Pilot Testing for Iron and Manganese Removal: Successes and Challenges for Two Water Districts

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Rockwood Water People's Utility District

Thurston PUD

murraysmith

Agenda

01 TPUD and RWPUD System Overviews

02 Pilot Testing Equipment and Setup

03 Thurston PUD – Pilot Testing and Results

04 Rockwood Water PUD – Pilot Testing and Results

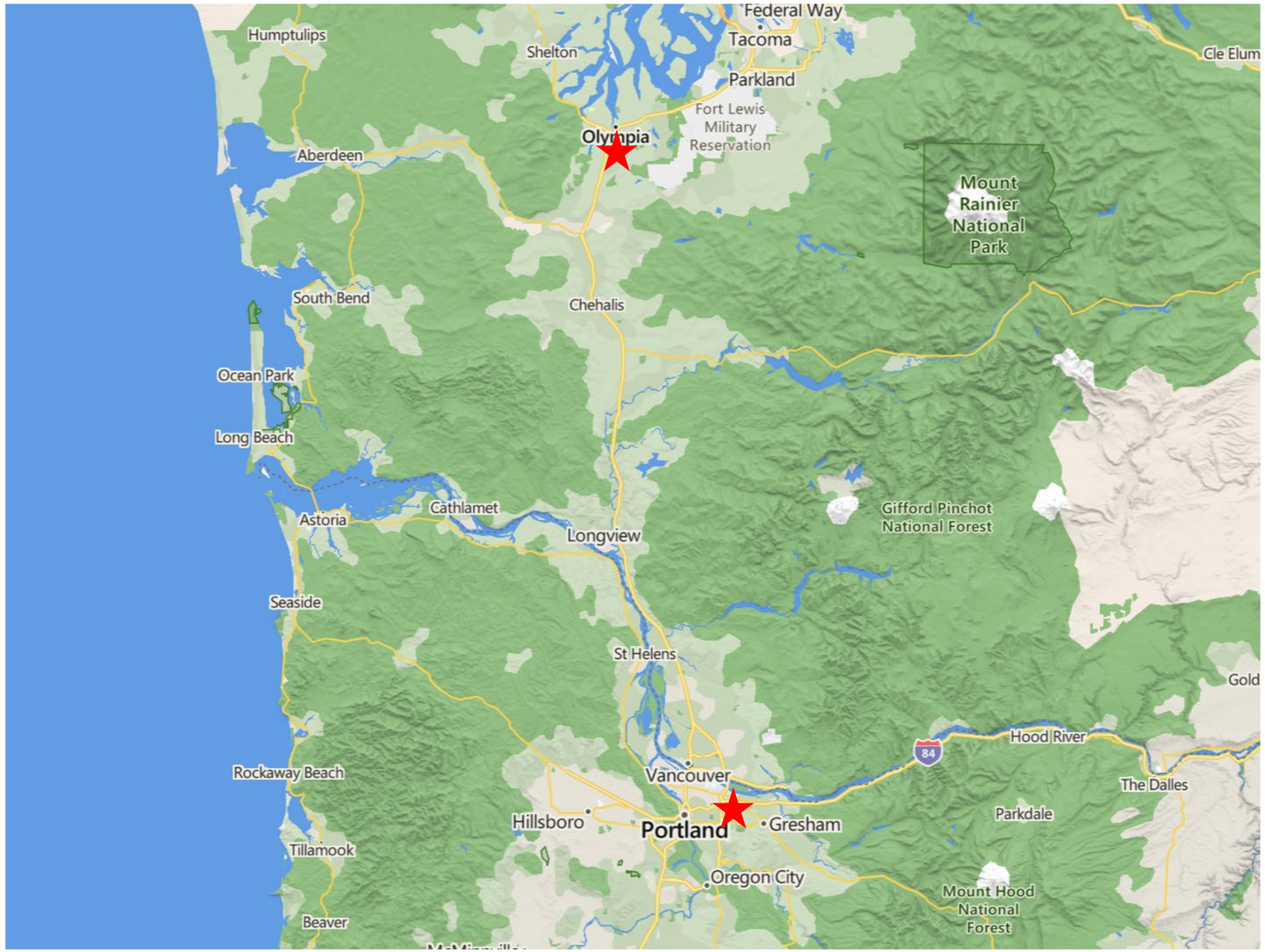
05 Summary

06 Q&A

1 - Systems Overview

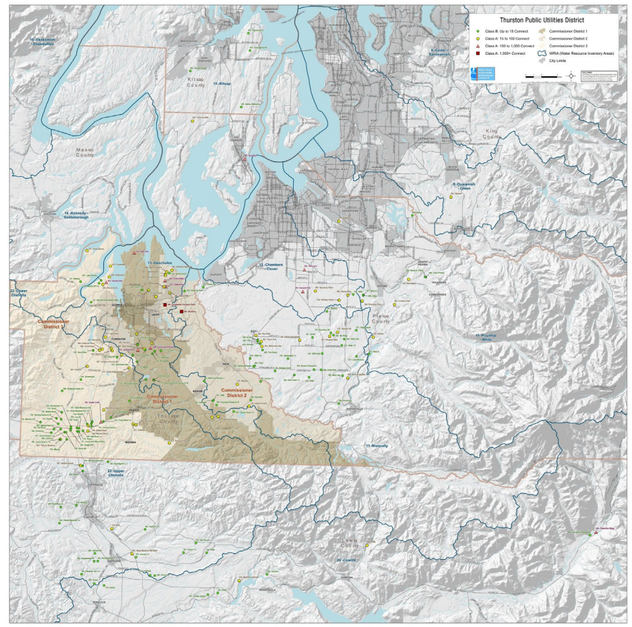
A Tale of Two Water Systems

- Thurston PUD:
  - Washington
- Rockwood WPUD:
  - Oregon



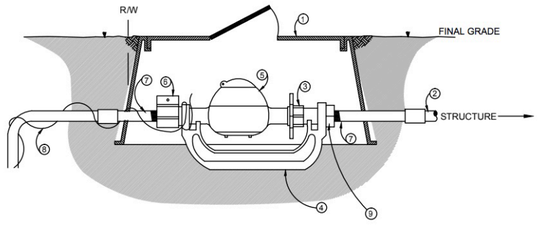
TPUD System Overview

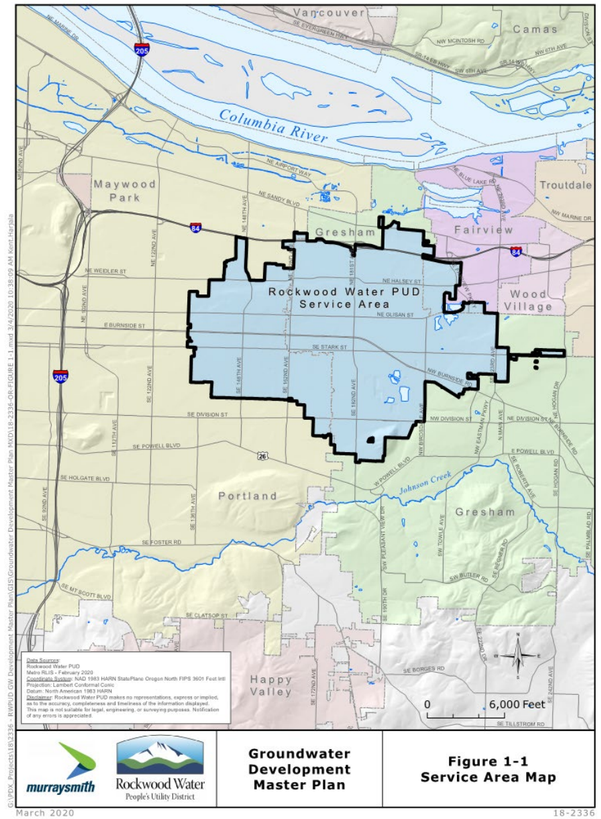
County	Number of Systems	Number of Connections
Thurston	147	5,690
Pierce	64	1,412
Lewis	54	672
Kitsap	5	28
King	1	76
Grays Harbor	4	37



Current Rockwood Water PUD System Overview

- 13,700 service connections serving approximately 65,000 residential, commercial/industrial customers in Portland, Gresham & Fairview
- 9.75 square miles
- 4 Pressure Zones
- 7 MGD average system demand
- Wholesale purchase the majority of our water from Portland Water Bureau
- Augment supply with our 3 production wells throughout the summer months





CASCADE
GROUNDWATER ALLIANCE
GRESHAM • ROCKWOOD

- The future of Rockwood Water PUD & City of Gresham
- Combined service to approximately 140,000 customers
- Partnering to develop groundwater as primary water source into the future
- Working together to drill 4 new wells (7 total), transmission piping, storage, disinfection & manganese removal treatment for 30 MGD by 2026
- Manganese removal is a significant part of this effort which is why we had MSA come out and do some pilot testing for us

The EPA has set a Secondary MCLs (not health threatening) for Iron and Manganese as concentrations above the SMCL can cause discoloration, staining and a bitter or metallic taste.

Iron SMCL .3mg/L

Rusty color; sediment; metallic taste; reddish or orange staining

Manganese SMCL .05mg/L

Black to brown color; black staining; bitter metallic taste

RWPUD Current Fe & Mn

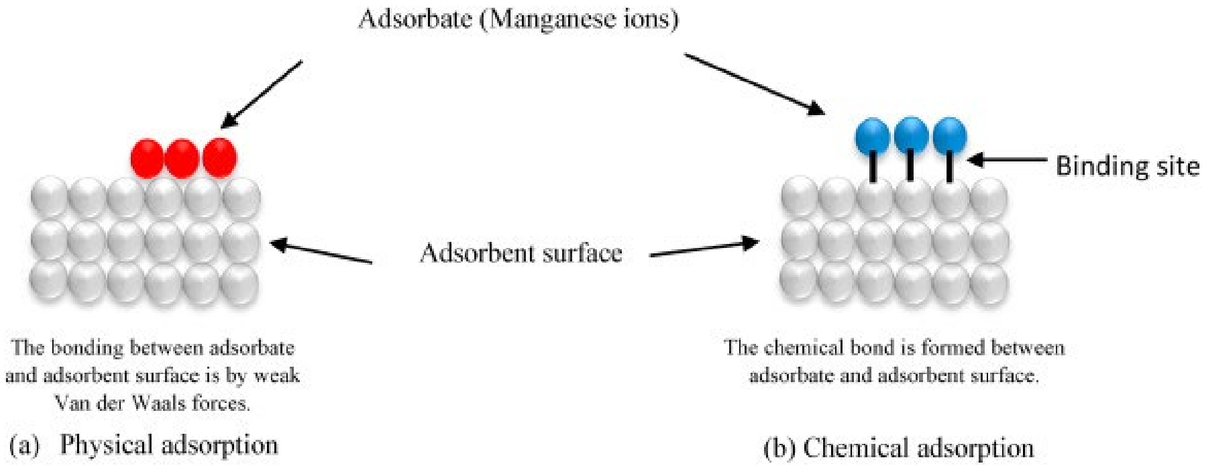
Iron: <.1 mg/L

Manganese: >.1 mg/L

2 - Pilot Testing Equipment and Setup

Removal Mechanisms

- Precipitation,
- Adsorption,
- Ion exchange, and
- Biological uptake.



