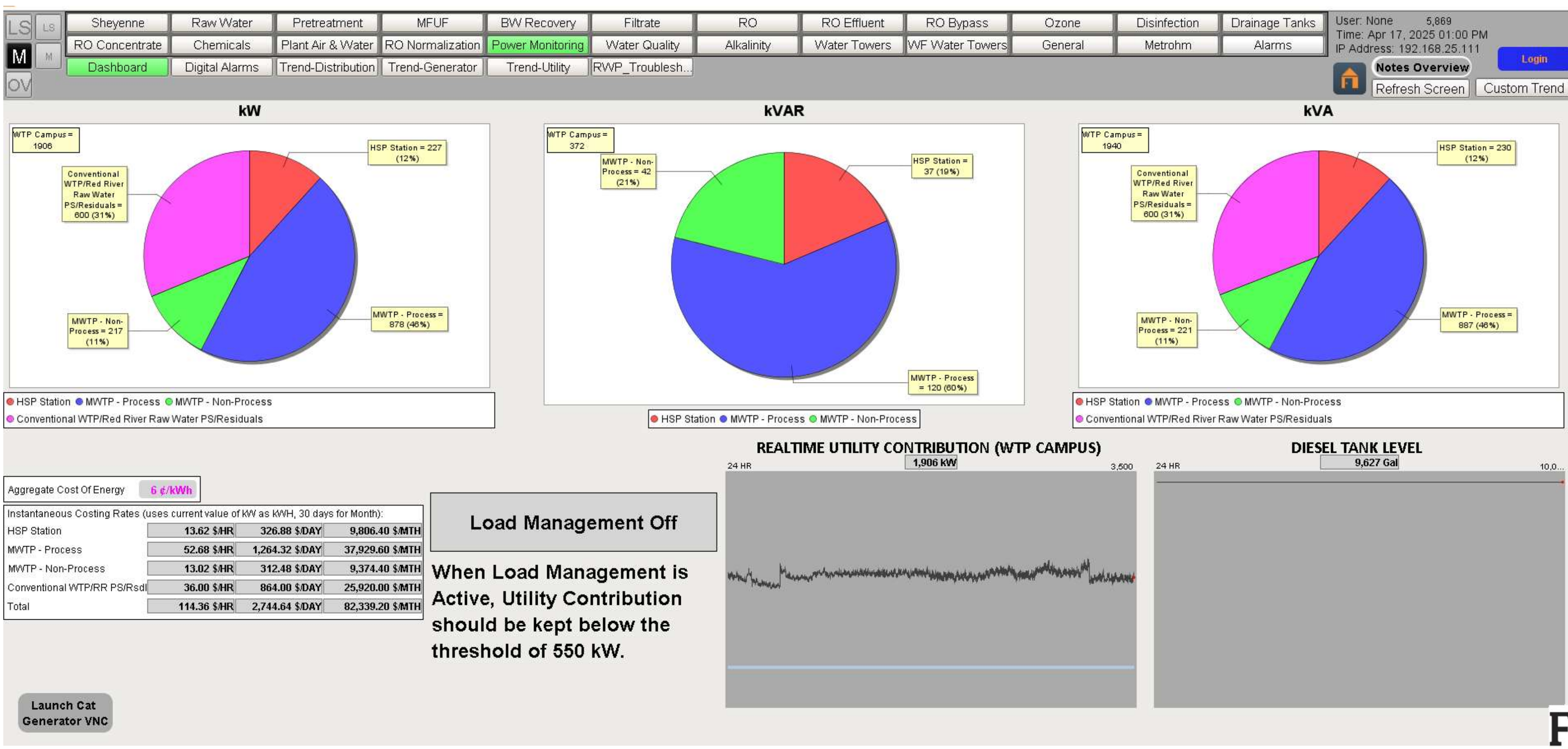
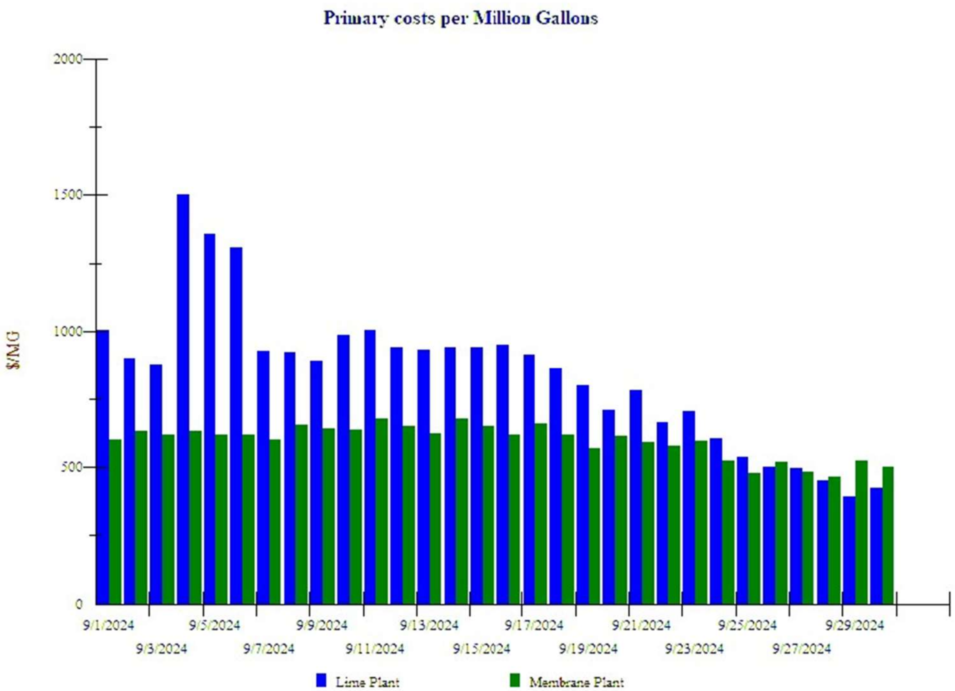
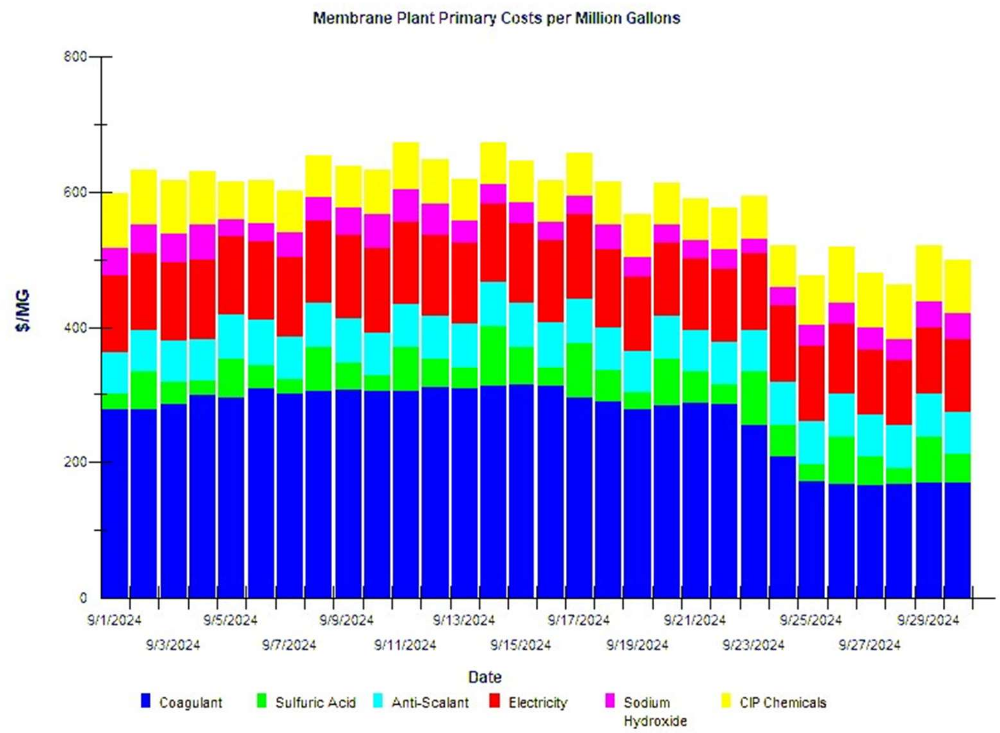
Tools in Place for Operational Improvement

Power Cost Analysis



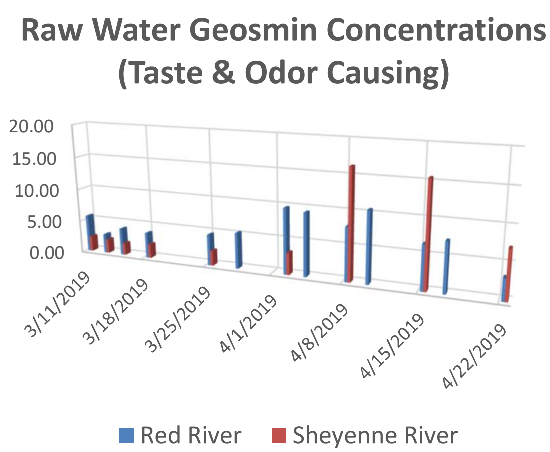
Tools in Place for Operational Improvement
Treatment Cost Model

