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When PFAS is Only Half the Battle:
Treating Multiple Contaminants with a Series of Media

Stephen Timko, PhD
Kennedy Jenks

Kennedy Jenks

WQTS
Water Quality & Treatment Solutions, Inc.
An environmental engineering and science consulting company

EVMWD
Elsinore Valley Municipal Water District

AGENDA

- Treatment Plant Overview and Water Quality
- Pilot Testing Overview and Findings
- Design Overview

Plant Overview and Water Quality

Canyon Lake Water Treatment Plant Overview

- Surface Water Treatment Plant with source water managed by Canyon Lake Property Owners Association and EVMWD
- Constructed as a conventional water treatment facility, 10% of water supply portfolio
- Previous design capacity 7 MGD
- Variable source water quality

Project Drivers

- Aging infrastructure requiring replacement
- Contaminants of Emerging Concern
  - PFAS
  - Cyanotoxins

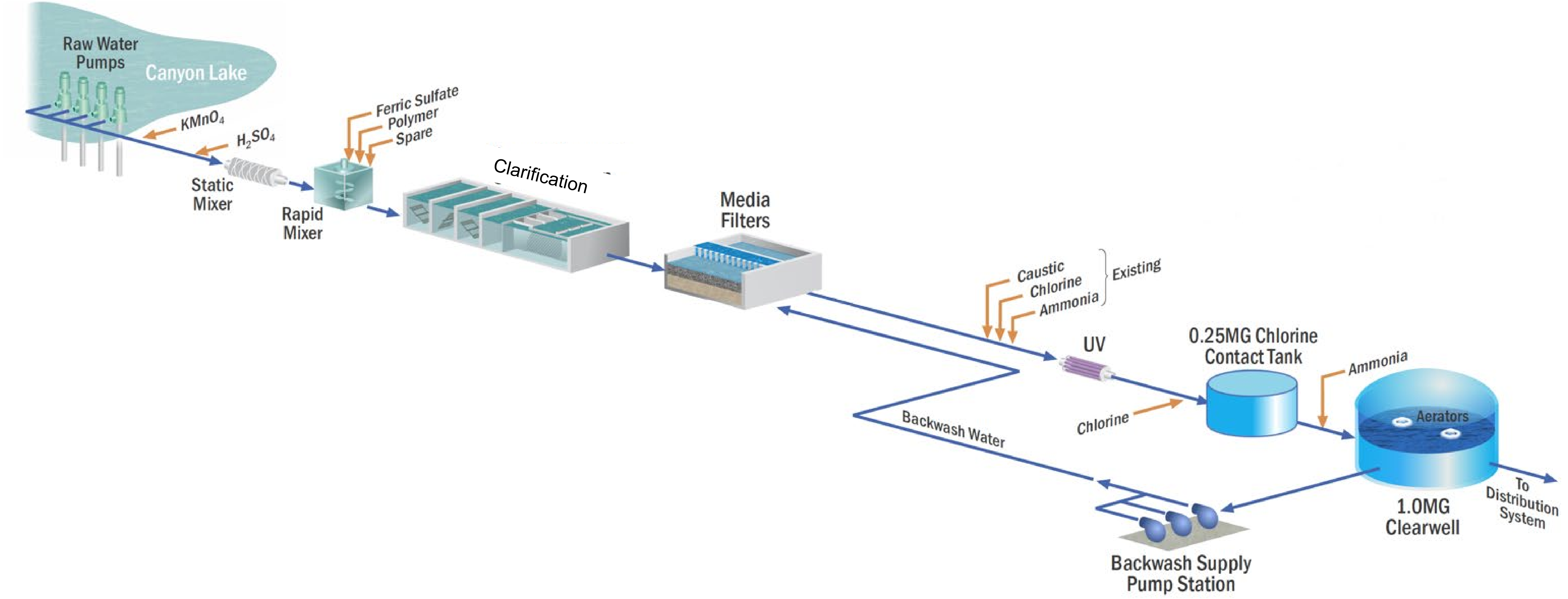
WATER QUALITY ISSUES

- Nutrients (algal blooms)
- TOC
- Manganese
- PFAS
- Algal toxins (potential)

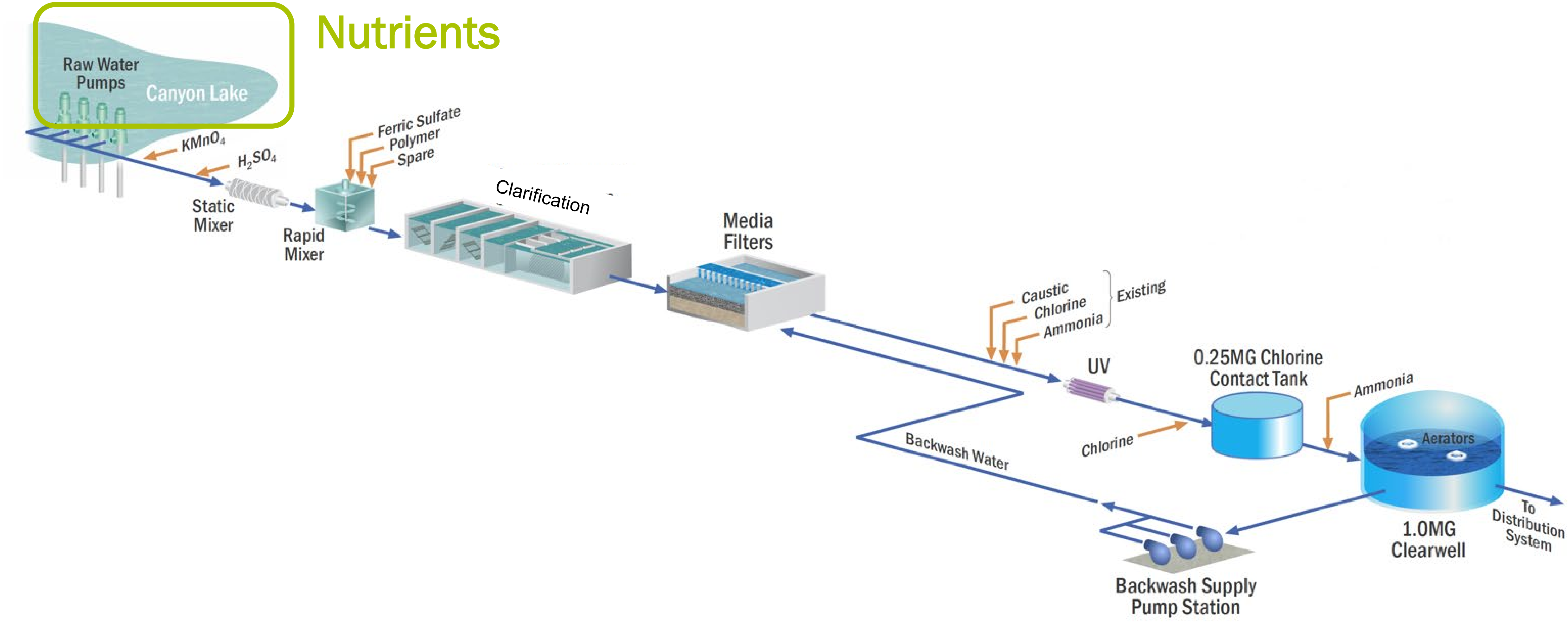
Water Quality

Constituent	Units	Average	Range	MCL/SMCL
TOC	mg/L	5.9	4.3-9.6	-
Color	units	15.7	3-45	15
Odor	TON	2.4	1-8	3
Manganese	µg/L	65	0.4-880	50
TDS	mg/L	430	46-1,000	500
Turbidity	NTU	5.3	0-83	-
Sulfate	mg/L	133	48-220	250
Iron (total)	µg/L	100	10-620	300
Alkalinity	mg/L as $CaCO_3$	96	11-165	-