- Pilot testing setup is designed to maximize precipitation and adsorption mechanisms
  - Oxidation Using Chlorine and/or Permanganate
  - Adsorption using Oxidized Pyrolusite Media

2

Pilot Testing Equipment:

- Two Stage Filters
- 4” Columns
- 6” Gravel Under-Drain
- 42” Manganese Dioxide Media

Pilot System Design Criteria

Criteria	Value
Plant Capacity (gpm)	8
Operating Pressure, psig	75
Run Time (hours/day)	12
Average Day Run Time (hours/day)	12
Pilot Filters	
Diameter of Vessels, ft	0.33
Surface areas, per vessel, sq ft	0.1
Number of Vessels	4 (1^{st} Stage) and 4 (2^{nd} Stage)
Loading Rate, gpm/sq ft	5-12
Media Depth, in	42
Media Volume, Cubic ft	1.2
Media Weight, lbs	143
Backwash	
Backwash Flow Rate, Each Vessel	1.3
Backwash Frequency, Hrs	24
Backwash Duration (min)	5
Backwash Volume, Gal/Backwash	26
Number of Backwashes Per Day	1
Backwash % of Production	0.22%
Chlorine	
Dose, mg/L	4.0
Dose (lbs/day)	0.1
Solution Strength	8.9%
Solution Feed Rate (gal/hr) each	0.01
Chemical Feed Tanks	1
Chemical Feed Tank Volume (gal)	5
Tank Storage (days)	40

2

Pilot System – Chemical Feed Equipment

STENNER PUMPS

Stenner Single Head Adjustable Output Pump 0.2 - 3 GPD #1 Tube 120V 25 psi

Part Number: 45MJL1A1S

45 SERIES PUMP ADJUSTABLE OUTPUT

Single Head Model	Maximum Pressure	Pump Tube Number	Approximate Output @ 60 Hz: gallons per day	liters per day	gallons per hour	liters per hour	ounces per minute	milliliters per minute	Approximate Output @ 50 Hz: liters per day	liters per hour	milliliters per minute
45MHP2* 45M1	100 psi (6.9 bar) 25 psi (1.7 bar)	#1 #1	0.2 to 3.0	0.8 to 11.4	0.01 to 0.13	0.03 to 0.48	0.02 to 0.27	0.56 to 7.92	0.6 to 9.1	0.03 to 0.38	0.31 to 6.32
45MHP10* 45M2	100 psi (6.9 bar) 25 psi (1.7 bar)	#2 #2	0.5 to 10.0	1.9 to 37.9	0.02 to 0.42	0.08 to 1.58	0.04 to 0.89	1.32 to 26.32	1.5 to 30.3	0.06 to 1.26	1.04 to 21.04
45MHP22* 45M3	100 psi (6.9 bar) 25 psi (1.7 bar)	#7 #3	1.1 to 22.0	4.2 to 83.3	0.05 to 0.92	0.18 to 3.47	0.10 to 1.96	2.92 to 57.85	3.3 to 66.6	0.14 to 2.78	2.29 to 46.25
45M4	25 psi (1.7 bar)	#4	1.7 to 35.0	6.4 to 132.5	0.07 to 1.46	0.27 to 5.52	0.15 to 3.11	4.44 to 92.01	5.1 to 106.0	0.21 to 4.42	3.54 to 73.61
45M5	25 psi (1.7 bar)	#5	2.5 to 50.0	9.5 to 189.3	0.10 to 2.08	0.40 to 7.89	0.22 to 4.44	6.60 to 131.46	7.6 to 151.4	0.32 to 6.31	5.28 to 105.14

*Pump supplied with injection check valve for 26-100 psi (1.7-6.9 bar) applications

Pilot Trailer Walk-Through

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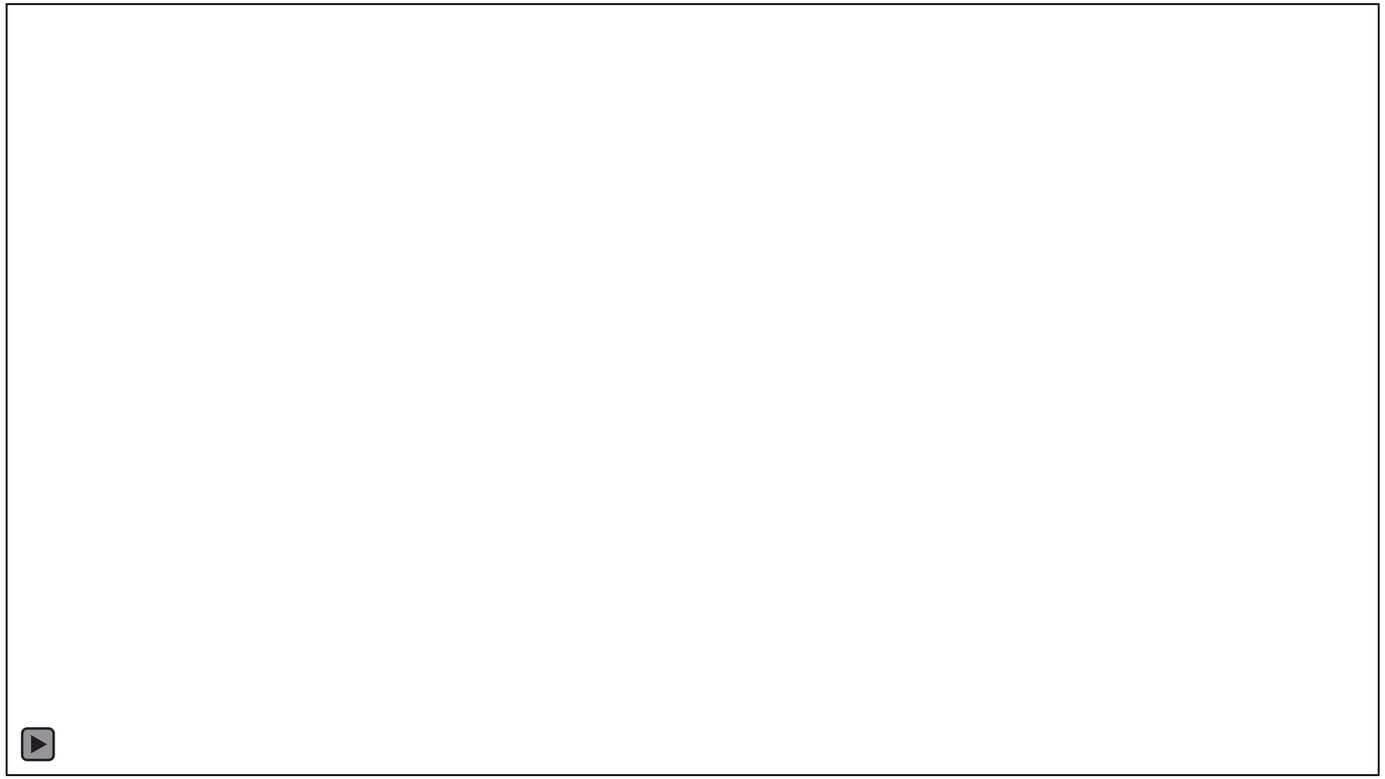

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Pilot Testing

- Field Testing
  - HACH DR900
  - RW & FW
    - Iron & Manganese
    - Chlorine: Free & Total
    - H_2S
    - Ammonia
    - pH, temp, Pressure Drop

- Lab Testing
  - RW & FW
    - Iron & Manganese
    - Ammonia
    - Arsenic
    - Alkalinity
    - Ca, Cl, Na
    - Radon

3 - Thurston PUD:
Pilot Testing and Results

Pilot Testing

3

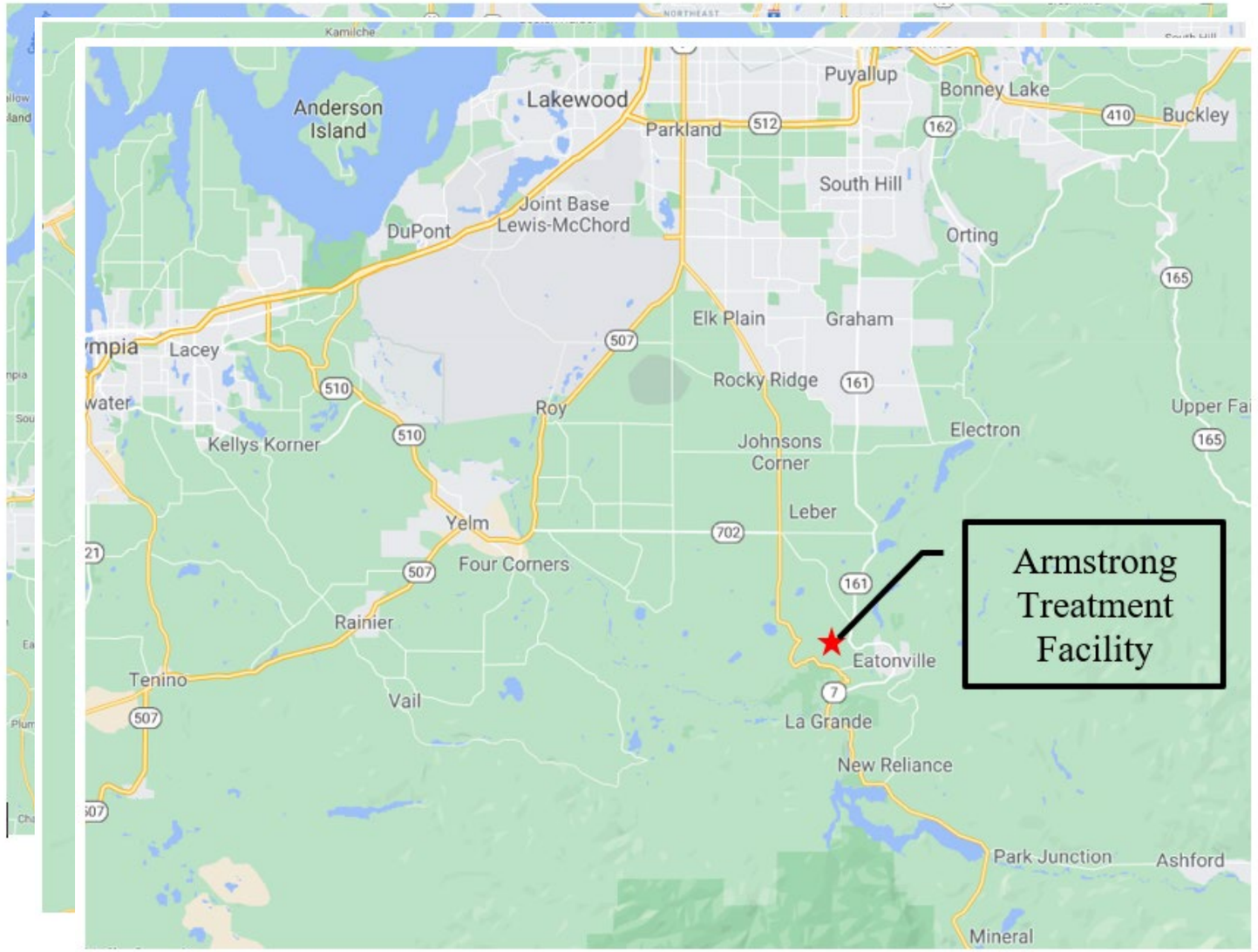
Testing Approach:

- Tested at 3 Locations:
  - Webster Hill
  - Eastridge West (2 Days of Testing)
  - Armstrong
- Observed elevated concentrations of Iron and Manganese at all sites
- Individual site challenges
- 20 – 100 gpm design capacity range
- 1 stage filtration and 2 stage filtration
- Chemical Feed: Chlorine, Permanganate
- Media: Pylox Advantage

Physical	Black granular media
pH Range	6.4—9.5
Max. Water Temp	115 degrees F
Specific Gravity	
Minimum Bed Depth	24"
Effective Size	
Freeboard	Minimum 40%
Uniformity Coefficient	< 1.8
Service Flow Rate	2 - 12 gpm/sq. ft.
Mesh Size	20 x 40
Bulk Density	88 lbs./sq. ft.
Backwash Flow Rate	10-20 gpm/sq. ft.
Backwash Expansion	15 - 50%
Packaging	20 or 1,000 kilo bags

Site Locations

- Webster Hill
  - Graham, WA
- Eastridge West
  - Centralia, WA
- Armstrong
  - Eatonville, WA

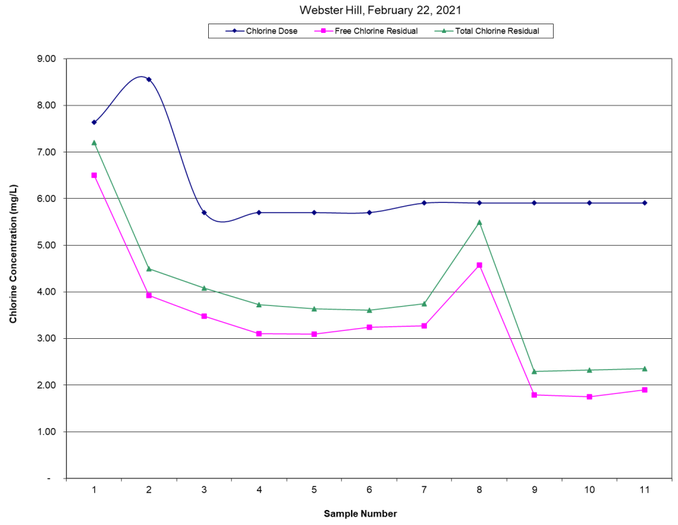


System Overview and Raw Water Quality

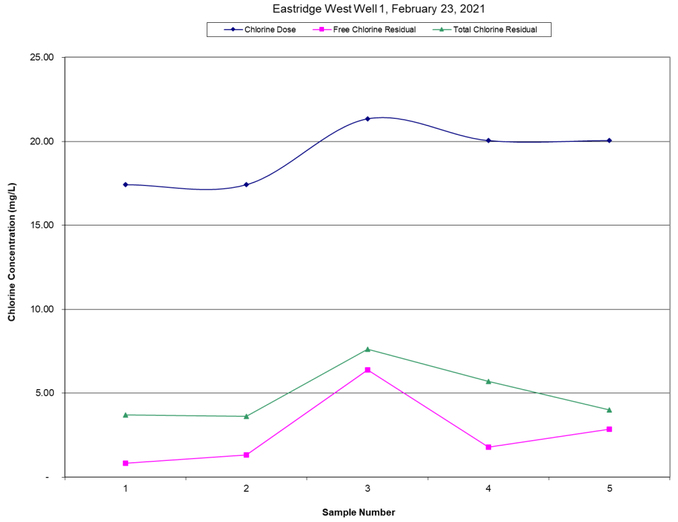
Planning Criteria	Webster Hill	Eastridge West	Armstrong
Well No. 1 Operating Flow, gpm	100	20	30
System Pressure, psi	75	75	75
Raw Water Quality			
pH, S.U.	6.3	6.49	7.87
Temperature, ^{o}C	15-20	15-20	15-20
Conductivity, umhos/cm^2	-	-	-
*Total Hardness, mg/L as $CaCO_3$	58	96	40
Iron, Total, mg/L	0.08	8.7	2.7
Manganese, Total, mg/L	0.196	0.68	0.40