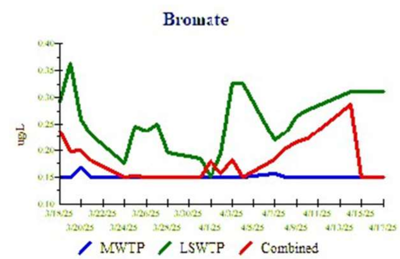


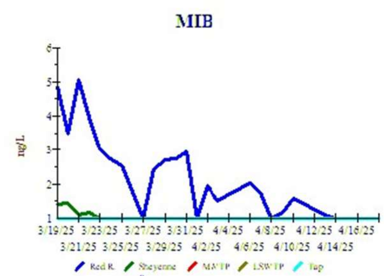


Tools in Place for Operational Improvement

Environmental Lab







	WQ13 Bromate	WQ 18 Bromate	WQ 19 Bromate	Red River Geosmin	Shey. River Geosmin	WQ 13 Geosmin	WQ 18 Geosmin	Tap Geosmin	Red River MIB	Shey. River MIB	WQ 13 MIB	WQ 18 MIB	Tap MIB
	ug/L	ug/L	ug/L	PPT	PPT	PPT	PPT	PPT	PPT	PPT	PPT	PPT	PPT
3/18/25	<0.150	0.292	0.236	6.025	3.558	<1.000	<1.000	<1.000	4.845	1.393	<1.000	<1.000	<1.000
3/19/25	<0.150	0.364	0.198	3.439	2.982	<1.000	<1.000	<1.000	3.504	1.446	<1.000	<1.000	<1.000
3/20/25	0.168	0.259	0.199	5.183	3.040	<1.000	<1.000	<1.000	5.071	1.088	<1.000	<1.000	<1.000
3/21/25	<0.150	0.229	0.181	5.055	2.907	<1.000	<1.000	<1.000	3.963	1.155	<1.000	<1.000	<1.000
3/22/25				2.821	<1.000	<1.000	<1.000	<1.000	3.030	<1.000	<1.000	<1.000	<1.000
3/23/25				2.065	1.150	<1.000	<1.000	<1.000	2.728	<1.000	<1.000	<1.000	<1.000
3/24/25	<0.150	0.176	<0.150	4.522	<1.000	<1.000	<1.000	<1.000	2.549	<1.000	<1.000	<1.000	<1.000
3/25/25	<0.150	0.245	0.152										
3/26/25	<0.150	0.236	<0.150	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
3/27/25	<0.150	0.250	<0.150	2.382	<1.000	<1.000	<1.000	<1.000	2.433	<1.000	<1.000	<1.000	<1.000
3/28/25	<0.150	0.196	<0.150	3.567	<1.000	<1.000	<1.000	<1.000	2.719	<1.000	<1.000	<1.000	<1.000
3/29/25				2.944	<1.000	<1.000	<1.000	<1.000	2.759	<1.000	<1.000	<1.000	<1.000
3/30/25				2.901	<1.000	<1.000	<1.000	<1.000	2.934	<1.000	<1.000	<1.000	<1.000
3/31/25	<0.150	0.185	<0.150	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
4/1/25	<0.150	<0.150	0.180	2.154	<1.000	<1.000	<1.000	<1.000	1.938	<1.000	<1.000	<1.000	<1.000
4/2/25	<0.150	0.194	0.157	1.688	<1.000	<1.000	<1.000	<1.000	1.501	<1.000	<1.000	<1.000	<1.000
4/3/25	<0.150	0.327	0.183										
4/4/25	<0.150	0.327	<0.150										
4/5/25				2.526	<1.000	<1.000	<1.000	<1.000	2.010	<1.000	<1.000	<1.000	<1.000
4/6/25				2.489	<1.000	<1.000	<1.000	<1.000	1.750	<1.000	<1.000	<1.000	<1.000
4/7/25	0.156	0.219	0.182	1.056	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
4/8/25	<0.150	0.235	0.205	1.289	<1.000	<1.000	<1.000	<1.000	1.168	<1.000	<1.000	<1.000	<1.000
4/9/25	<0.150	0.266	0.216	1.948	<1.000	<1.000	<1.000	<1.000	1.577	<1.000	<1.000	<1.000	<1.000
4/10/25	<0.150	0.277	0.221										
4/11/25													
4/12/25				1.886	<1.000	<1.000	<1.000	<1.000	1.104	<1.000	<1.000	<1.000	<1.000
4/13/25				1.830	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
4/14/25	<0.150	0.311	0.288	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000	<1.000
4/15/25	<0.150		<0.150	1.003		<1.000		<1.000	<1.000		<1.000		<1.000
4/16/25	<0.150		<0.150	1.464		<1.000		<1.000	<1.000		<1.000		<1.000
4/17/25	<0.150		<0.150										

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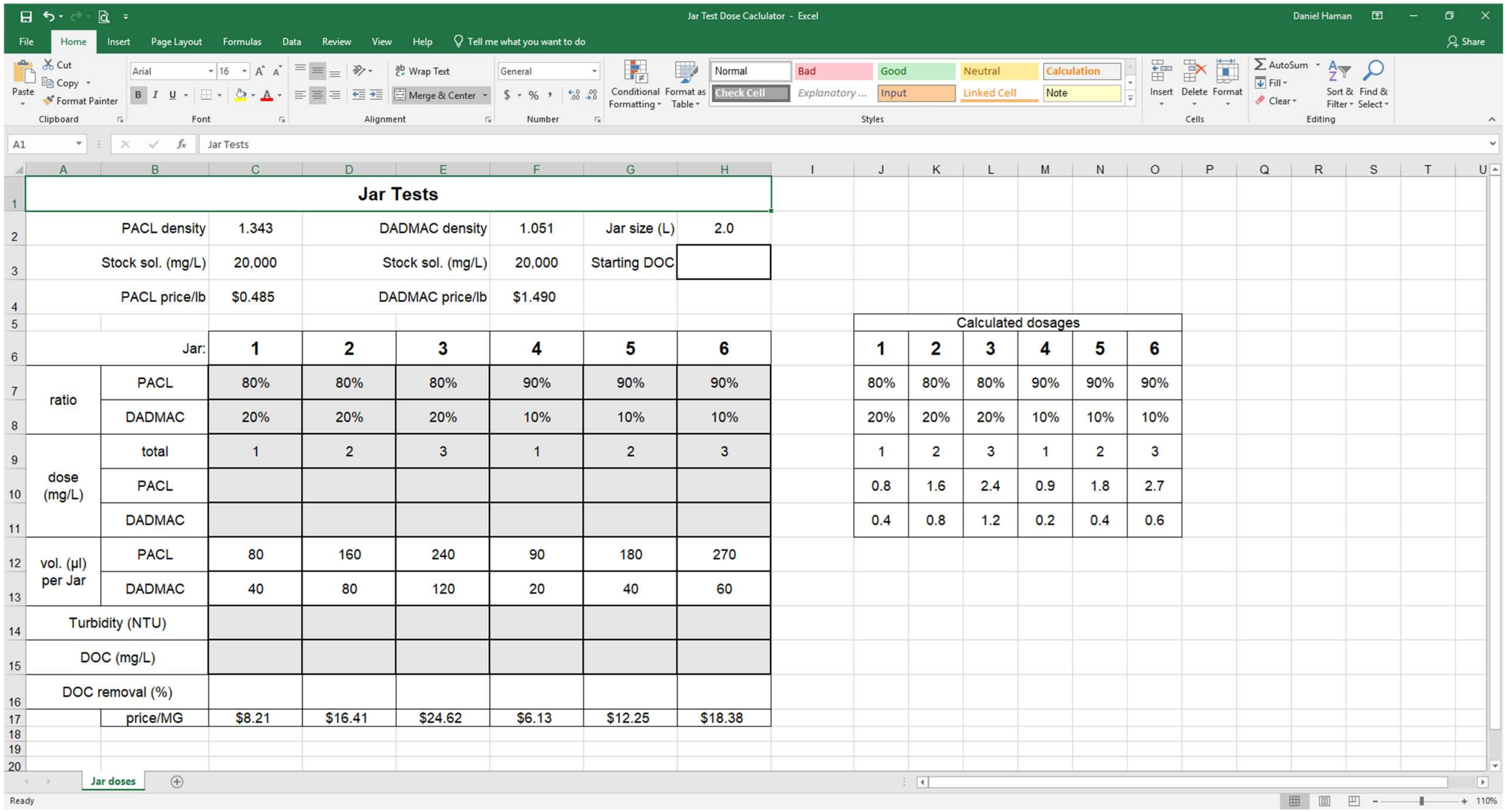
Tools in Place for Operational Improvement