Historical Process Flow Diagram



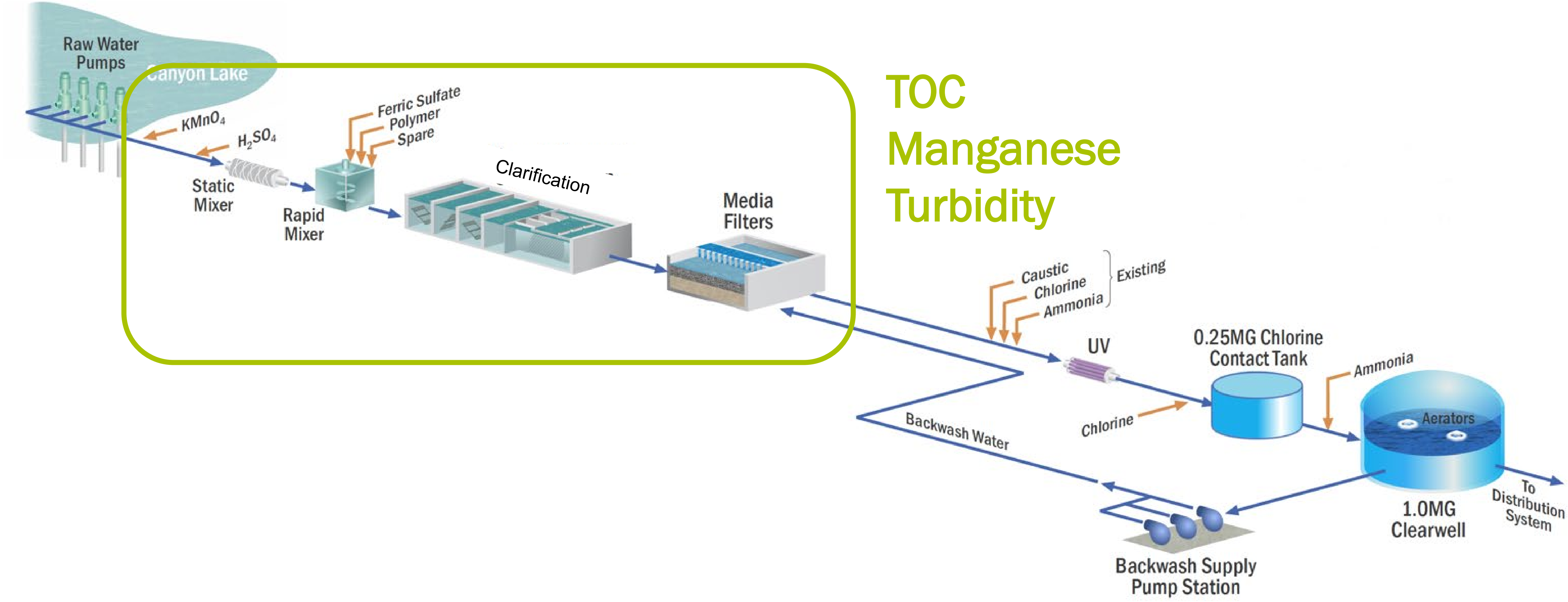
Historical Process Flow Diagram



Nutrients in Canyon Lake

- Nutrient input from runoff
- Seasonal algal blooms
- Phosphorus main limiting nutrient
- Alum application to sequester P seasonally

Historical Process Flow Diagram



TOC
Manganese
Turbidity

PFAS Detections

Abbreviation	Average (ng/L)	Range (ng/L)	California NL	California RL
PFOA	25	24 – 26	5.1	10
PFOS	15	14 – 16	6.5	40
PFBS	12	8.8 – 14	500	5,000
PFDA	5.8	5.0 – 6.6	--	--
PFHpA	9.9	8.1 – 11	--	--
PFHxS	8.6	8.0 – 9.1	2*	20*
PFHxA	21	16 – 24	--	--
PFNA	5.1	4.7 – 5.3	--	--

Water Quality and Process Selection

CHALLENGES

- High TOC, T&O
- No permitted surface water treatment application for PFAS removal in CA
- High manganese and pre-oxidation requirements
- Competing surface water quality goals with turbidity, DBPs, and others