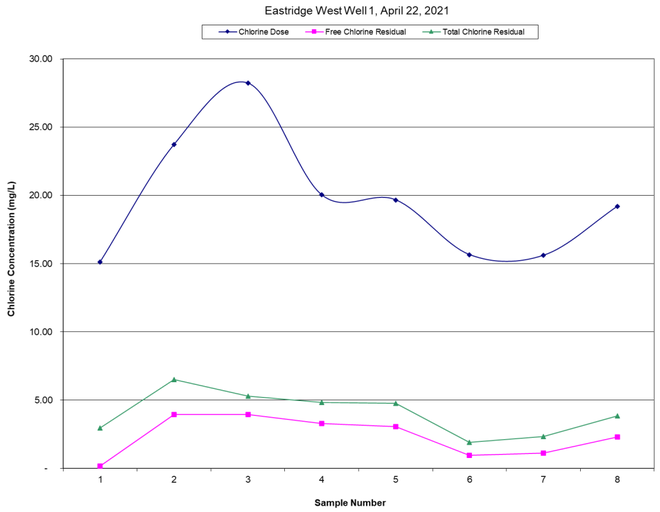
Chlorine Dosing

Webster Hill

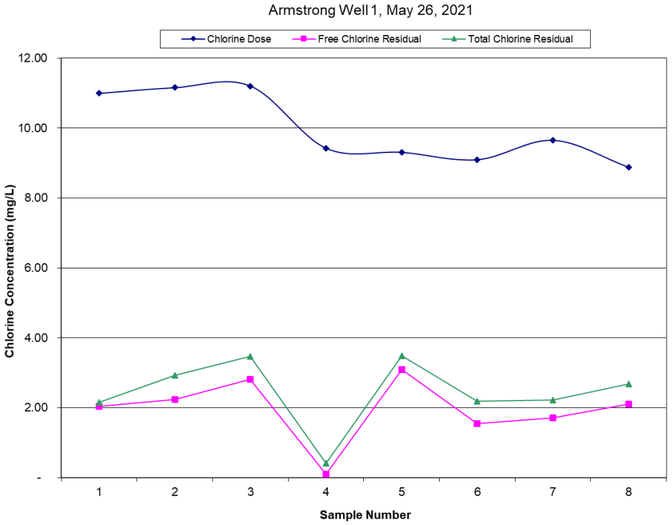


Eastridge West



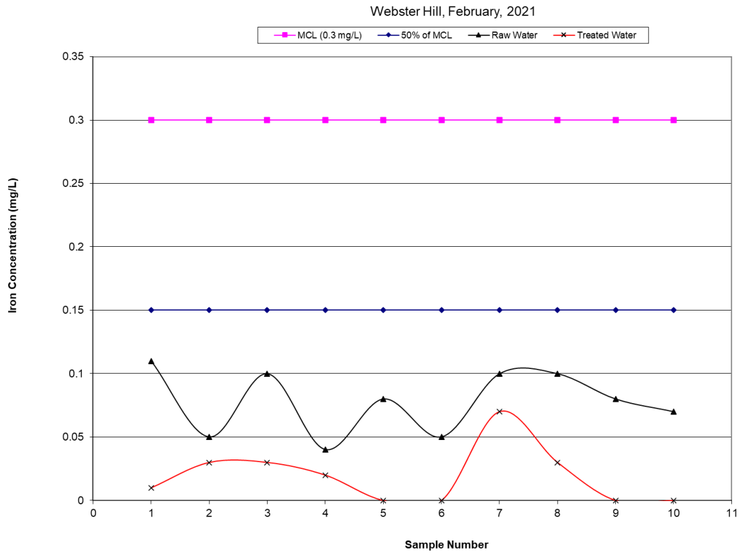


Armstrong

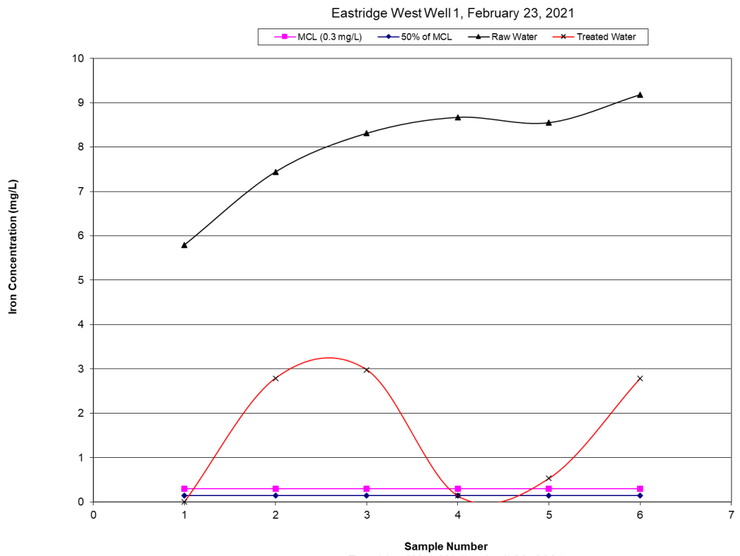


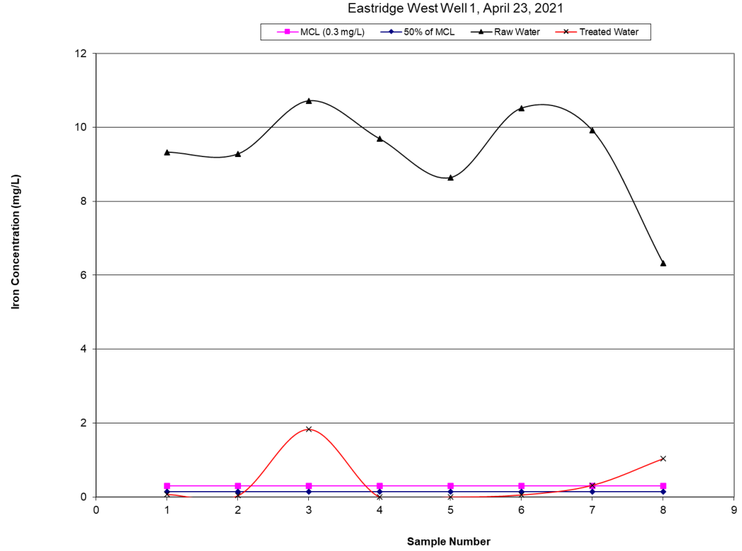
Iron Removal

Webster Hill



Eastridge West





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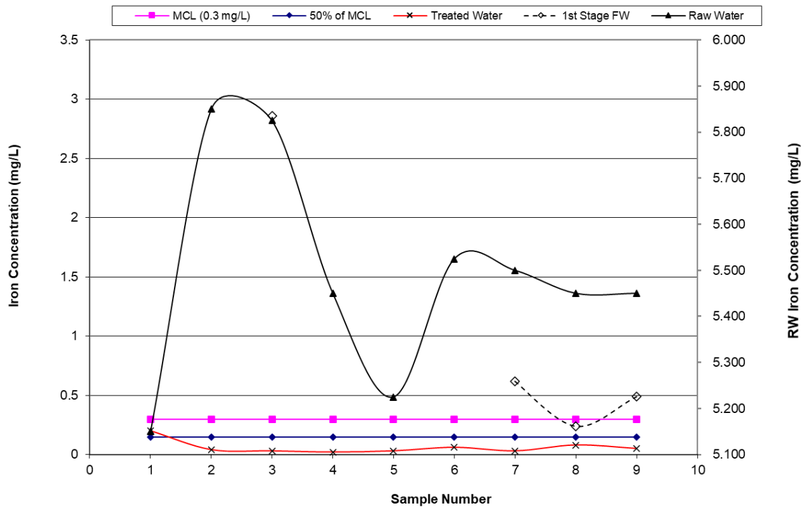
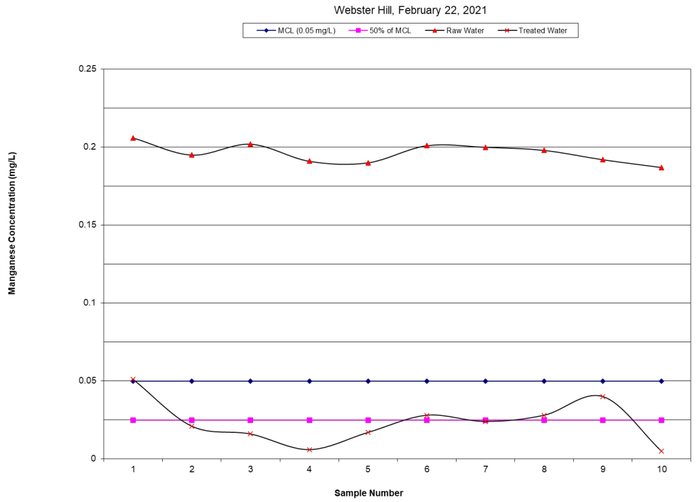
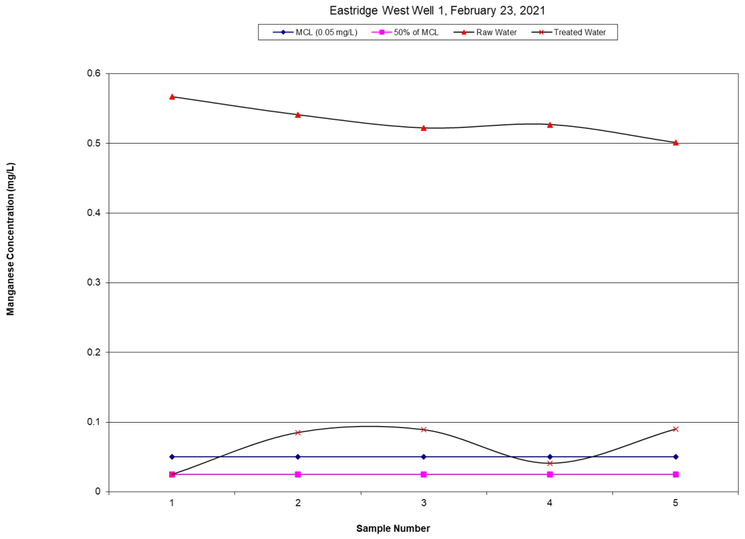


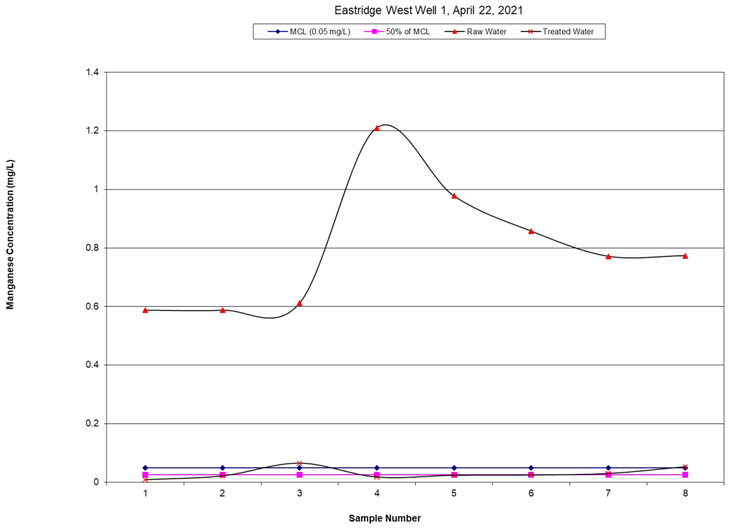
Manganese Removal

Webster Hill

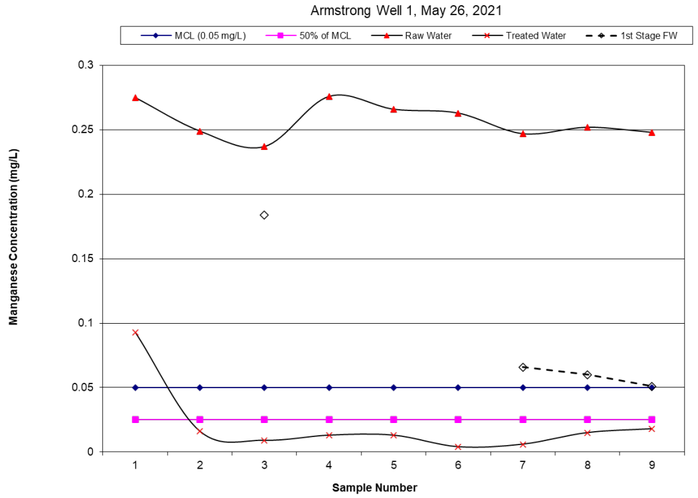


Eastridge West





Armstrong



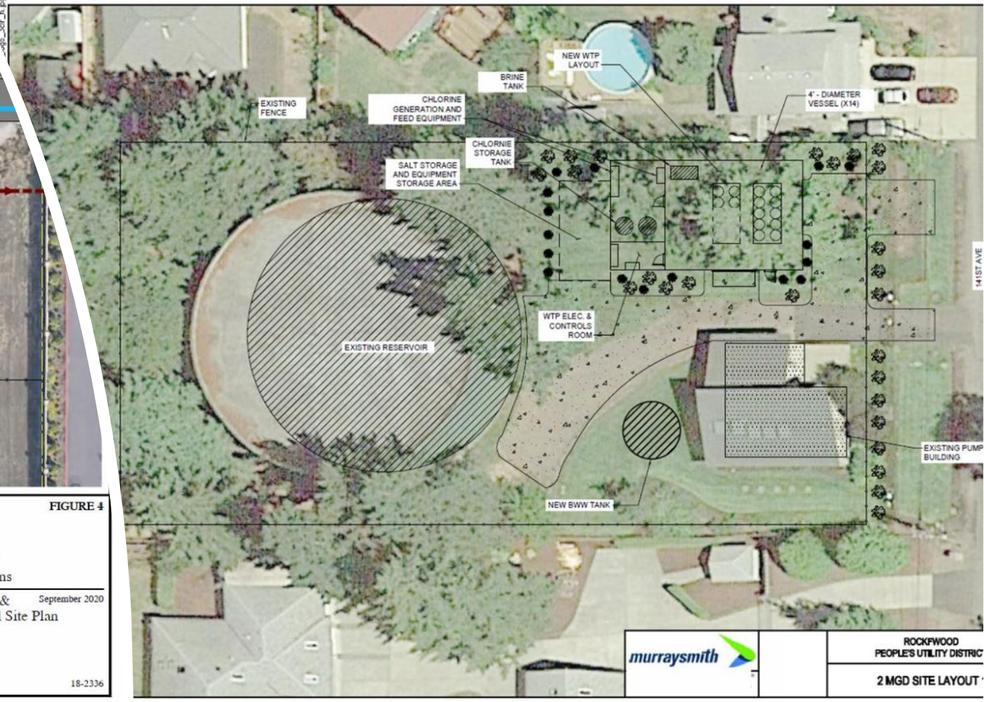
4 - Rockwood WPUD: *Pilot Testing and Results*

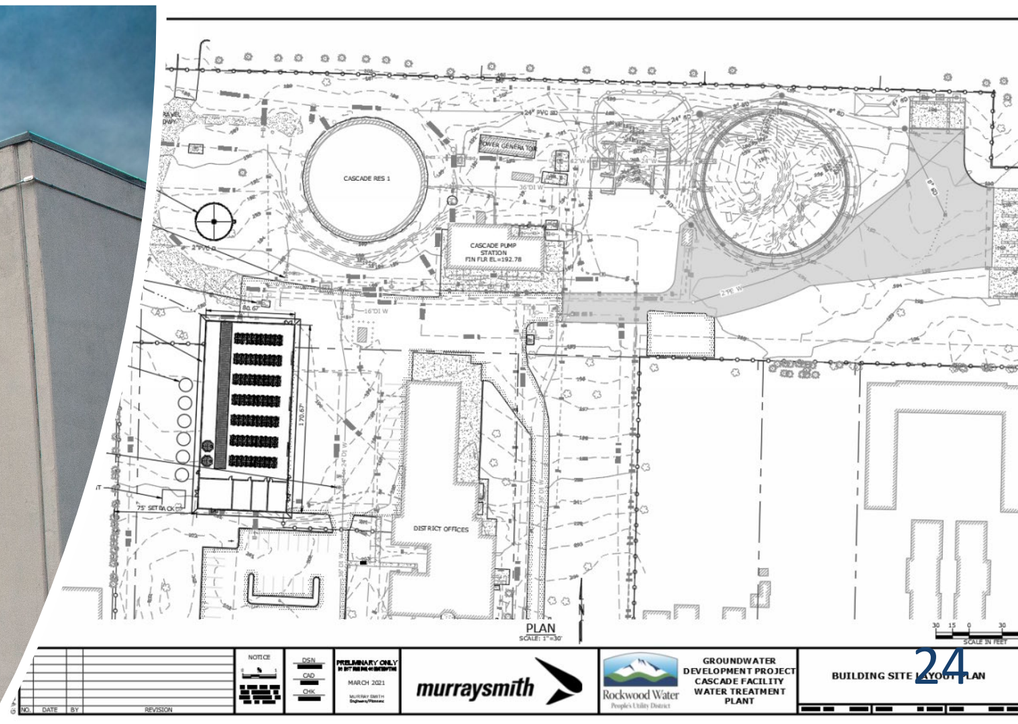
Piloted Wells & Planned Treatment Facilities Testing Completed between Dec. '20-Apr. '21

- Cascade Facilities
  - Well 3 – 3.6 MGD (Piloted)
  - Well 4 – 6.6 MGD (Piloted)
  - Well 5 – 7.8 MGD (Piloted)
  - Well 7 – 5.7 MGD
  - Well 9 – 4.3 MGD (Piloted)
  - **Total = 30 MGD peak capacity**

- 141st WTP
  - Not Piloted
  - 2-5 MGD

- Cascade Well 6 Plant
  - Not Piloted
  - 5 MGD





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Testing Approach:

- Tested 2 Types of Media
  - Prince Minerals
    - **Pyrolox**
    - **Pyrolox Advantage**
- Cl_2 Adjustment: 2-4 mg/L
- Loading Rates: 4-12 gpm/sf

ADVANTAGES

- Effective reduction of iron, manganese and hydrogen sulfide
- Durable media with long service life

PHYSICAL PROPERTIES

- Color: Black
- Bulk Density: 120 lbs./cubic foot
- Mesh Sizes: US 8 x 20, US 20x40, UK 18/44
- Specific Gravity: 3.8
- Packaging: 60 lb. bags, 2,000 or 2,205 lb. super sacks

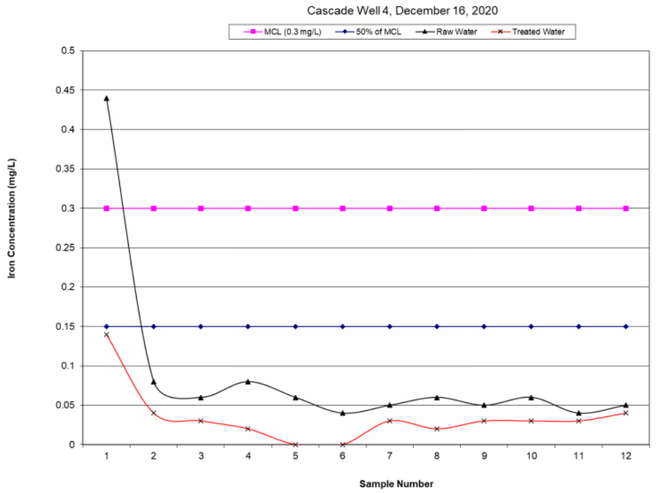
CONDITIONS FOR OPERATION

- pH: 6.5-9.0
- Bed Depth: Suggested depth 18 inches. Dependent on application and water quality.
- Backwash Flow Rate: 25-30 gpm/sq.ft.
- Freeboard: 40% of bed depth (min.)
- Underbed: Garnet #8, #8-#12. #3 Silica. Other materials are also suitable but must keep media from migrating downward and be heavy enough to remain in place during backwash.
- Service flow rate: 5 gpm/sq. ft.