Treatment Cost Model



Jar Test Dose Calculator - Excel

Jar Tests

	PACL density	1.343		DADMAC density	1.051	Jar size (L)	2.0
	Stock sol. (mg/L)	20,000		Stock sol. (mg/L)	20,000	Starting DOC	
	PACL price/lb	$0.485		DADMAC price/lb	$1.490		
	Jar:	1	2	3	4	5	6
ratio	PACL	80%	80%	80%	90%	90%	90%
	DADMAC	20%	20%	20%	10%	10%	10%
dose (mg/L)	total	1	2	3	1	2	3
	PACL						
	DADMAC						
vol. (µl) per Jar	PACL	80	160	240	90	180	270
	DADMAC	40	80	120	20	40	60
Turbidity (NTU)							
DOC (mg/L)							
DOC removal (%)							
	price/MG	$8.21	$16.41	$24.62	$6.13	$12.25	$18.38

Calculated dosages

1	2	3	4	5	6
80%	80%	80%	90%	90%	90%
20%	20%	20%	10%	10%	10%
1	2	3	1	2	3
0.8	1.6	2.4	0.9	1.8	2.7
0.4	0.8	1.2	0.2	0.4	0.6

Jar doses

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Tools in Place for Operational Improvement

Treatment Cost Model

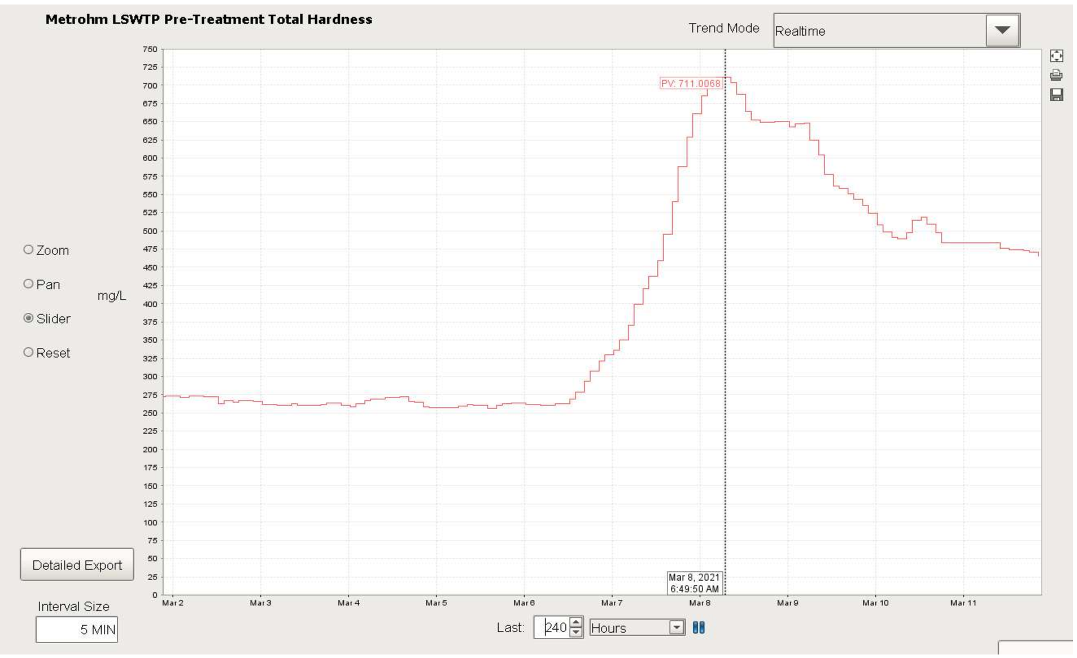
Membrane plant flow planner - Excel

	A	B	C	D	E	F	G	H	I
1									
2	MWTP Influent	# of RO Skids		RO to Degas	RO Bypass	MWTP effluent	Total effluent		
3	(MGD)	to Degas	% Recovery	(MGD)	(MGD)	(MGD)	(MGD)	Comments	
4	15.42	4	78%	6.23	1.2	7.43	16.54		
5	estimated RO Bypass to get Hardness target at MWTP:				1.83				
6									
7		P alk	M alk	Tot Hardness	Ca Hardness	Mg Hardness	Non-Carbs	Test Date/Time	Comments
8	MWTP Raw (WQ7 metrohm)	6	198	461	206	255	263	4/14/25 9:00	Use WQ7 on scada metrohm "M1 Raw" when blended
9	Est. Finished MWTP		40	91	42	50	51		RAW WATER RED
10	Actual MWTP (WQ 13)	0	40	91	42	50	51	n/a	using estimated
11				↑ minimum hardness = 90					
12		LSWTP infl.	RO to 2ndaries		LSWTP effl.	UF Backwash			
13		(MGD)	Skids	(MGD)	(MGD)	(MGD)			
14		6	2	3.11	9.11	0			
15			.						
16		P alk	M alk	Tot Hardness	Ca Hardness	Mg Hardness	Non-Carbs	Test Date/Time	Comments
17	Primary #1 tests	59	78	210	151	59	132	4/5/25 9:00	
18	Primary #2 tests								
19	Primary #3 tests	34	52	205	120	85	153		
20	Average Primaries	47	65	208	136	72	143		
21	Est. Finished LSWTP		46	143	93	51	97		
22	Actual LSWTP (WQ 18)		46	143	93	51	97	n/a	using estimated
23									
24	Est. at High Service	0	44	120	70	50	76		
25	(uses "Actual" values)	High Service hardness target:		120					
26									
27	Estimated RO Tot H	20		Estimated Lime Plant Primaries Hardness Target:			208		
28	Estimated RO NC H	10							
29	Estimated RO Ca H	10							
30	Estimated RO M Alk	10							
31	Type in gray cells.								

Sheet1 Sheet2

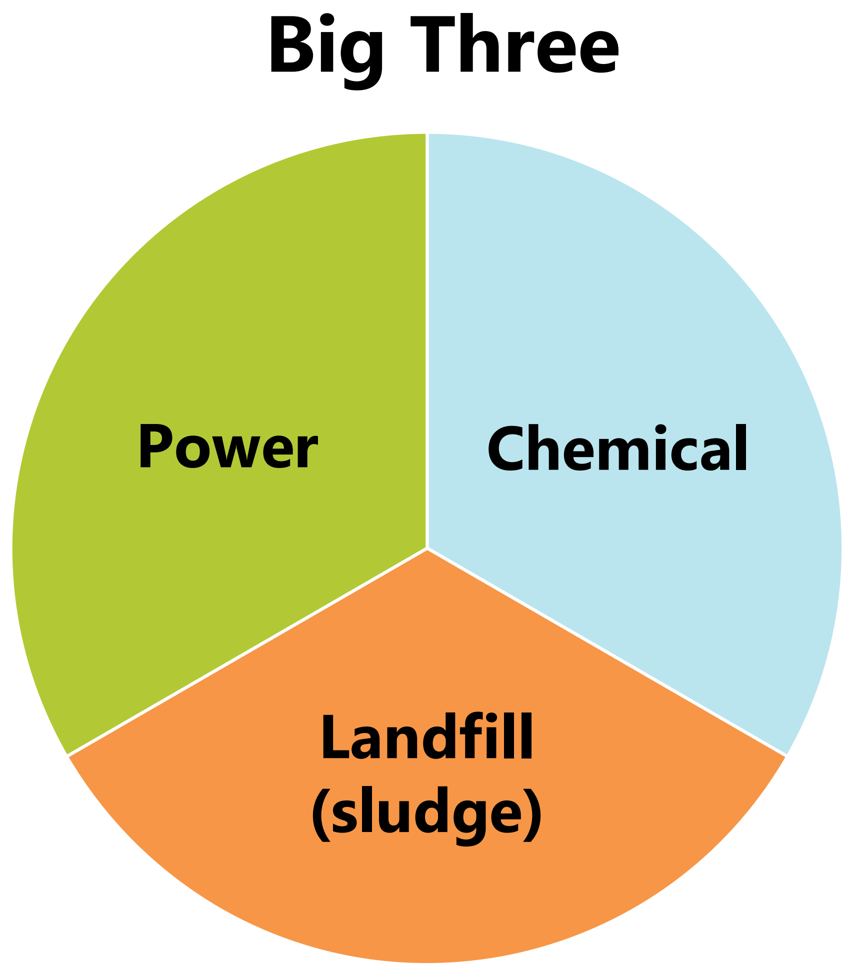
Tools in Place for Operational Improvement