MARKET SOLUTIONS

- [x] GAC
- [x] IX
- [x] Specialty Adsorbents
- [ ] Reverse Osmosis

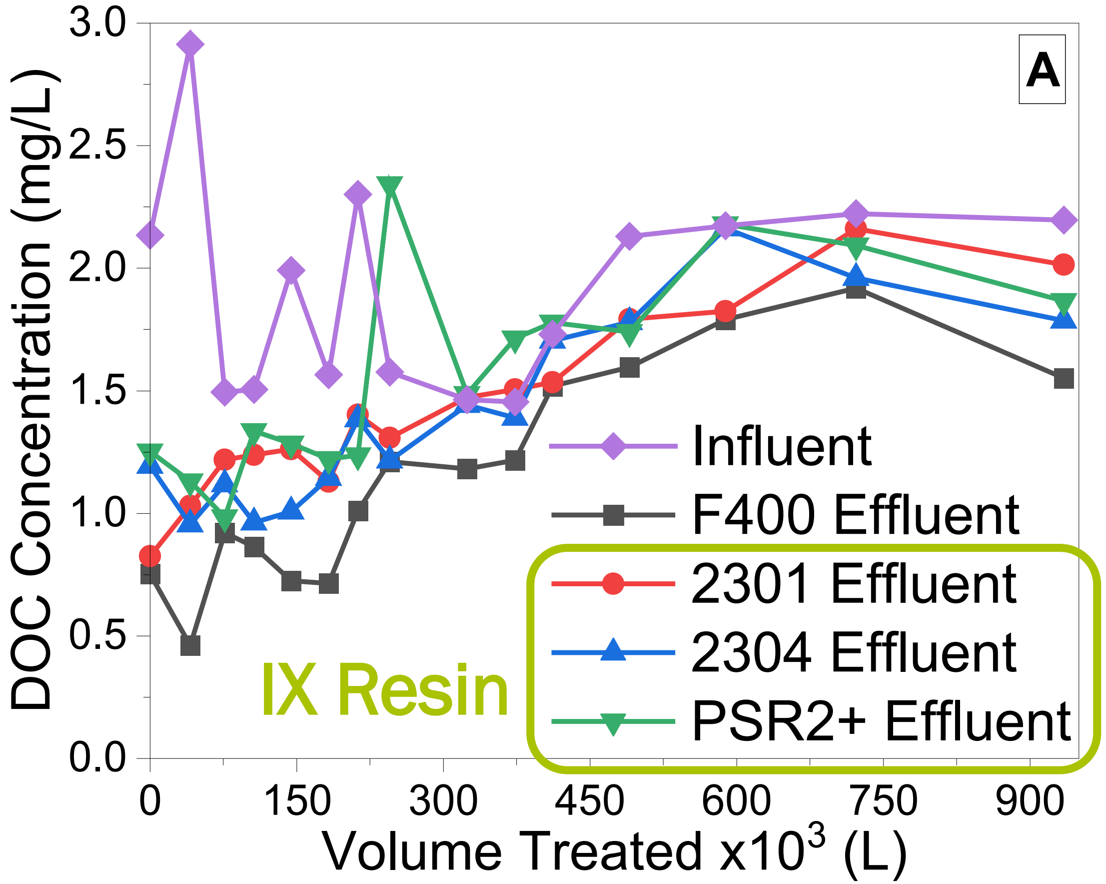
SELECTION

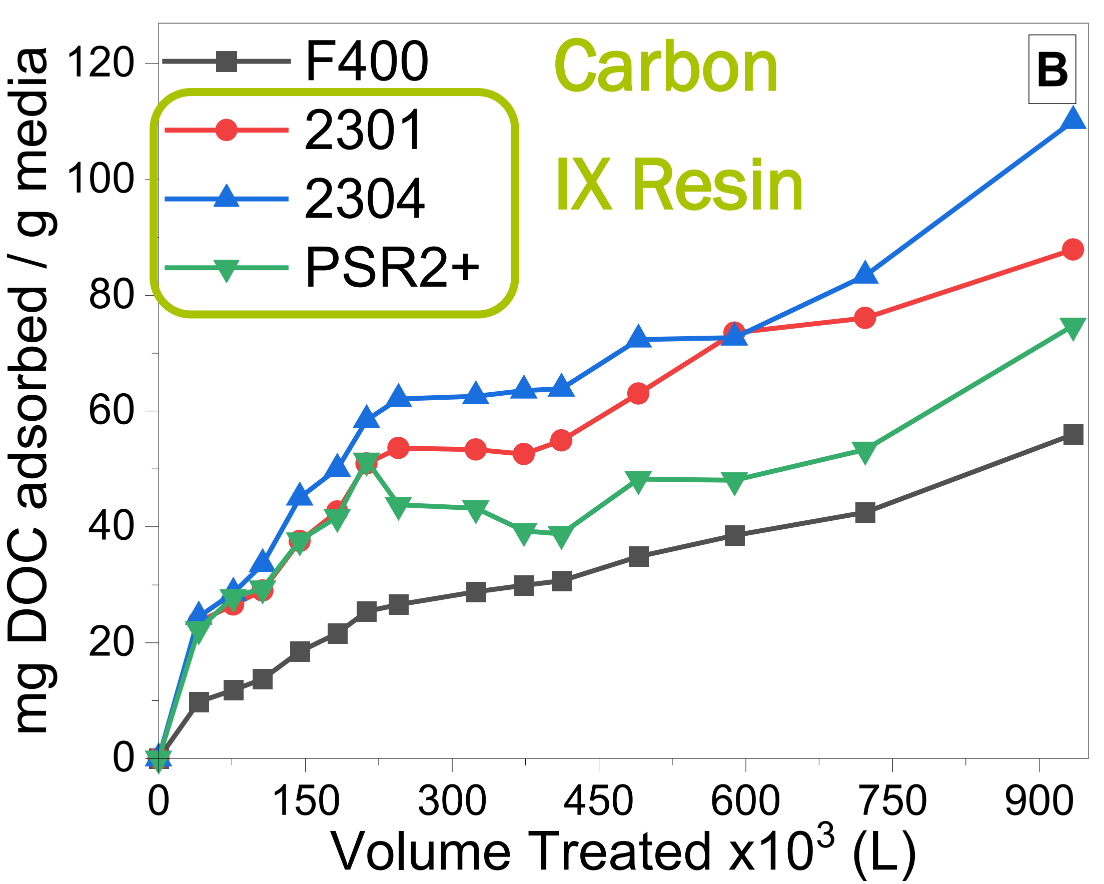
- Dual-Barrier Treatment approach
- Further confirmed by evaluating treatment configurations with pilot testing