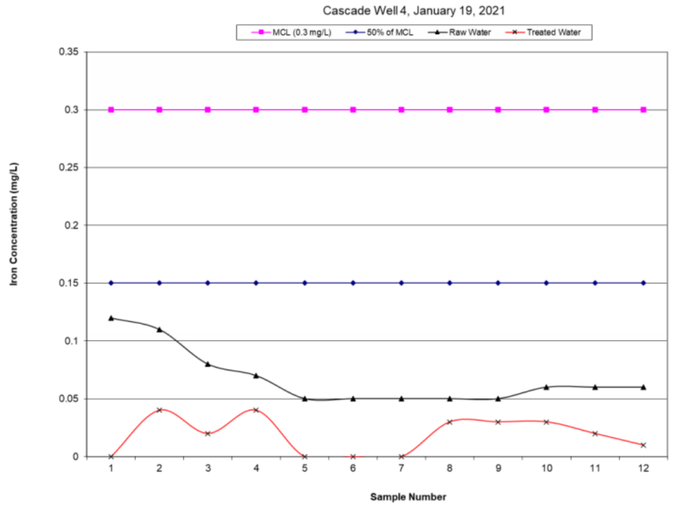
Physical	Black granular media
pH Range	6.4–9.5
Max. Water Temp	115 degrees F
Specific Gravity	
Minimum Bed Depth	24"
Effective Size	
Freeboard	Minimum 40%
Uniformity Coefficient	< 1.8
Service Flow Rate	2 - 12 gpm/sq. ft.
Mesh Size	20 x 40
Bulk Density	88 lbs./sq. ft.
Backwash Flow Rate	10-20 gpm/sq. ft.
Backwash Expansion	15 - 50%
Packaging	20 or 1,000 kilo bags

Results of Well 4 (Highest Mn Concentrations)

Iron

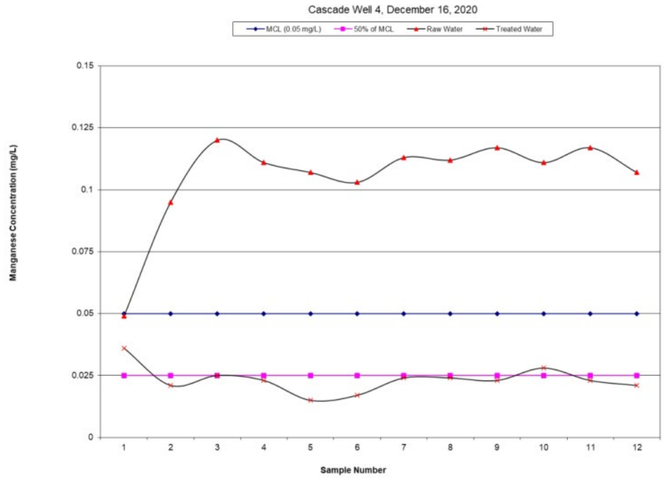


Pyrolox

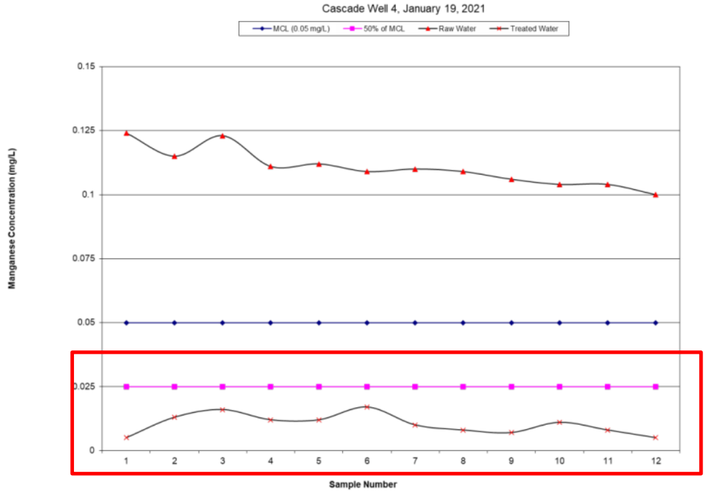


Pyrolox Advantage

Manganese



Pyrolox



Pyrolox Advantage

Typical Chlorine Demands

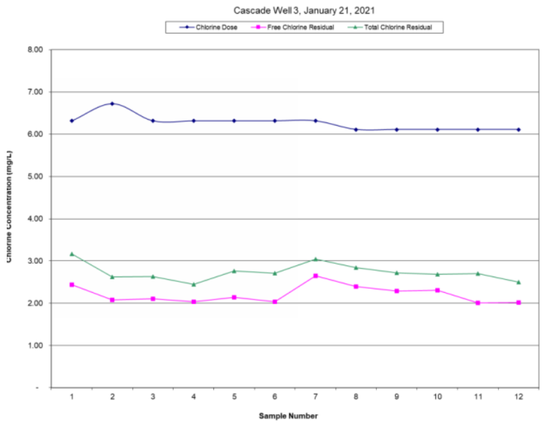


Figure 4-3. Well 3 Free and Total Chlorine Residual Concentrations

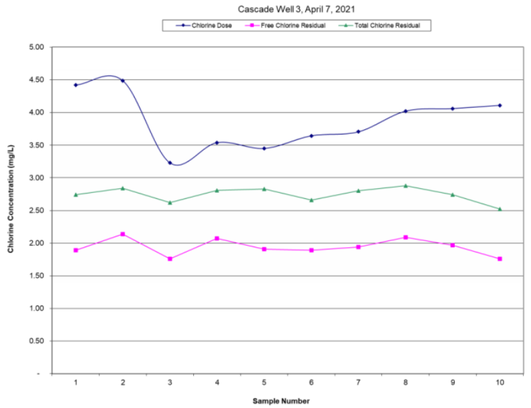
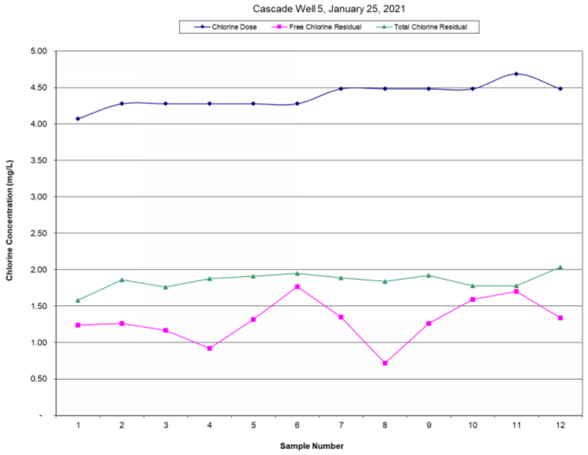


Figure 4-4. Well 3 (with High Loading Rate) Free and Total Chlorine Residual Concentrations

Well 3



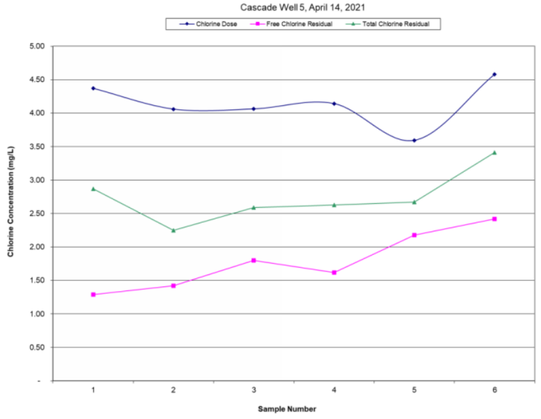


Figure 4-8. Well 5 (with High Loading Rate) Free and Total Chlorine Residual Concentrations

Well 5

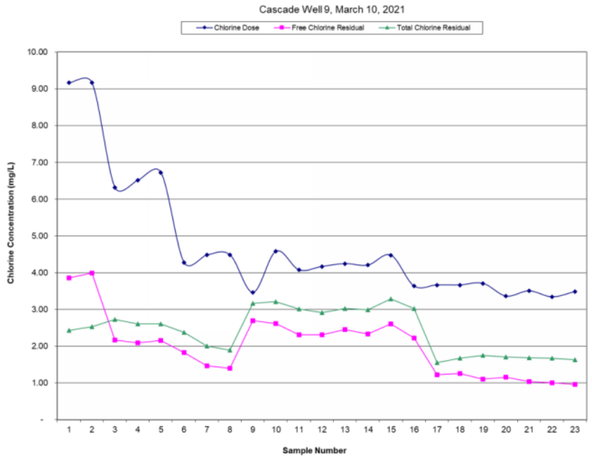


Figure 4-9. City of Gresham Well 9 Free and Total Chlorine Residual Concentrations

Well 9

Iron Removal

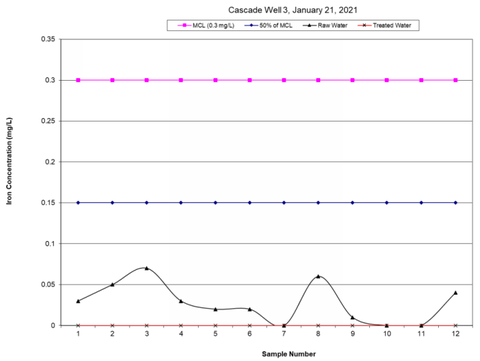


Figure 4-10. Well 3 Iron Concentrations

5.92 gpm/sf (avg)

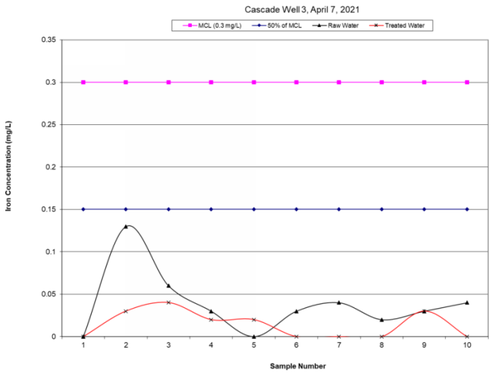


Figure 4-11. Well 3 (with High Loading Rate) Iron Concentrations

12.23 gpm/sf (avg)