Continuous Monitoring

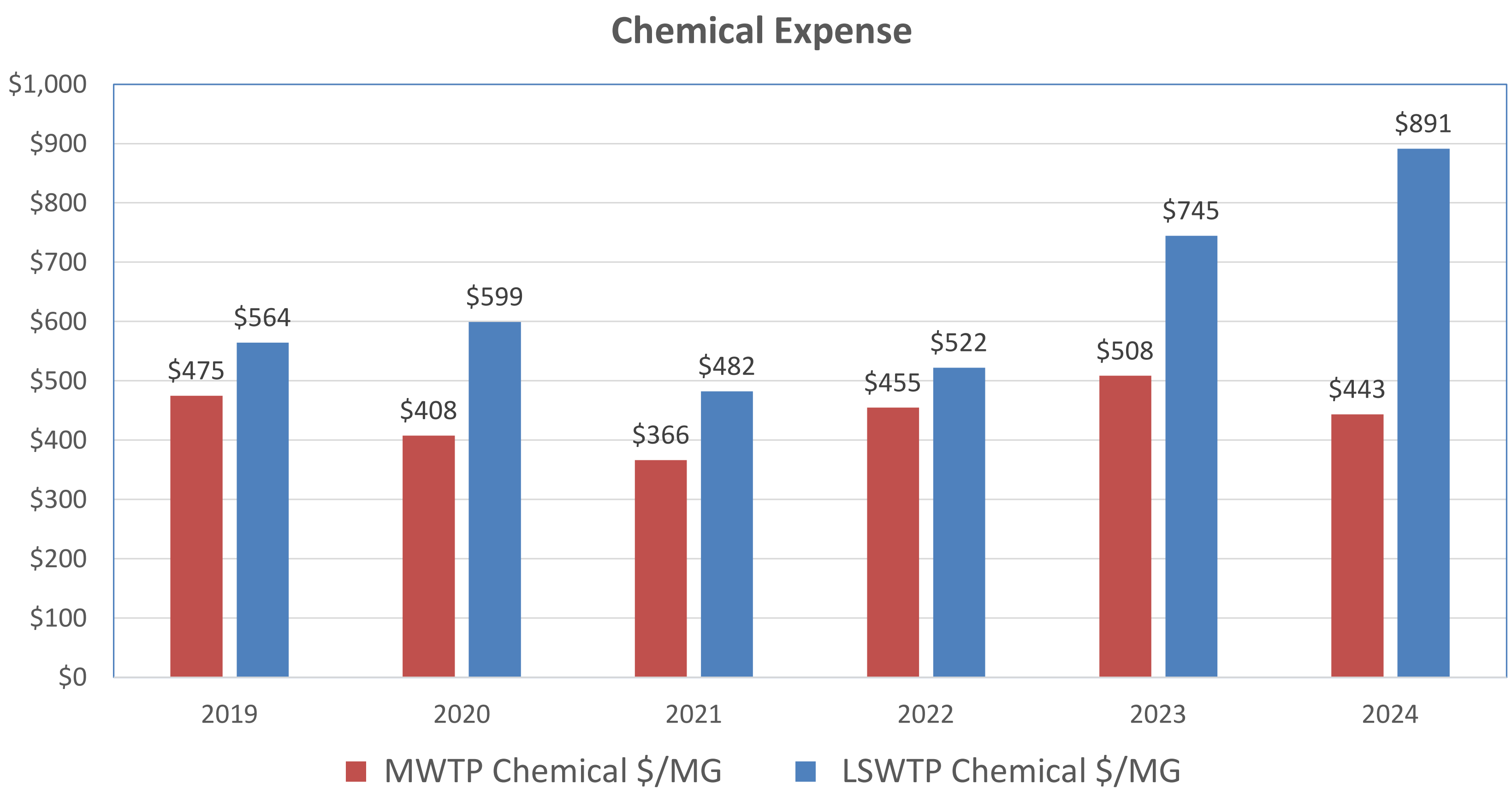


Accurate Cost to Produce Water at Each Plant and Finished Water Quality from Each Plant are Key to Achieve the Impossible Triangle