Dual-Barrier Approach

- Reduce fouling
  - Turbidity
  - Manganese
  - TOC
- Meet water quality goals

TOC Removal by Media



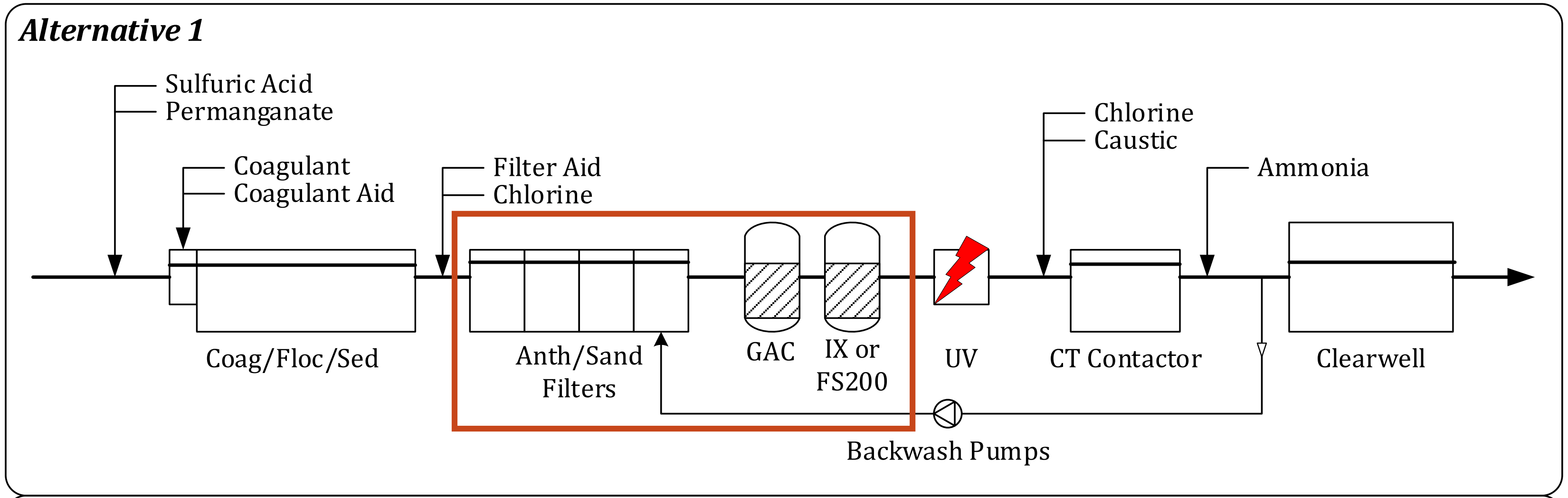


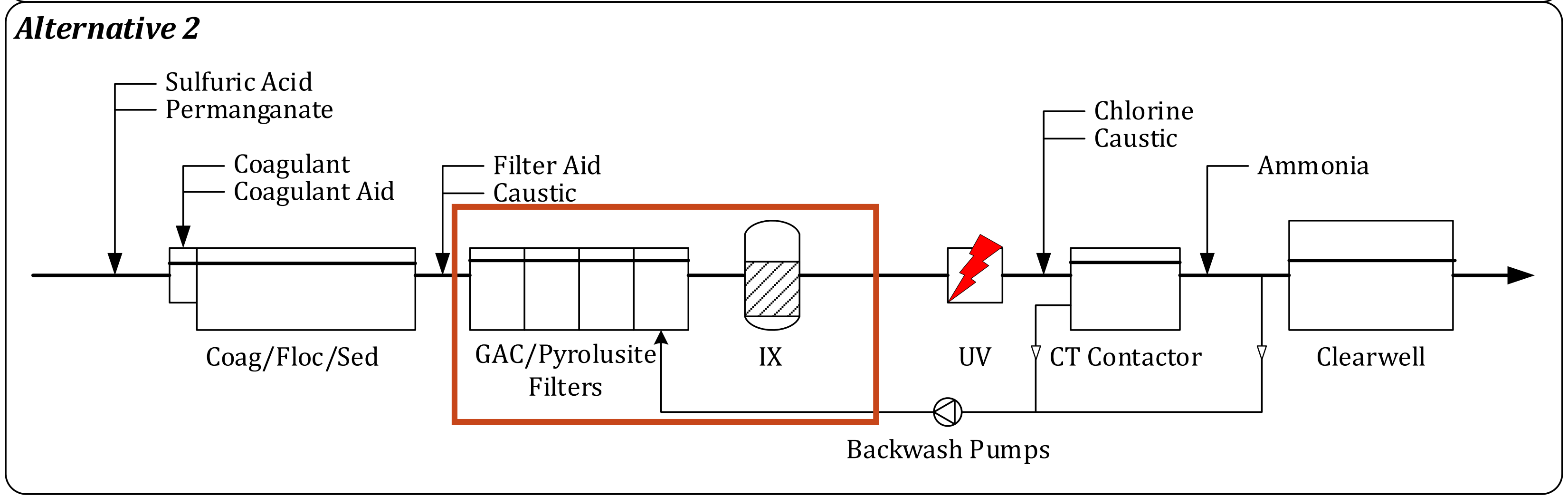
Need to maximize TOC removal prior to PFAS removal media

Dual-Barrier Approach

- GAC before IX
  - TOC removal
  - Dechlorination
- IX/novel adsorbent for PFAS removal

Alternatives Evaluated





- Post-Filtration dual-barrier treatment configuration
- Configuration 2 evaluated to see if any beneficial O&M impacts of replacing filters with GAC rather than post-filtration solution

Pilot Testing Overview

Pilot Testing Overview

1. Continuously operated over a duration of 9 months

2. Treatment trains located under a covered canopy, located in the existing parking lot

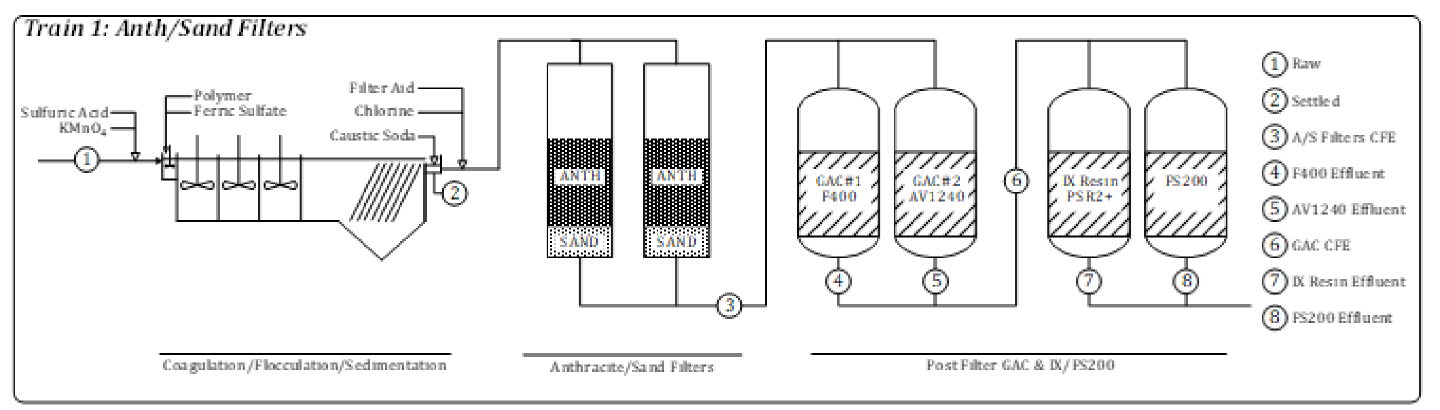
Pilot Testing Objectives

- Evaluate and validate the performance of the two treatment trains
- Compare the performance of alternative PFAS adsorbents, and to provide input to the process design criteria
- Evaluate performance of GAC when treating high TOC surface water
- Determine if use of Pyrolusite under GAC in Alternative 2 adequately controls manganese at CLWTP

Treatment Train Overview

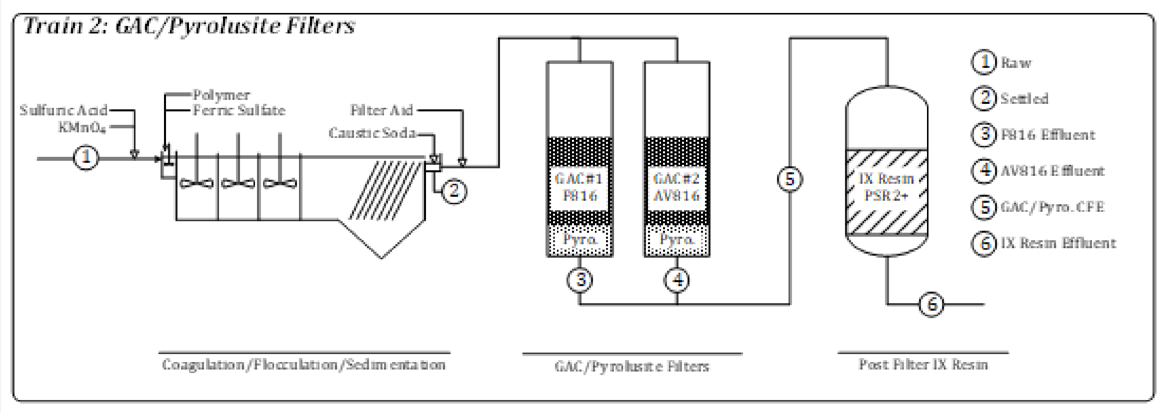
TRAIN 1

- F400- Calgon
- AV 1240 (Aqueous Vets)
- PSR2+ (Dupont/Dow)
- FS 200 (CETCO)