Well 3

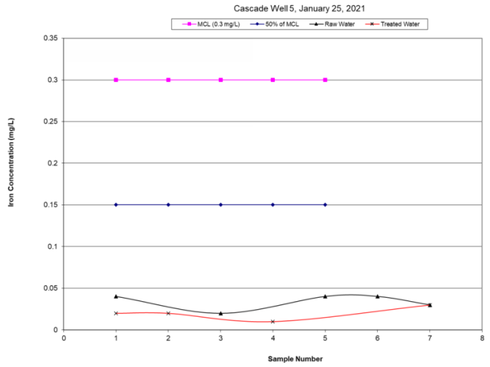


Figure 4-14. Well 5 Iron Concentrations

7.78 gpm/sf (avg)

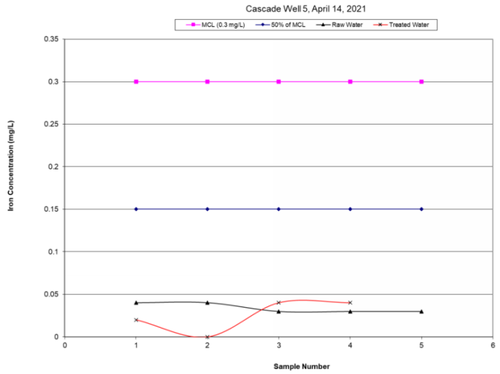


Figure 4-15. Well 5 (with High Loading) Iron Concentrations

11.09 gpm/sf (avg)

Well 5

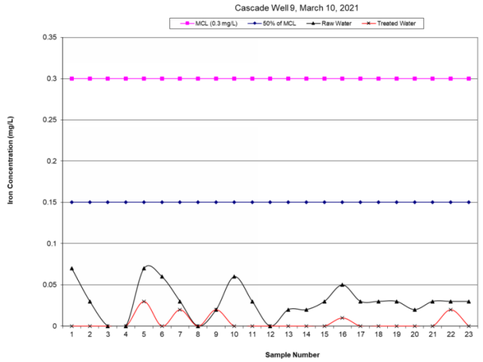


Figure 4-16. City of Gresham Well 9 Iron Concentrations

8.78 gpm/sf (avg)

Well 9

Manganese Removal

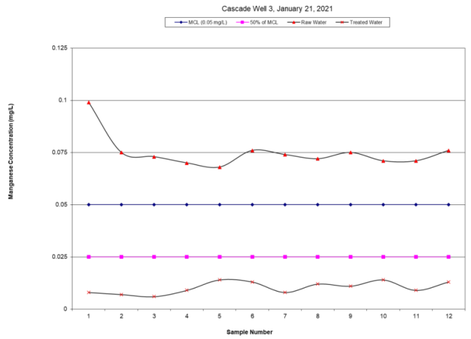


Figure 4-17. Well 3 Manganese Concentrations

5.92 gpm/sf (avg)

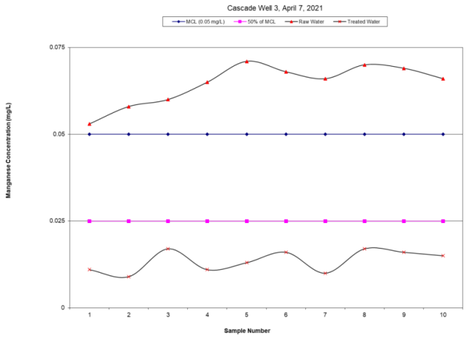


Figure 4-18. Well 3 (with High Loading Rate) Manganese Concentrations

12.23 gpm/sf (avg)

Well 3

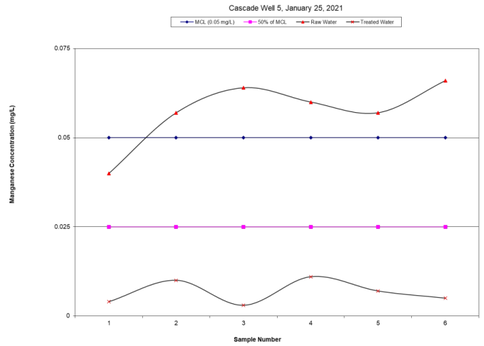


Figure 4-21. Well 5 Manganese Concentrations

7.78 gpm/sf (avg)

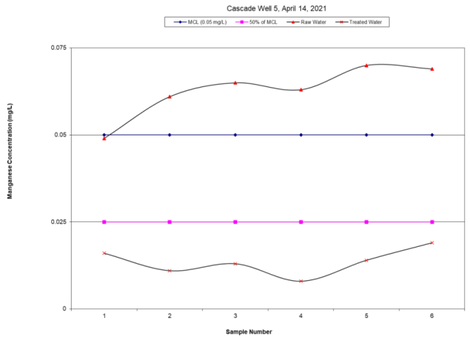


Figure 4-22. Well 5 (with High Loading Rate) Manganese Concentrations

11.09 gpm/sf (avg)

Well 5

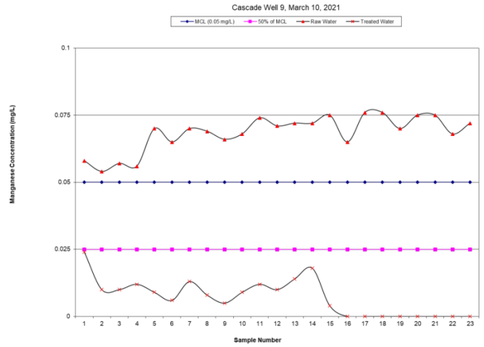


Figure 4-23. City of Gresham Well 9 Manganese Concentrations

8.78 gpm/sf (avg)

Well 9

Manganese Removal Efficiency vs Loading Rate

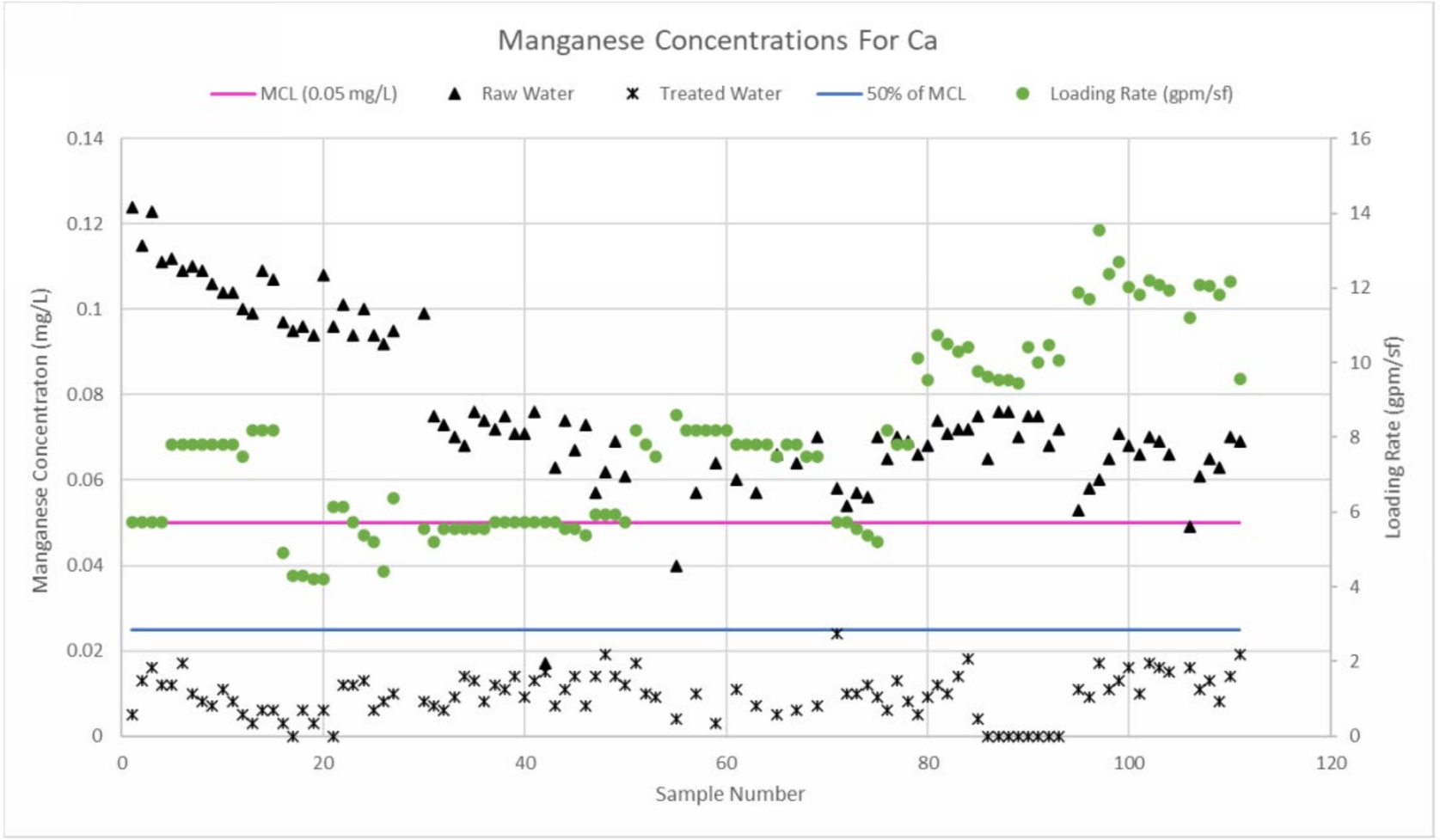
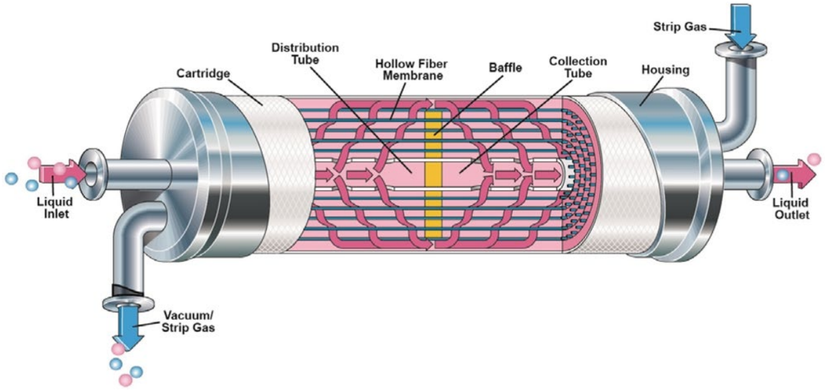


Figure 4-24. Manganese Removal vs Filter Loading Rate (with Pyrolox Advantage)