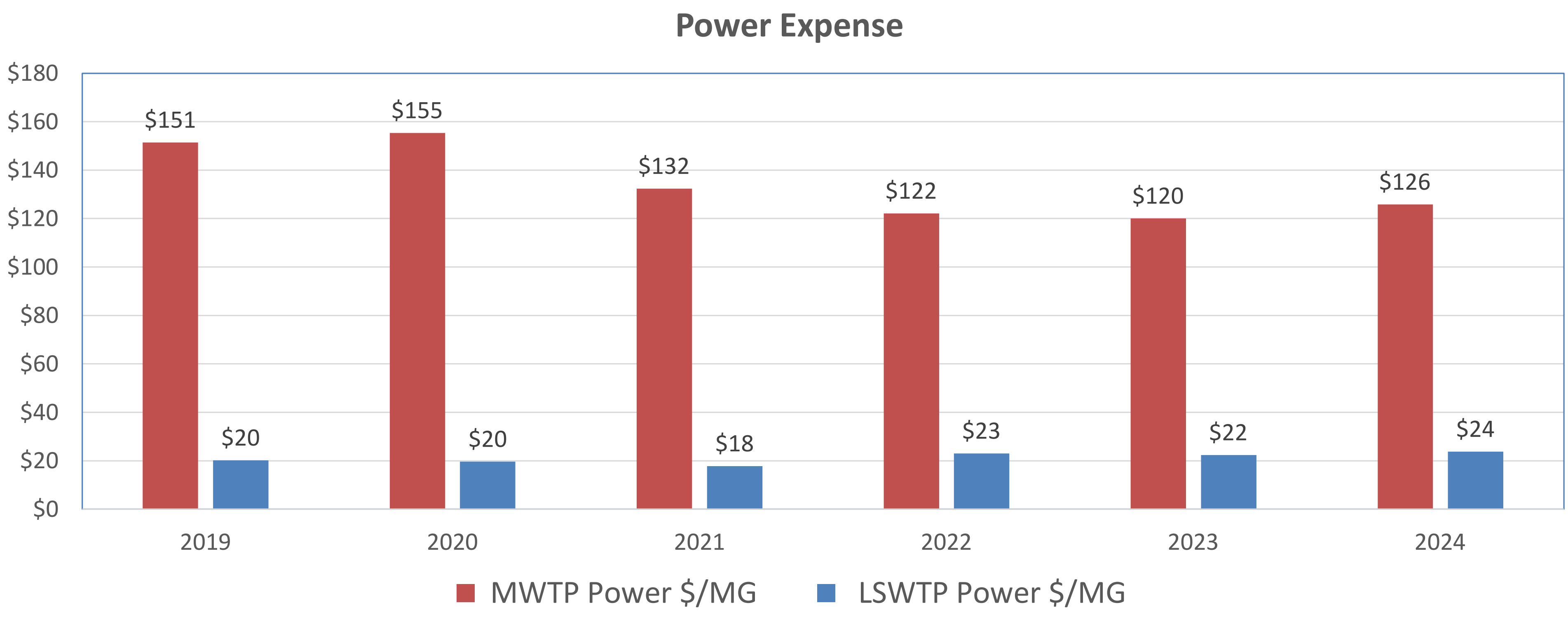
Major Cost to Produce Water



Chemical Cost

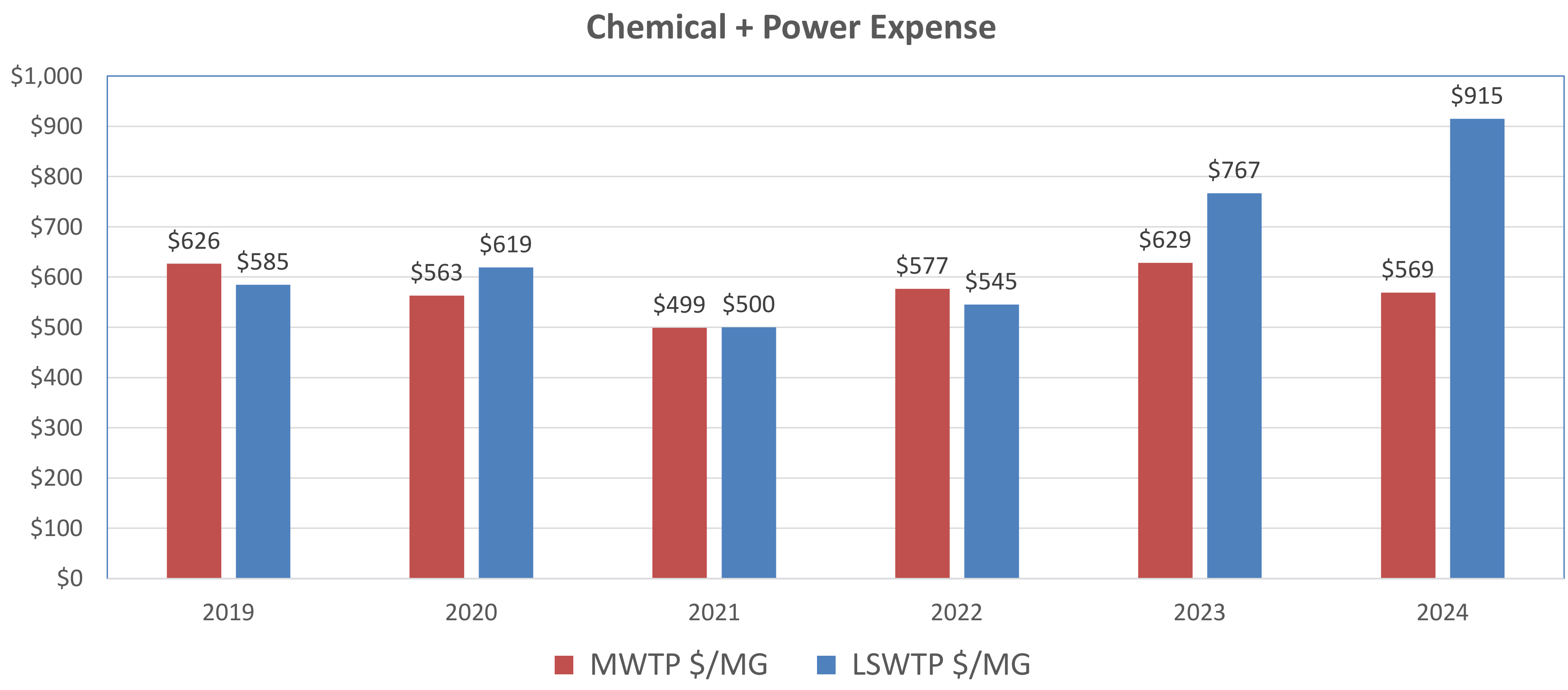


Power Cost

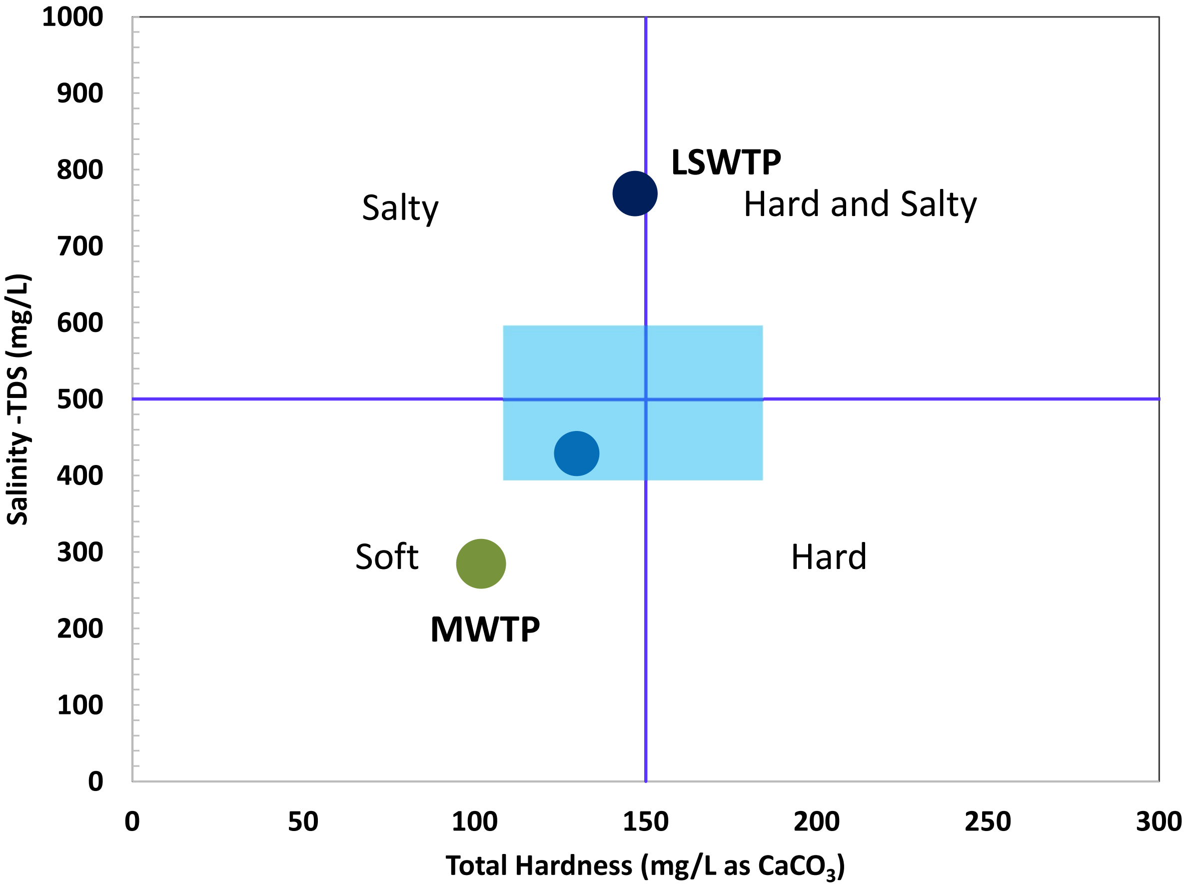


Power Expense
$180
$160
$140
$120
$100
$80
$60
$40
$20
$0
$151
$20
$155
$20
$132
$18
$122
$23
$120
$22
$126
$24
2019
2020
2021
2022
2023
2024
MWTP Power $/MG
LSWTP Power $/MG

Cost to Produce Water

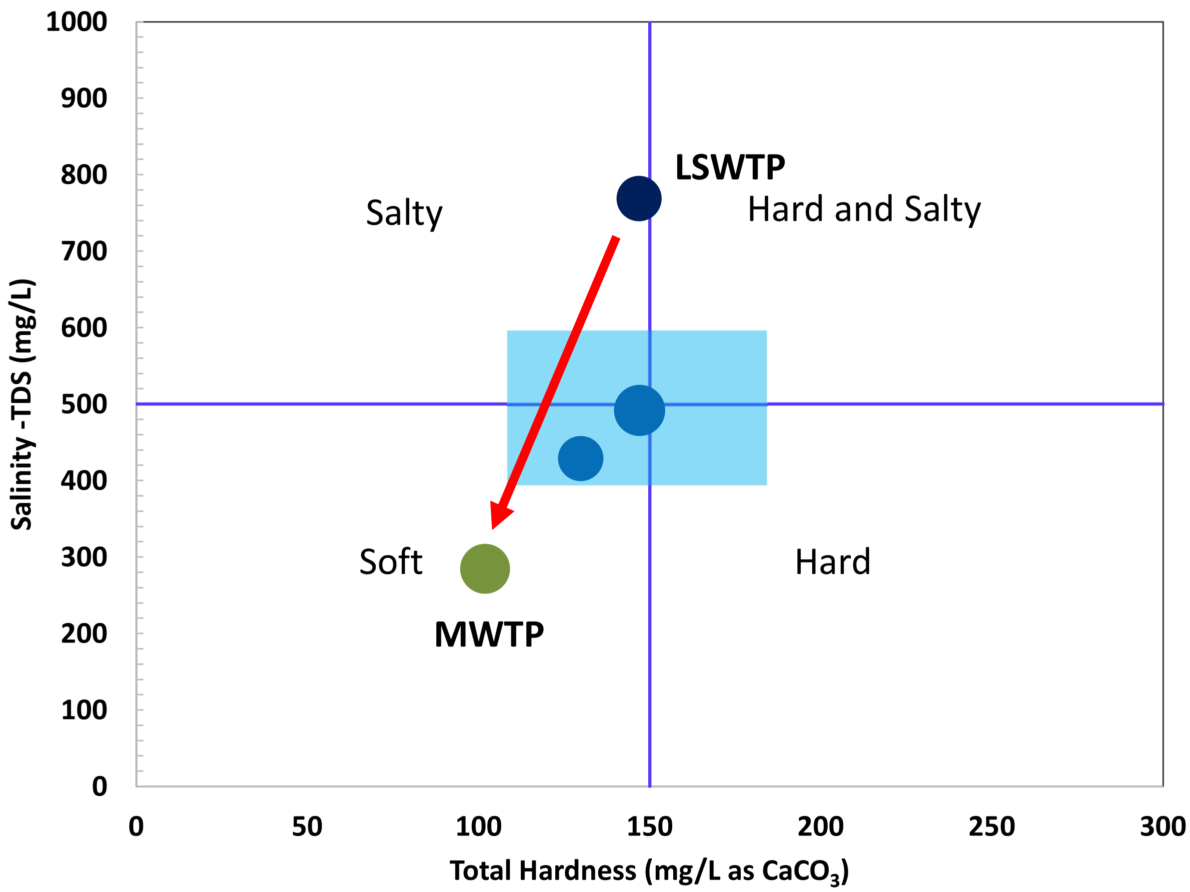


LSWTP and MWTP Finished Water Quality



- The finished water from the Membrane WTP is much softer, lower TDS , and lower TOC.