TRAIN 2

- F816- Calgon
- AV 816 (Aqueous Vets)
- PSR2+ (Dupont/Dow)



Pilot Testing Parameters

Pretreatment Performance Goals

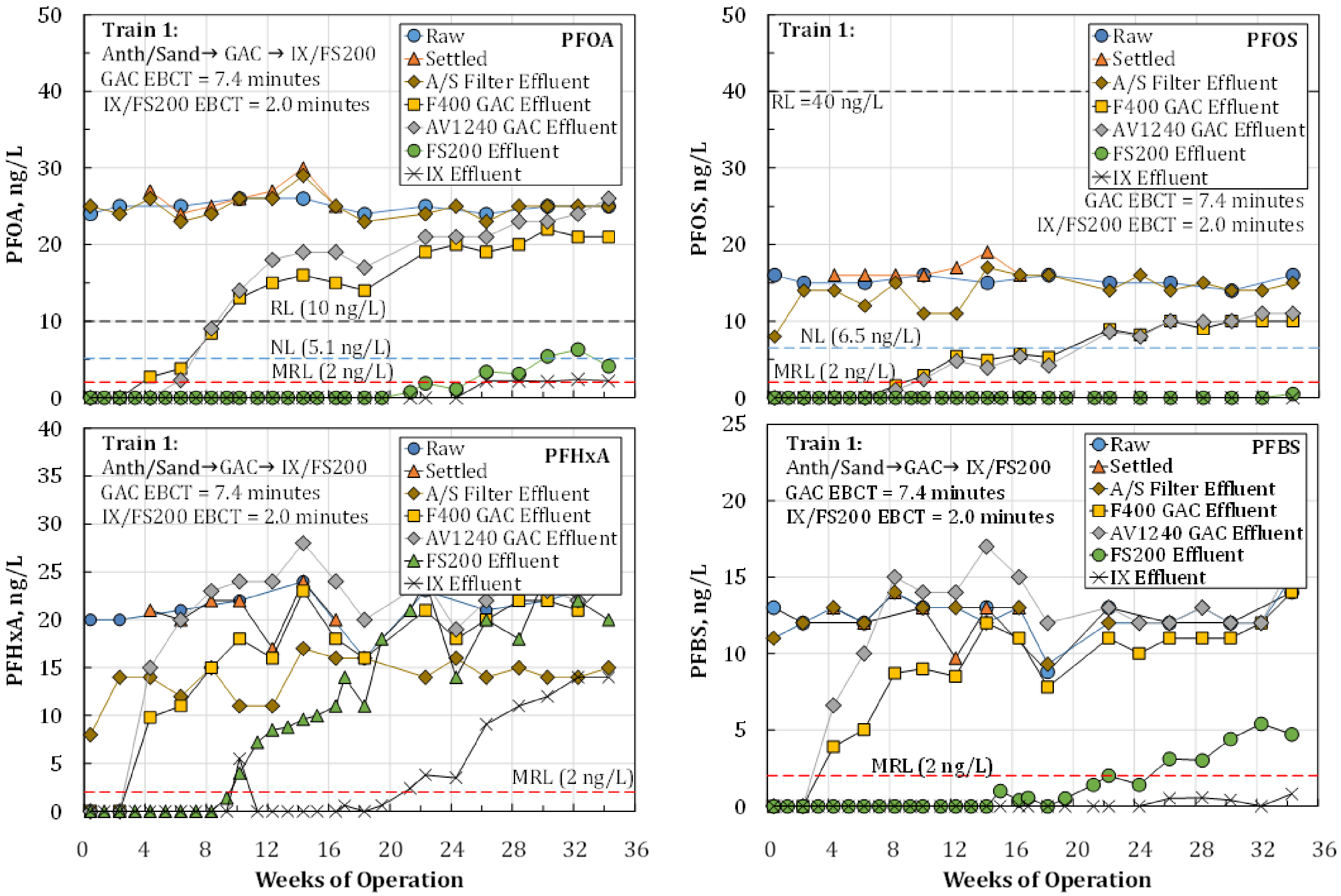
Parameter	Goal
Settled Water Turbidity	<2NTU (preferably <1NTU)
TOC Removal	>40%
Filtered Water Turbidity	<0.1 NTU
Filter Runtime (@ 4.5 gpm/sf)	>28 hours
Filtered Water Manganese	<15 µg/L

Pilot Testing Findings

Manganese Impacts

- Approximately half of the manganese in CLWTP source water can be removed by pre-treatment (>5 µm)
- The other half of manganese removed by oxidation (<0.45 µm)
- Permanganate dose optimization: chlorine application pre-filtration effective at maintaining manganese in filter effluent below treatment goal

PFAS Removal- Train 1



CONCLUSIONS:

- All 8 PFAS broke through first barrier
- PFOA breakthrough at week 26 in IX/FS

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WQTS Water Quality & Treatment Solutions, Inc.
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TOC Removal- Train 1