Additional Piloting

Constituent of Concerns

- Radon



Air Stripping

Packed Tower

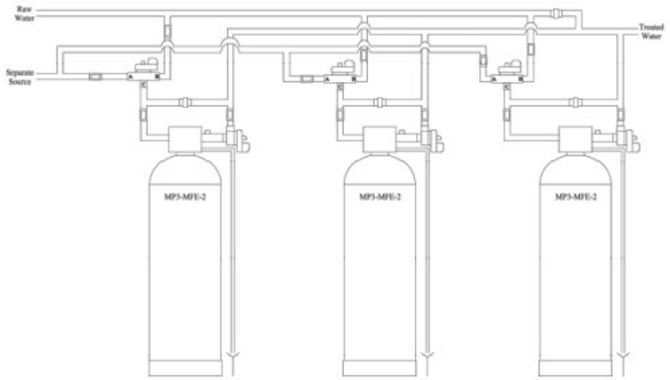
Table 4-18. Radon Testing Results (4/19/2021)

Radon Testing Summary	Raw Water	Degassing Membrane	Air Stripping 50:1 Air to Water	Air Stripping 100:1 Air to Water	Air Stripping 200:1 Air to Water
Concentration, pCi/L	327	74	78	<1.0	<1.0
Percent Removal	-	77%	76%	100%	100%

Summary

Full Scale Systems

5



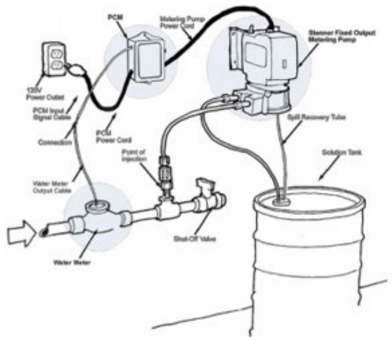
FILTER CONNECTION PIPING WITH CLEAN WATER BACKWASH (TYP)

SCALE: NTS

1
-

FILTER MEDIA:

1. FILTER MEDIA SHALL BE PYROLX ADVANTAGE OR APPROVED EQUAL.
2. EACH FILTER SHALL BE PROVIDED WITH GRAVEL UNDER-BEDDING TO COVER THE HUP AND LATERAL UNDERATRAIN INCLUDING AN 1/8" X 1/16" BARRIER GRAVEL BETWEEN THE GRAVEL AND FITLER MEDIA.
3. THE MEDA LAYERS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.



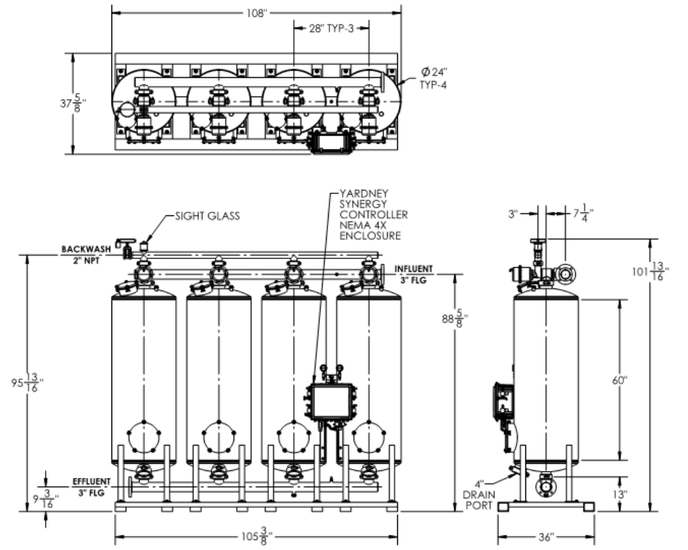
PUMP CONTROL MODULE

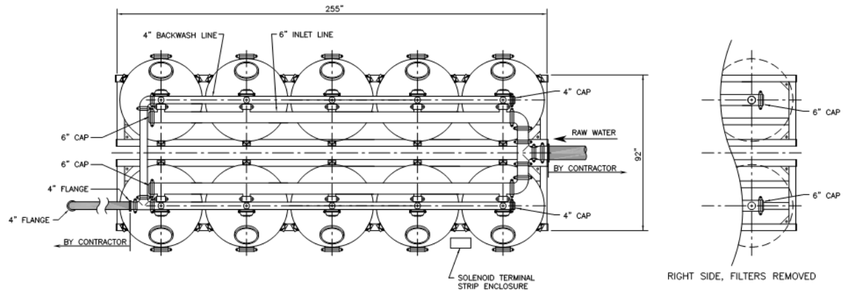
SCALE: NTS

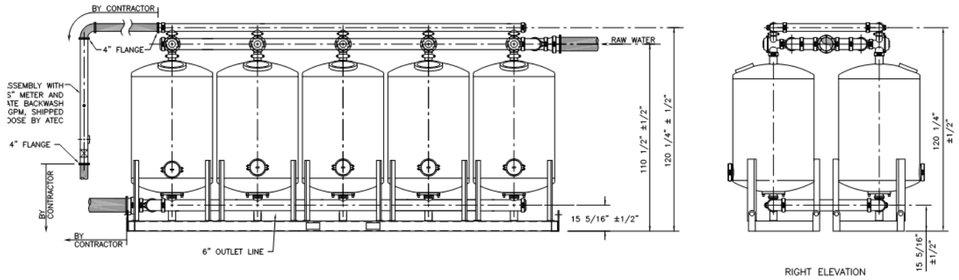
2
-

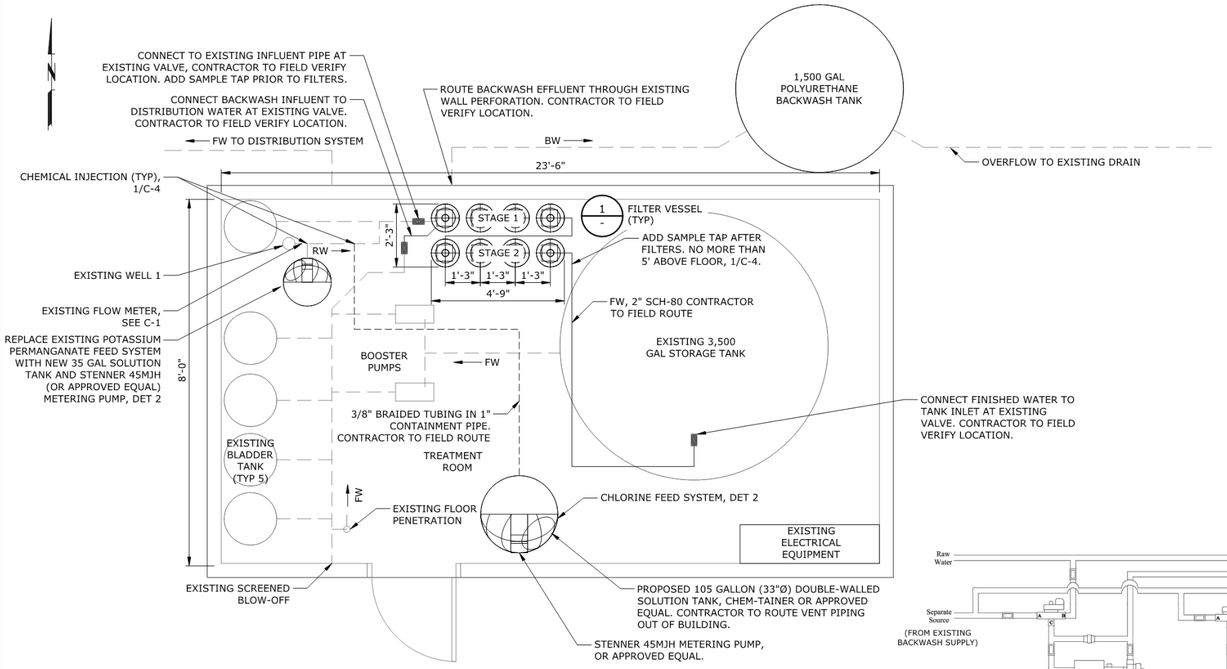
Full Scale Systems

5



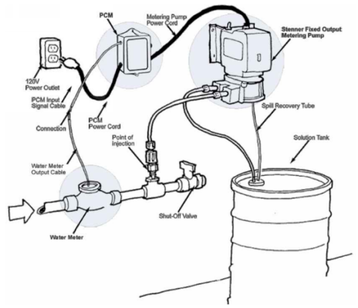






PLAN

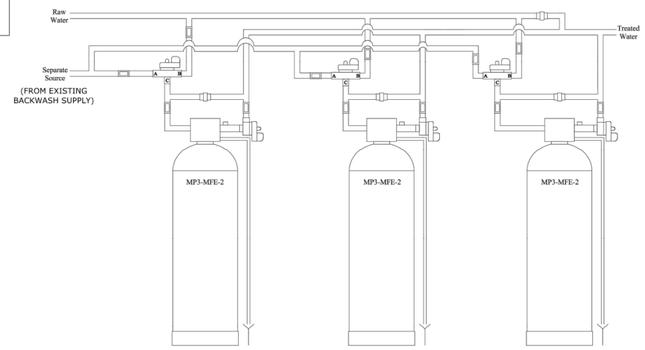
SCALE: 1/2" = 1'-0"



PUMP CONTROL MODULE

SCALE: NTS

2 -



FILTER CONNECTION PIPING WITH CLEAN WATER BACKWASH (TYP)

SCALE: NTS

1 -

FILTER MEDIA:

1. FILTER MEDIA SHALL BE PYROLOX ADVANTAGE OR APPROVED EQUAL.
2. EACH FILTER SHALL BE PROVIDED WITH GRAVEL UNDER-BEDDING TO COVER THE HUP AND LATERAL UNDERATRAIN INCLUDING AN 1/8" X 1/16" BARRIER GRAVEL BETWEEN THE GRAVEL AND FITLER MEDIA.
3. THE MEDIA LAYERS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.

NOTES:

1. FOR EXISTING PIPING DETAILS SEE SHEET C-1.
2. ALL CONNECTIONS TO EXISTING SYSTEM MUST BE FILED VERIFIED BY CONTRACTOR WITH OPERATOR OR OTHER KNOWLEDGEABLE OWNER'S REPRESENTATIVE PRESENT TO CONFIRM AND SUPERVISE CONNECTION.
3. CONTRACTOR TO INSTALL PIPE SUPPORTS, EQUIPMENT PADS AND APPURTENANCES AS NEEDED, SEE DETAILS 1-6/C-4.
4. STAGE 1 AND STAGE 2 FILTERS OPERATED IN SERIES. CONTRACTOR TO ROUTE TREATED WATER FROM FIRST STAGE EFFLUENT TO SECOND STAGE INFLUENT.