LSWTP and MWTP Finished Water Quality



To match the water quality from the MWTP, LSWTP will have to:

1. Lower Total Hardness
2. Lower TDS

1. Use more lime and soda ash to drive up chemical cost
2. Produce more sludge to increase landfill cost

What will be the total cost impact?

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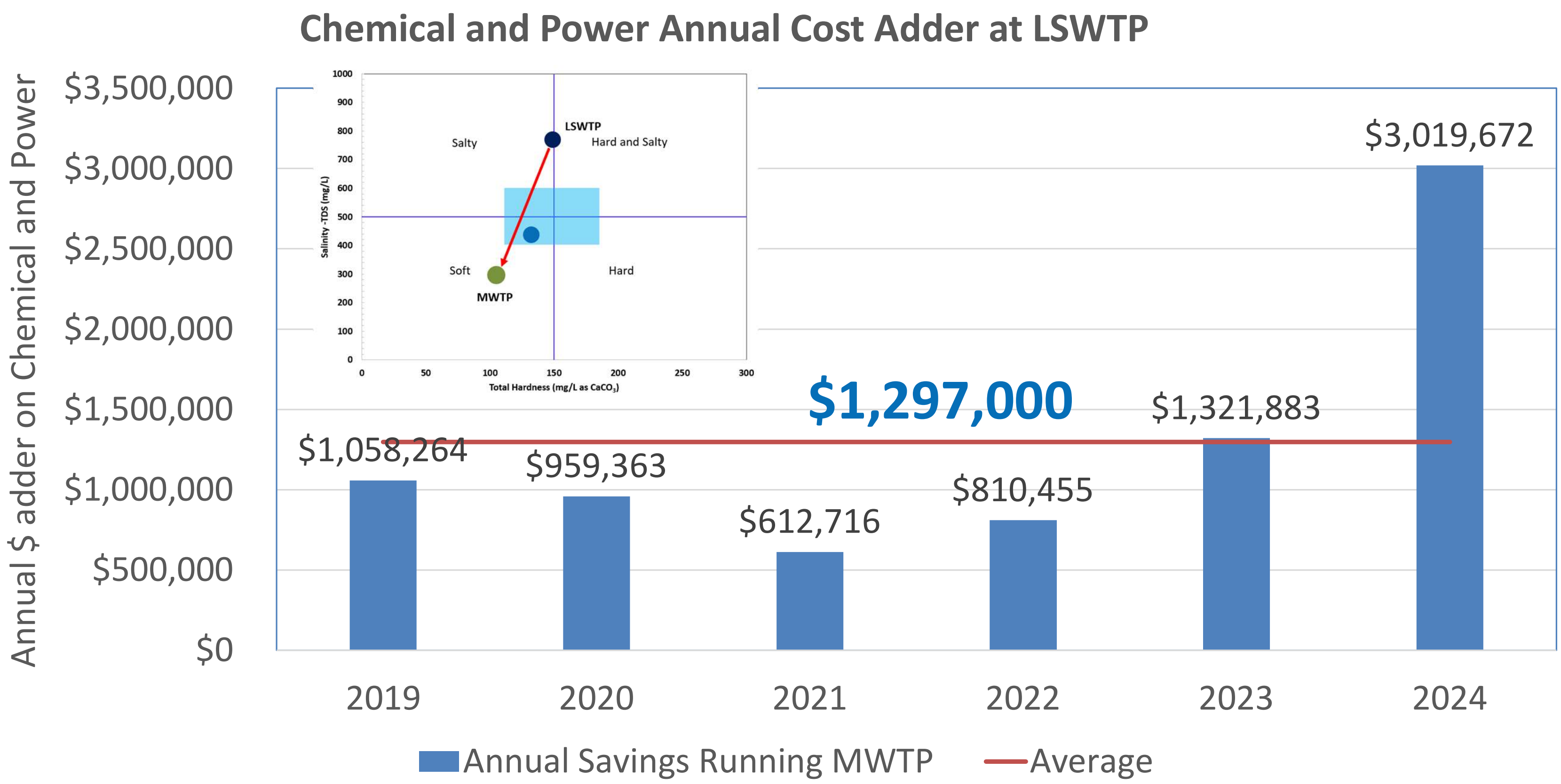
Production Cost Impact



Strategy to Run Both Plants

Knowing the membrane process is more cost-efficient, the plant staff relies more on the MWTP to manage both water quality and production costs.

---

1. **Maintain high production** at the membrane water treatment plant (WTP).
2. **Transfer RO permeate** to the lime-softening WTP to support overall system performance.
3. **Slightly elevate total hardness** in the effluent from the lime-softening basins to reduce lime and soda ash usage and associated chemical costs.
4. **Minimize scaling** in the primary softening basin and downstream processes to help lower operations and maintenance (O&M) expenses.

Supporting Projects

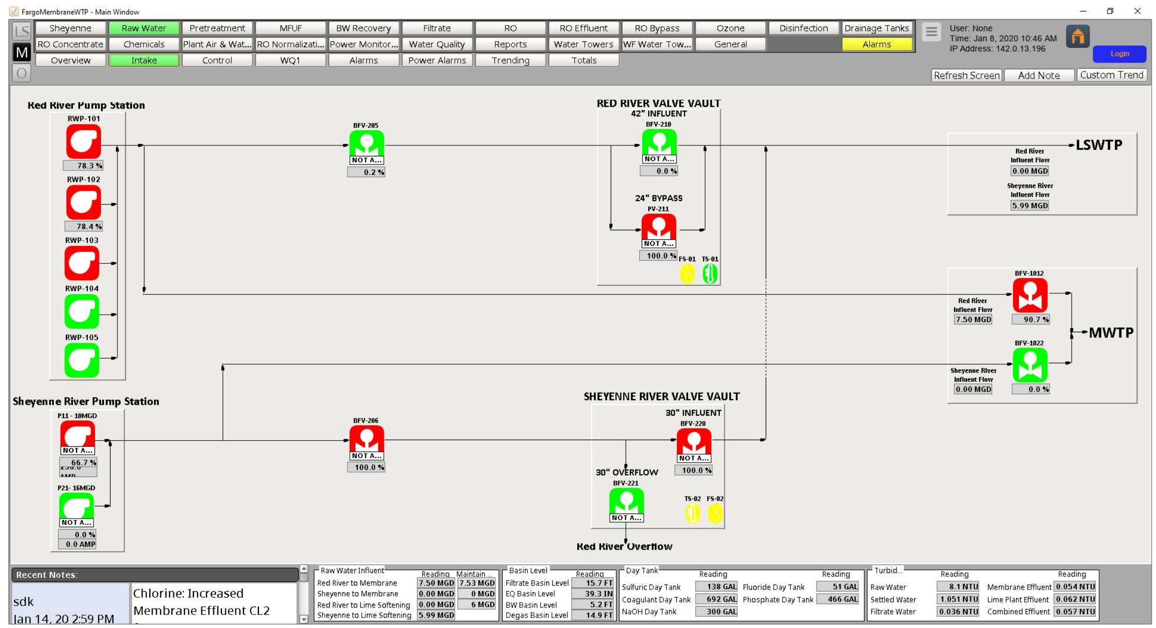
A series of projects/programs aimed at enabling Fargo WTP staff to operate both plants with optimal cost efficiency and water quality:

---

1. **Red and Sheyenne Raw Water Intake Projects**
2. **Raw Water Meter/Valve Vault Project *(with photos)***
3. **Grow Our Own Staff**
    - Routine Staff Training Program
    - Conferences/Workshop
4. **Empowering our staff to develop innovative solutions**.