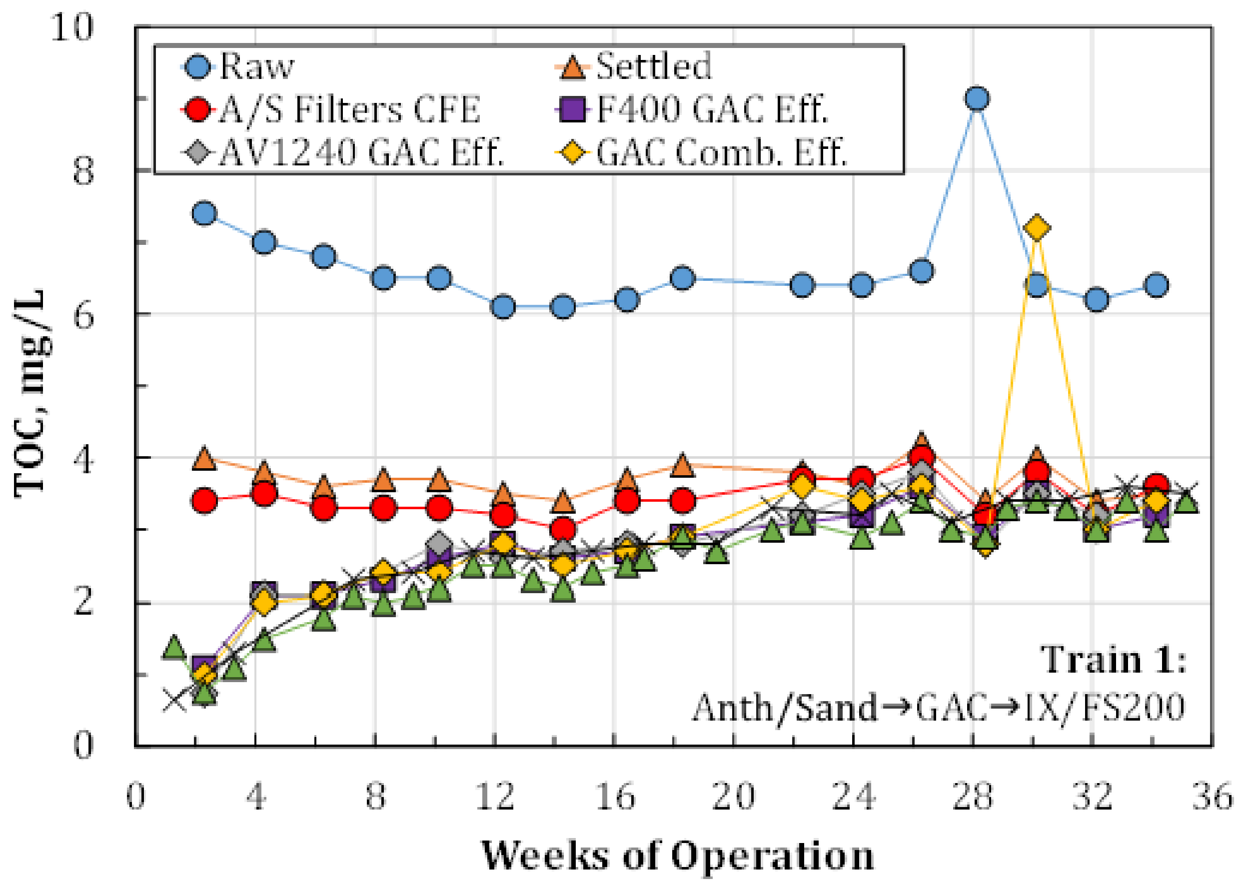
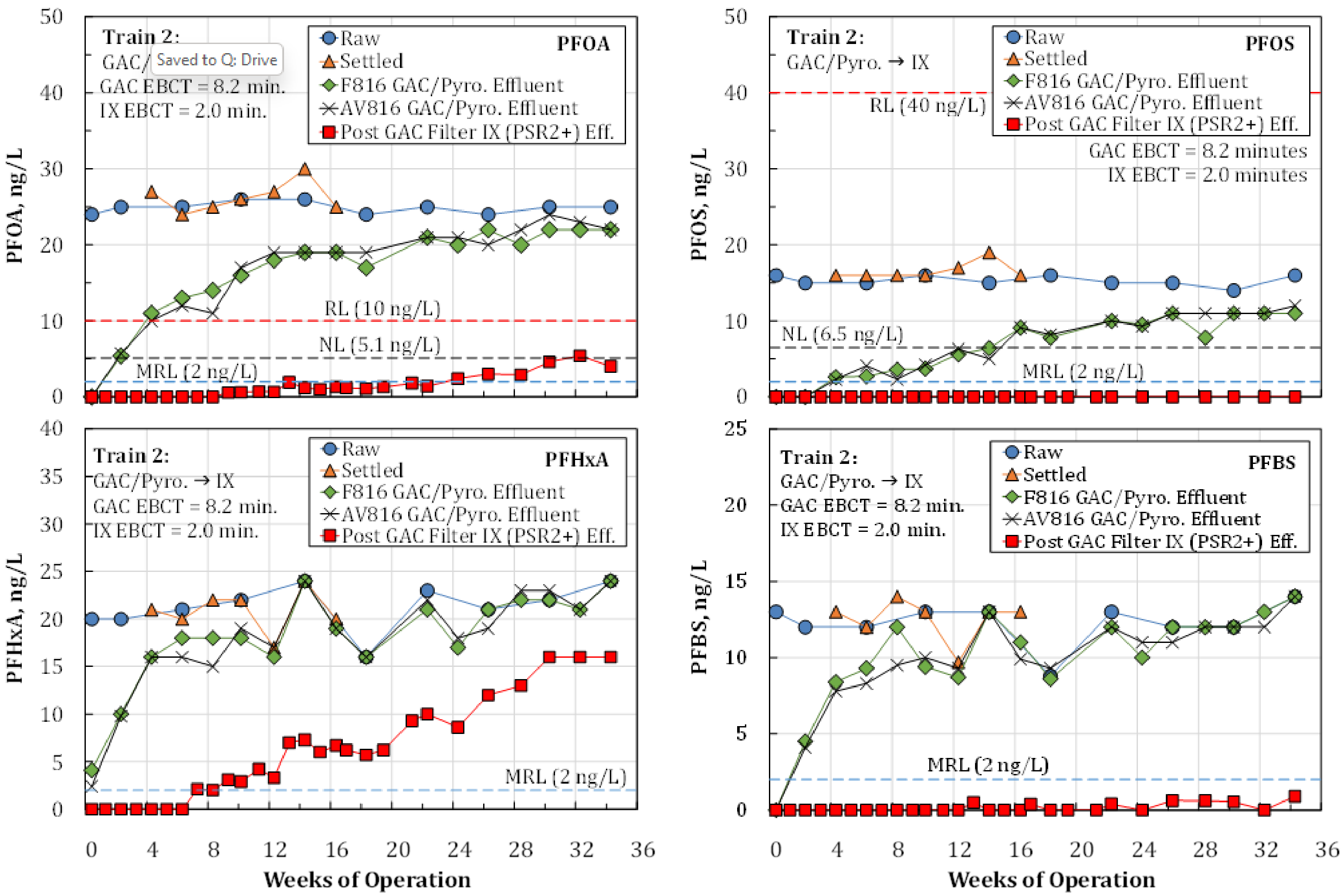


Figure 4.13 – TOC Profiles at Multiple Locations in Train 1 (Anth/Sand Filters)

CONCLUSIONS:

- ~45% removal of TOC through pre-treatment and media filtration, and GAC
- Steady rise of TOC throughout pilot operation in GAC effluent
- No impact of IX/FS on TOC removal

PFAS Removal- Train 2



CONCLUSIONS:

- All 8 PFAS broke through
- PFOA breakthrough at week 24 in IX

Conclusions and Recommendations

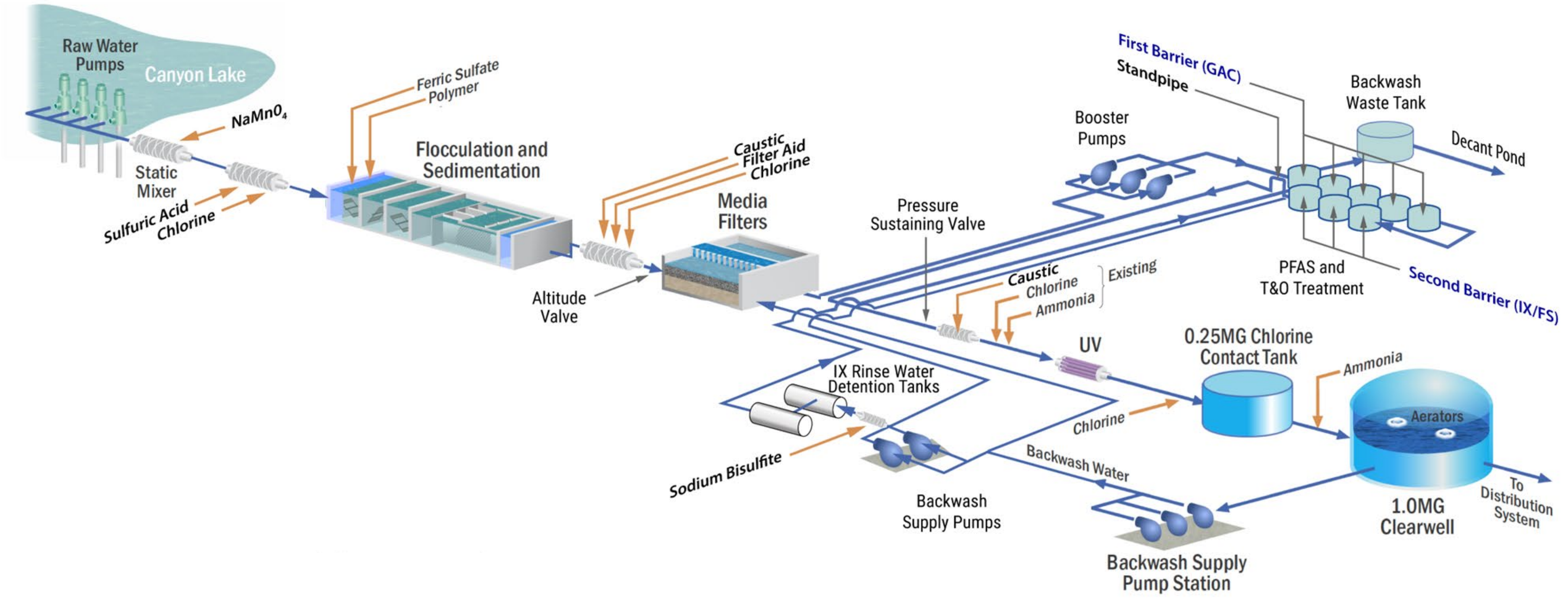
1. Train 1 recommended for implementation at CLWTP. Train 2 had less effective manganese removal through GAC/pyrolusite filters, and filter run times were shorter than A/S run times in Train 1
    a) Train 1 configuration included in design

2. Dual barrier (GAC followed by IX/FS200) achieved reliable PFAS removal.
    a) GAC contributed to less than 20% of removal of PFOA throughout pilot duration, but provided DBP and T&O reduction.

3. Manganese control optimized during the pilot, new chlorine addition points are recommended at the raw water line and sedimentation basin effluent, with chlorine analyzer installed at filter influent
    a) These elements incorporated in design

4. Combination of permanganate and chlorine use sufficient and reliable for destruction of five cyanotoxins
    a) Both chemicals incorporated in design

Process Flow Diagram



Q & A

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StephenTimko@KennedyJenks.com

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IX OR FS?

IX vs. FS: Non-Cost Factors (1/2)

Key Factors	Fluorosorb	Ion Exchange
Capital Cost	• Same number of vessels	• Same number of vessels
	• Backwash waste tank required, already included in design, provisions for backwash included on valve tree	
O&M Costs	• **Lower** head loss & lower pumping costs.	• **Higher** head loss through vessels & higher pumping costs. Design incorporates higher head conditions for conservative pump sizing
	• Similar frequency of media changeouts.	• Similar frequency of media changeouts.
O&M Considerations	• Low O&M, Similar to IX. **Reduced** flow capabilities during vessel media changeout due to lower maximum HLR	• Low O&M, similar to FS
Pre-Treatment Considerations	• Elevated levels of iron and manganese can cause fouling on media	• Elevated levels of iron and manganese can cause fouling on media

IX vs. FS: Non-Cost Factors (2/2)

Key Factors	Fluorosorb	Ion Exchange
PFAS Treatment	• **Less effective** than ion exchange for removing some PFAS with Canyon Lake water quality	• **More effective** than FS for removing smaller chain PFAS with Canyon Lake water quality
Permitting Considerations(1)	• Lead-lag configuration not previously permitted by DDW for PFAS removal in CA	• Lead-Lag configuration DDW approved for PFAS removal in CA
Constructability/Contracting ★	• Unknowns in warranty and production at large scale	• Widely installed for PFAS removal, several full -scale installations across CA
Waste Disposal	• Spent resin hauled off-site for disposal and incinerated	

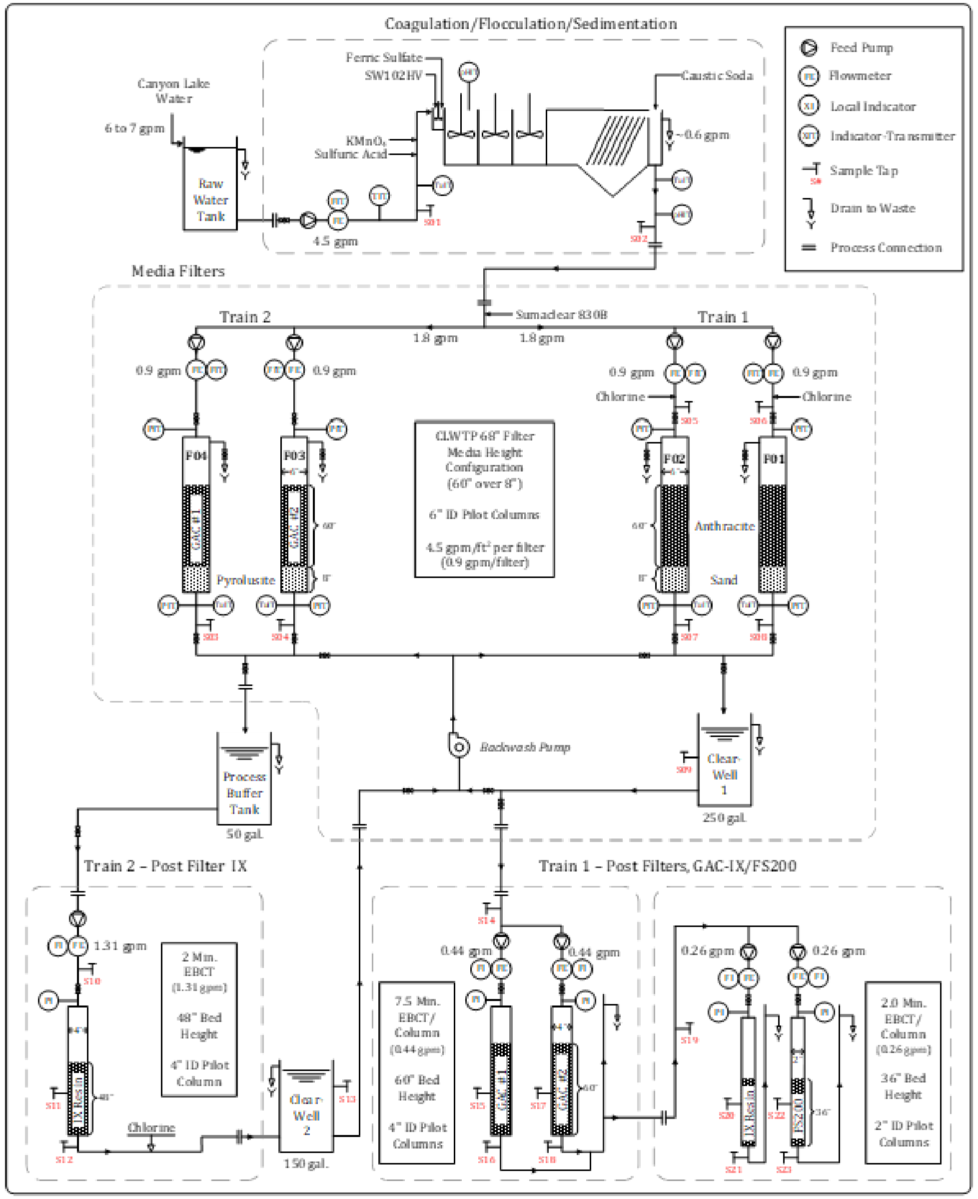
(1) NSF certification limits FS installation at 4-foot bed depth currently. Design parameters for FS possibly subject to change in the future.