NO.	DATE	BY	REVISION

NOTICE

0 ½ 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

CAG DESIGNED

JLC DRAWN

CAG CHECKED

REGISTERED PROFESSIONAL ENGINEER STATE OF WASHINGTON

EXPIRES: 11-01-2022

murraysmith

Thurston PUD

EASTRIDGE WEST GROUNDWATER TREATMENT

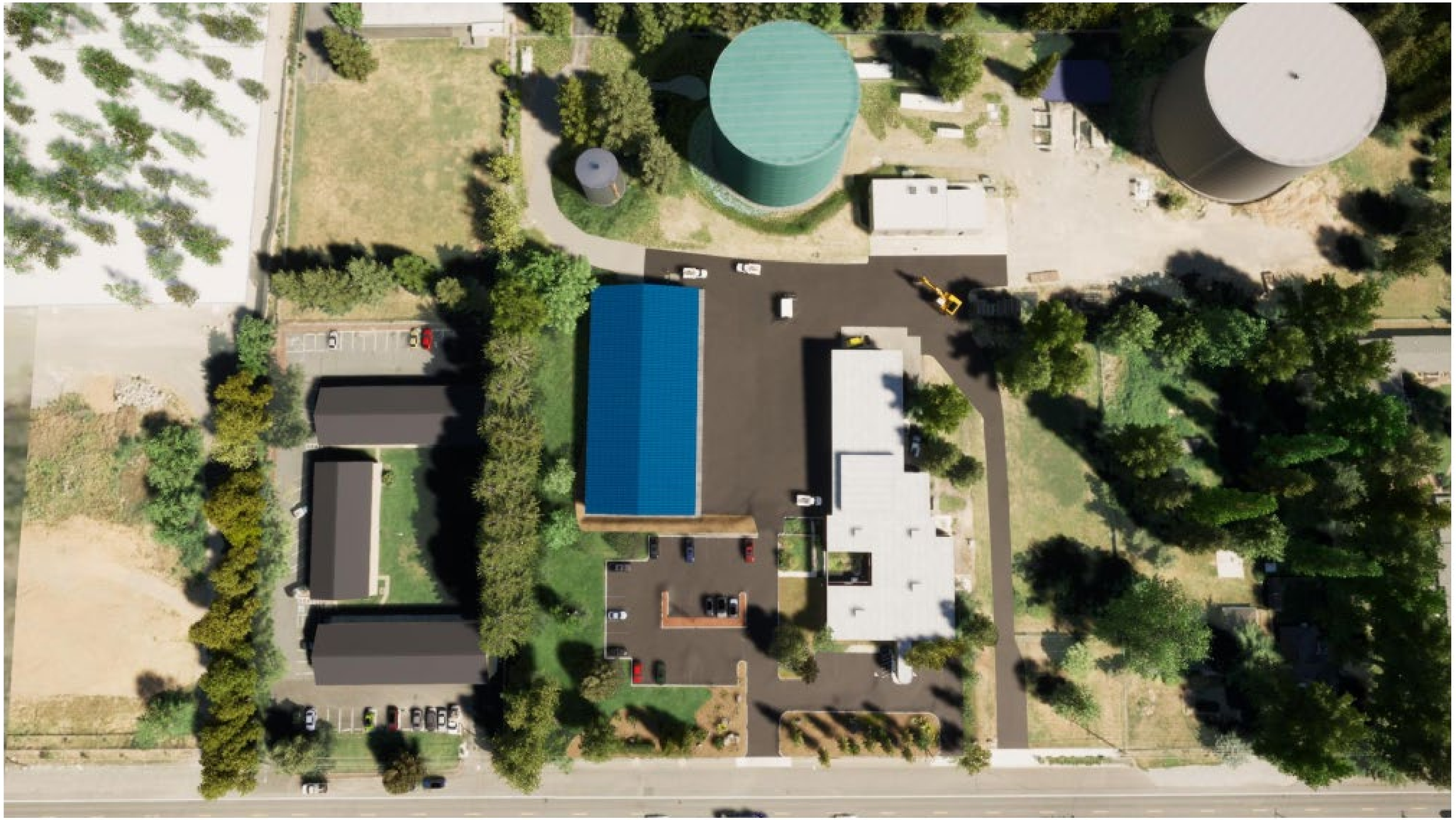
SITE PLAN

PROJECT NO.: 21-3053 | SCALE: AS SHOWN | DATE: NOVEMBER 2021

SHEET C3

4 of 5

G:\pdx_projects\21\3053 - Thurston County Pud No. 1 - Eastridge West Gdwtr Treatment\CAD\Sheets\C3.dwg C3 11/5/2021 3:23 PM JARED.CLOUD 23.0s (LMS Tech)



Rockwood WPUD

5

Cascade Facility

Rockwood WPUD

Design Criteria: Thurston PUD

Equipment	Design Criteria
	Webster Hill Well 1
Initial Plant Capacity, gpm	100
Operating Pressure, psig	75
Run Time, hrs/day	24
Average Day Run Time, hrs/day	12
Filters	
Diameter of Vessels, ft	2
Surface areas, per vessel, sq ft	3.14
Number of Vessels for Initial Plant Capacity	4
Loading Rate, gpm/sq ft	8.0
Media Depth, in	42
Media Volume, cubic ft	11
EBCT, min	3.3
Backwash	
Backwash Loading Rage, gpm/sf	15
Backwash Flow Rate, Each Vessel	47
Approximate Backwash Frequency, hrs	14
Backwash Duration, min	5
Backwash Volume, gal/backwash (each vessel)	236
Total Backwash Volume (Buildout)	942
Backwash Frequency, #/day	1
Backwash % of Production	0.16%
Recommended Backwash Tank Volume, gal	1,413
Settling Time, min	1,416
Backwash recycle time, min/day	94
Chlorine (Sodium Hypochlorite)	
Dose, mg/L	2
Dose, lbs/day	2
Solution Strength	12.5%
Solution Feed Rate, gal/hr (each)	0.1
Solution Feed Pumps, #	2
Solution Feed Pump Capacity, gph (each)	0.19
Chemical Feed Tanks, #	1
Chemical Feed Tank Volume, gal	100
Tank Storage, days	43

Equipment	Design Criteria
	Eastridge West Well 1
Initial Plant Capacity (gpm)	20
Operating Pressure, psig	75
Run Time (hours/day)	24
Average Day Run Time (hours/day)	12
Filters (First Stage)	
Diameter of Vessels, ft	1
Surface areas, per vessel, sq ft	0.79
Number of Vessels for Initial Plant Capacity	4
Loading Rate, gpm/sq ft	6.0
Media Depth, in	42
Media Volume, Cubic ft	3
EBCT, min	4.1
Filters (Second Stage)	
Diameter of Vessels, ft	1
Surface areas, per vessel, sq ft	0.79
Number of Vessels for Initial Plant Capacity	4
Loading Rate, gpm/sq ft	6.0
Media Depth, in	42
Media Volume, Cubic ft	3
EBCT, min	4.1
Backwash	
Backwash Loading Rage, gpm/sf	15
Backwash Flow Rate, Each Vessel	
Backwash Frequency, Hrs	14
Backwash Duration (min)	5
Backwash Volume, Gal/Backsash (each vessel)	59
Total Backwash Volume (Buildout)	472
Number of Backwashes Per Day	1
Backwash % of Production	0.16%
Recommended Backwash Tank Volume, Gal	1,413
Settling Time (min)	1,416
Backwash recycle time, min/day	94
Chlorine (Sodium Hypochlorite)	
Dose, mg/L	12
Dose (lbs/day)	3
Solution Strength	12.5%
Solution Feed Rate (gal/hr) each	0.12
Solution Feed Pumps	2
Solution Feed Pump Capacity (gph) each	0.23
Chemical Feed Tanks	1
Chemical Feed Tank Volume (gal)	100
Tank Storage (days)	36

Equipment	Design Criteria
	Armstrong Well 1
Initial Plant Capacity (gpm)	30
Operating Pressure, psig	75
Run Time (hours/day)	24
Average Day Run Time (hours/day)	12
Filters (First Stage)	
Diameter of Vessels, ft	1.5
Surface areas, per vessel, sq ft	1.77
Number of Vessels for Initial Plant Capacity	3
Loading Rate, gpm/sq ft	5.7
Media Depth, in	42
Media Volume, Cubic ft	6
EBCT, min	4.6
Filters (Second Stage)	
Diameter of Vessels, ft	1.5
Surface areas, per vessel, sq ft	1.77
Number of Vessels for Initial Plant Capacity	3
Loading Rate, gpm/sq ft	5.7
Media Depth, in	42
Media Volume, Cubic ft	6
EBCT, min	4.6
Backwash	
Backwash Loading Rage, gpm/sf	15
Backwash Flow Rate, Each Vessel	26
Backwash Frequency, Hrs	14
Backwash Duration (min)	5
Backwash Volume, Gal/Backsash (each vessel)	132
Total Backwash Volume (Buildout)	397
Number of Backwashes Per Day	1
Backwash % of Production	0.31%
Recommended Backwash Tank Volume, Gal	1,000
Settling Time (min)	1,396
Backwash recycle time, min/day	132
Chlorine (Sodium Hypochlorite)	
Dose, mg/L	6
Dose (lbs/day)	2
Solution Strength	12.5%
Solution Feed Rate (gal/hr) each	0.09
Solution Feed Pumps	2
Solution Feed Pump Capacity (gph) each	0.17
Chemical Feed Tanks	1
Chemical Feed Tank Volume (gal)	50
Tank Storage (days)	48

Design Criteria: Cascade Facility (Initial and Buildout Capacity)

Design Criteria	Phase 1 - Initial Capacity: (20 mgd)	Total Capacity at Buildout (30 mgd)
Initial Plant Capacity (mgd)	20	30
Operating Pressure, psig	75	75
Run Time (hours/day)	24	24
Average Day Run Time (hours/day)	12	12
Filters		
Diameter of Vessels, ft	4	4
Surface areas, per vessel, sq ft	12.56	12.56
Number of Vessels for Initial Plant Capacity	100	140
Loading Rate, gpm/sq ft	11.15	12
Media Depth, in	42	42
Media Volume, Cubic ft	44	44
EBCT, min	2	2
Backwash		
Backwash Loading Rage, gpm/sf	15	15
Backwash Flow Rate, Each Vessel	188	188
Backwash Frequency, Hrs	14	14
Backwash Duration (min)	5	5
Backwash Volume, Gal/Backwash (each vessel)	942	942
Total Backwash Volume (Buildout)	95,000	132.000
Number of Backwashes Per Day	1	1
Backwash % of Production	0.01%	0.4%
Recycle Rate, gpm	500	500
Recommended Backwash Tank Volume, Gal	200,000	300,000
Settling Time (min)	1252	1776
Backwash recycle time, min/day	188	264
Chlorine (Sodium Hypochlorite)		
Dose, mg/L	3.5	3.5
Dose (lbs/day)	437	875
Solution Strength	12.5%	12.5%
Solution Feed Rate (gal/hr) each	17.47	34.94
Solution Feed Pumps	2	3
Solution Feed Pump Capacity (gph) each	34.94	69.89
Chemical Feed Tanks	1	2
Chemical Feed Tank Volume (gal)	5,800	6000
Tank Storage (days)	14	14

5

Summary

Next Steps

Thurston PUD

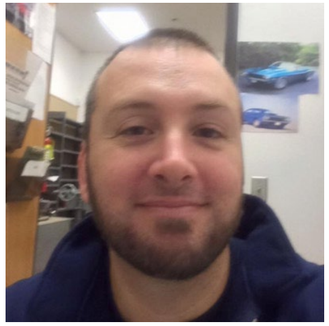
- Construction
- Operation

Rockwood WPUD

- Planning
  - Corrosion Control
    - Pilot Loop Testing
- Design
- Construction

Special Thanks

- Kim Gubbe, TPUD
- Jim Cambell, TPUD



- Jeremy Hudson, RWPUD
- Jay Breen, RWPUD
- Jed Pacheco, RWPUD

- Lee Odell, Murraysmith
- Daniel Mosiman, Murraysmith,
- Aaron Gress, Murraysmith
- Shanna Myers, Murrasmith

Thank you!

murraysmith

Rockwood Water
People's Utility District

Thurston
PUD

Q&A