Supporting Projects – Intake Projects

Supporting Projects – Raw Water Valve Vault



Supporting Projects – Routine Training Program

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Plant Innovations and Operations Creativities to Get the Job Done

Membrane Replacement Schedule

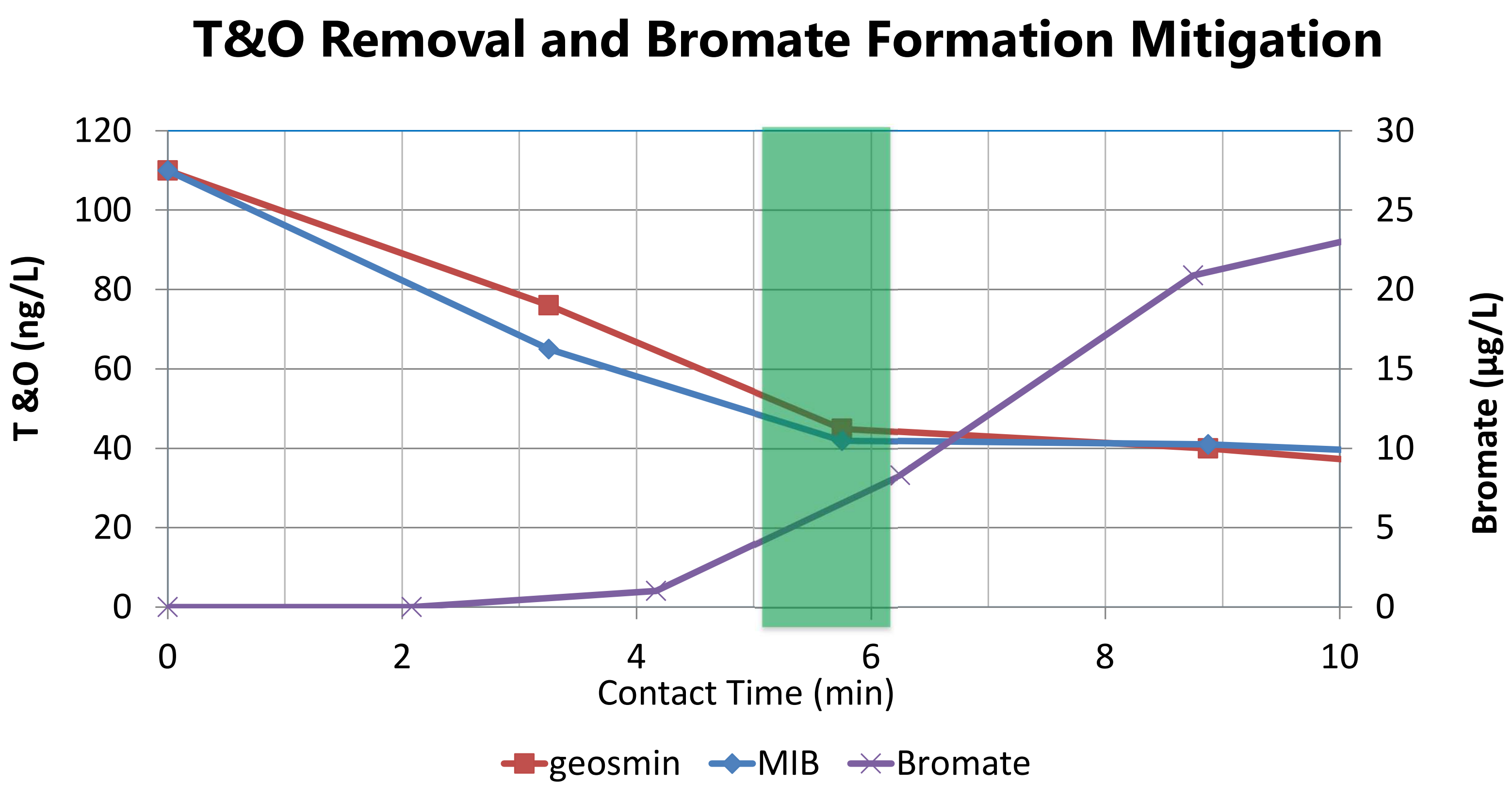
1. **Accelerate UF membrane replacement schedule:**
   - Release the stress on the operation team to repair broken fibers
   - Increase MWTP treatment availability to manage the overall cost and production
2. **Steady pace to replace RO membranes**
   - Competitive RFP to reduce the replacement cost
   - Manage RO permeate quality

Select Appropriate Technology

3 **Liquid Oxygen (LOX) –VSA Installation**

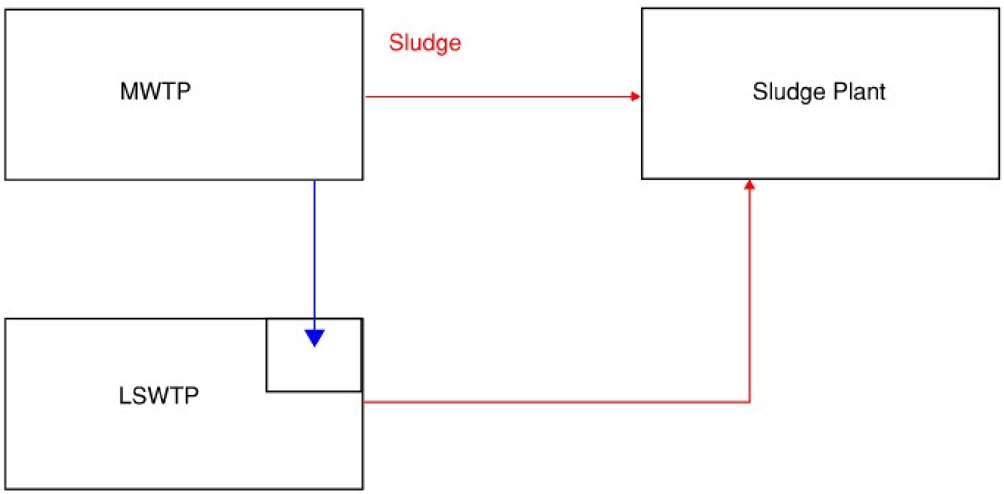
- Annual usage reduction: 624 tons
  - 2017-2018 (Ave): 1,065 tons
  - 2022-2023 (Ave): 441 tons
- Cost reduction: **$88,875** in 2024.

Data Driven Operation Decision to Improve Water Quality



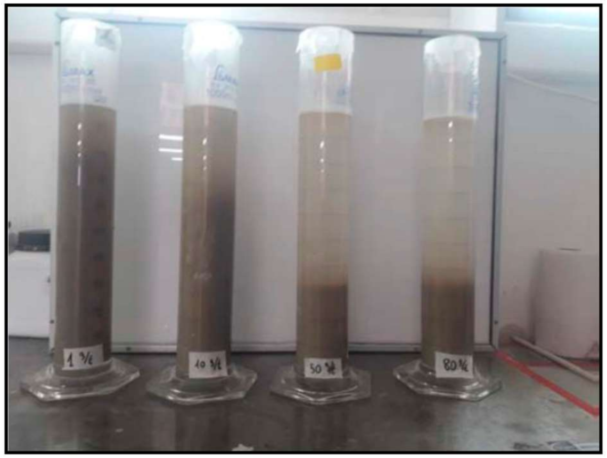
Fargo WTP T&O Ozone Pilot Study (2013)

Creative Plant Operation – Sludge Thickening

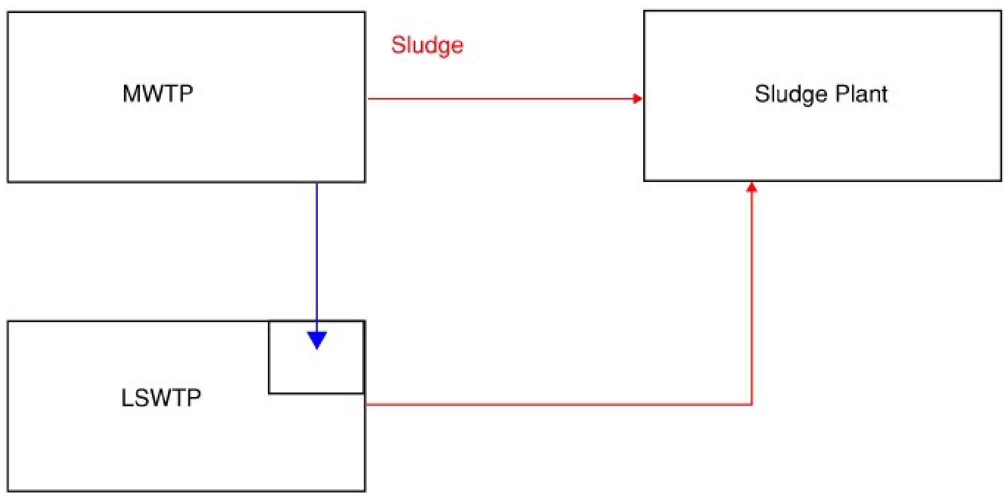


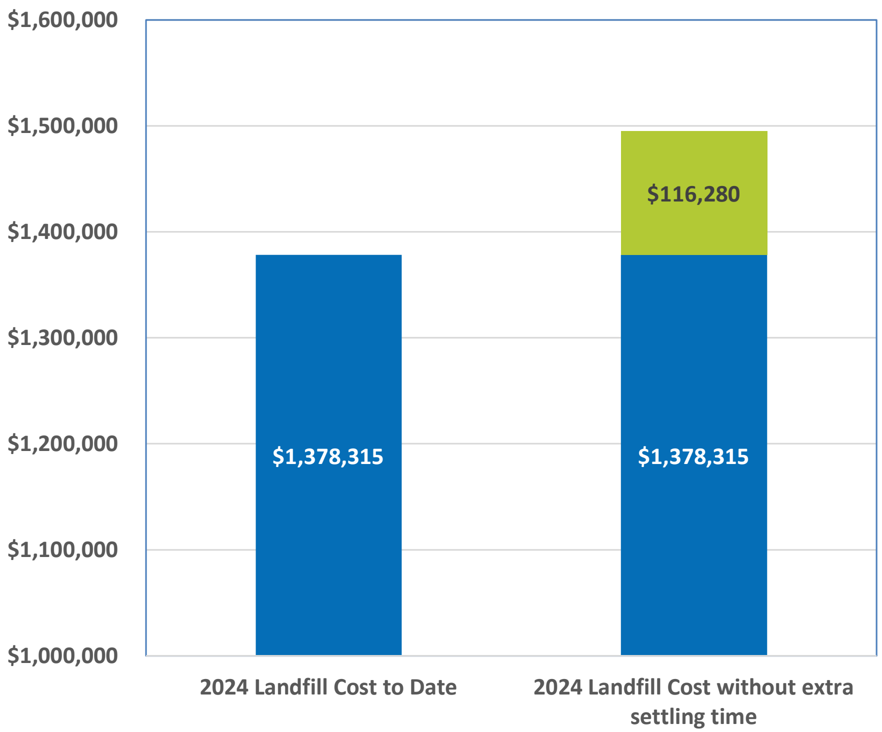
Solids content increased from 37% up to 41% on an average.