IX vs. FS: Cost Factors

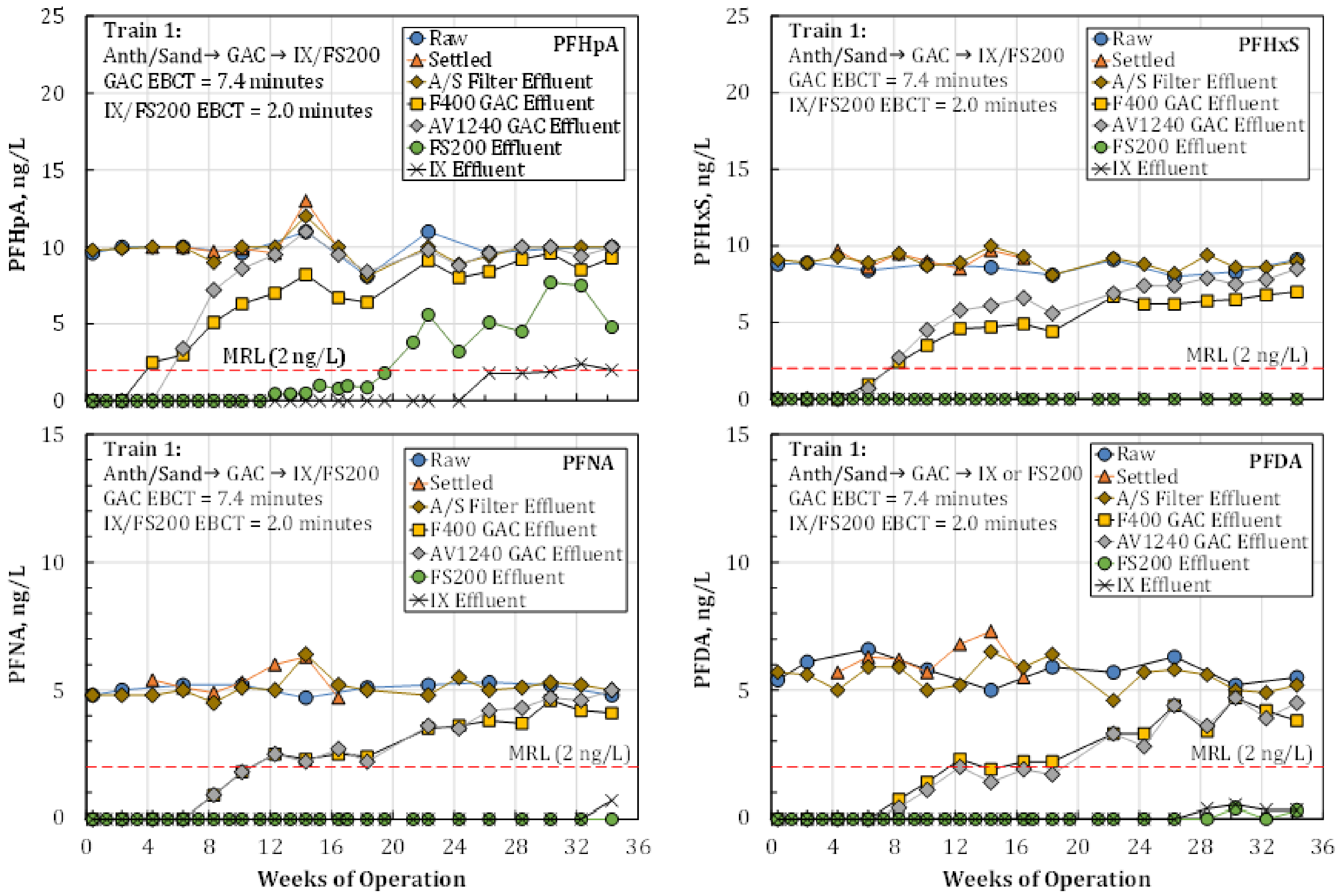
Life Cycle Costs

- Recent budgetary costs for FS at $193/cf, and IX at $295/cf, with similar disposal costs ($110/cf)
- Lifecycle costs comparison indicate FS is more cost effective overall compared to IX, at **$4.1 M over 20 years**

★ EVMWD decided to incur risks associated with FS and intends to bid FS in one vessel



Coagulation/Flocculation/Sedimentation
Feed Pump
Flowmeter
Local Indicator
Indicator-Transmitter
Sample Tap
Drain to Waste
Process Connection
Canyon Lake Water
6 to 7 gpm
Raw Water Tank
4.5 gpm
Ferric Sulfate
SW102HV
KMnO4
Sulfuric Acid
Caustic Soda
~0.6 gpm
Media Filters
Train 2
Train 1
Sumaclear 830B
1.8 gpm
1.8 gpm
0.9 gpm
0.9 gpm
0.9 gpm
0.9 gpm
Chlorine
Chlorine
F04
F03
F02
F01
Pyrolusite
Anthracite
Sand
CLWTP 68" Filter Media Height Configuration (60" over 8")
6" ID Pilot Columns
4.5 gpm/ft² per filter (0.9 gpm/filter)
Backwash Pump
Process Buffer Tank
50 gal.
Clear Well 1
250 gal.
Train 2 – Post Filter IX
1.31 gpm
2 Min. EBCT (1.31 gpm)
48" Bed Height
4" ID Pilot Column
Chlorine
Clear Well 2
150 gal.
Train 1 – Post Filters, GAC-IX/FS200
0.44 gpm
0.44 gpm
7.5 Min. EBCT/ Column (0.44 gpm)
60" Bed Height
4" ID Pilot Columns
0.26 gpm
0.26 gpm
2.0 Min. EBCT/ Column (0.26 gpm)
36" Bed Height
2" ID Pilot Columns



Train 1:
Anth/Sand→ GAC → IX/FS200
GAC EBCT = 7.4 minutes
IX/FS200 EBCT = 2.0 minutes
PFHpA
Raw
Settled
A/S Filter Effluent
F400 GAC Effluent
AV1240 GAC Effluent
FS200 Effluent
IX Effluent
MRL (2 ng/L)
PFHpA, ng/L
PFHxS
PFHxS, ng/L
PFNA
PFNA, ng/L
Anth/Sand→ GAC → IX or FS200
PFDA
PFDA, ng/L
Weeks of Operation