What is the impact?



Creative Plant Operation – Sludge Thickening





Compared to 2023 Data

Staff Go Above and Beyond

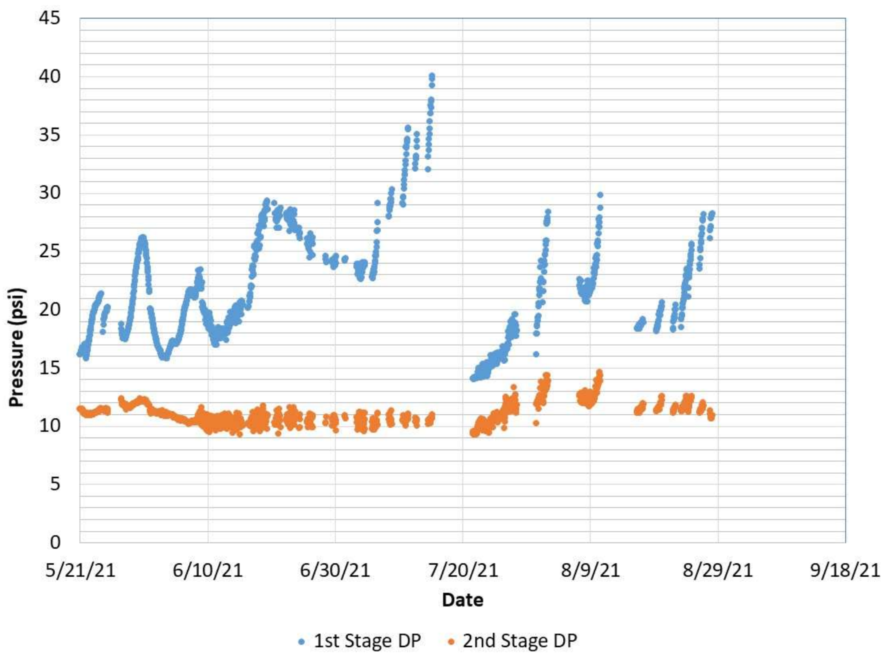
0.02 N Standard acid solution for online hardness and alkalinity instrument:

Home-Made

- 40% sulfuric acid: $0.53-$0.77/lb
- Weekly Usage: 80-100 mL
- Annual Cost: $6-$9

Annual Saving: $40,000

Staff Go Above and Beyond



1. Feed chlorine to Filtrate wetwell
2. Feed sodium bisulfite to quench chlorine residuals
3. Relocate anti-scalant feed point
4. Install an inline mixer
5. Feed hydrogen peroxide to RO feed
6. Test various anti-scalants
7. Test a biocide (NSF approved)
8. Evaluated various CIP regimes
   1) Circulate time/flow rate
   2) Soaking time
   3) CIP chemicals
9. Rinse the 1st stage lead elements
10. Replace the RO element interconnectors
11. Replace RO brine seals
12. Relocate 1st stage lead RO elements
13. Blackboxes monitoring
14. Bacteriological testing (HPC)
15. Membrane autopsy
16. Cleaning study

Cost Efficiency

1. **MWTP Design: $1.30 million annually**
    - RO Transfer line
    - Biological GAC after ozone-peroxide
    - Cost information analysis tools
2. **LSWTP Solids Production Avoidance ($1,7-$3.3 million)**
3. **Ozone: Phase 2: $60,000 annually**
    - VSA System Installation
4. **MWTP Sludge Settling: $100,000-$150,000 annually**
    - 2024 to landfill: 37% → 41%
    - Hauling less water
    - Less sludge plant polymer use ($38,000)
5. **Analyzer Reagent Savings: $40,000 annually**
6. **What's left: More than $200,000 annually**
    - Increase MWTP/RO operation
    - RO CIP Optimization
    - Lime softening WTP process optimization

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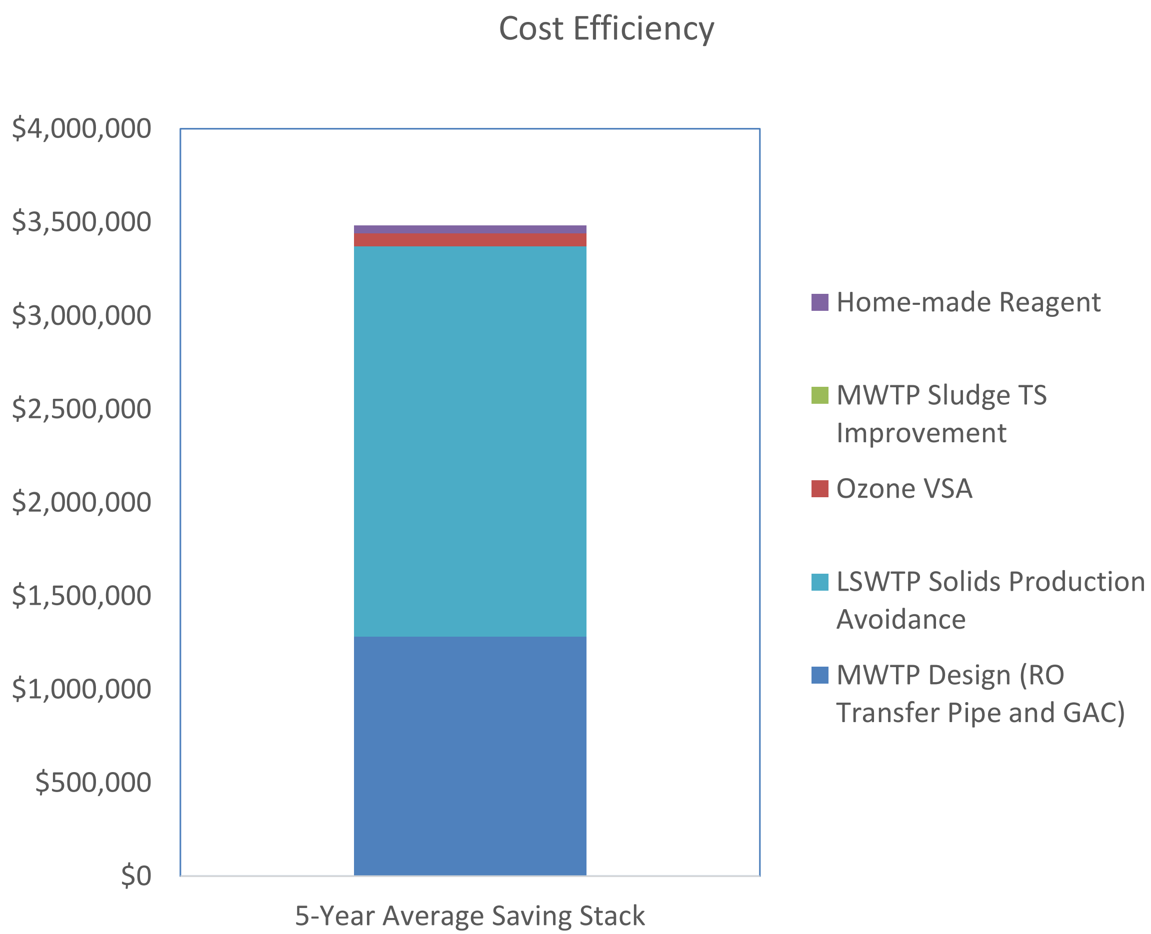
Cost Efficiency



What is in the Near Future?

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Master Planning: Next 2-3 Years

Every 7 years or so….

Assess Whole Water System

- Water Plant
- Raw Water Supply
- Water Distribution System
- Future Financial Needs

Work In-progress

- LSWTP Processes Rehab
- Treatment Process Optimization (CO2, Ozone,…)
- City-wide AMI project
- Lead Service Line Replacement

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QUESTIONS?

THANK YOU!

T. Hall, Water Utility Director, Fargo

Q. Chang, Senior Advanced Technical Specialist, AE2S

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AE2S Think Big. Go Beyond.