Government Affairs Seminar
Real Compliance Stories:
Waukesha Clean Water Plant

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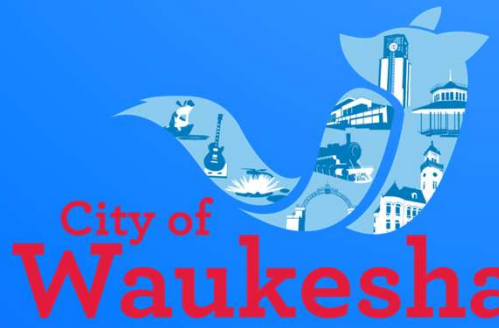
City of Waukesha

Jacobs Challenging today. Reinventing tomorrow.

Background

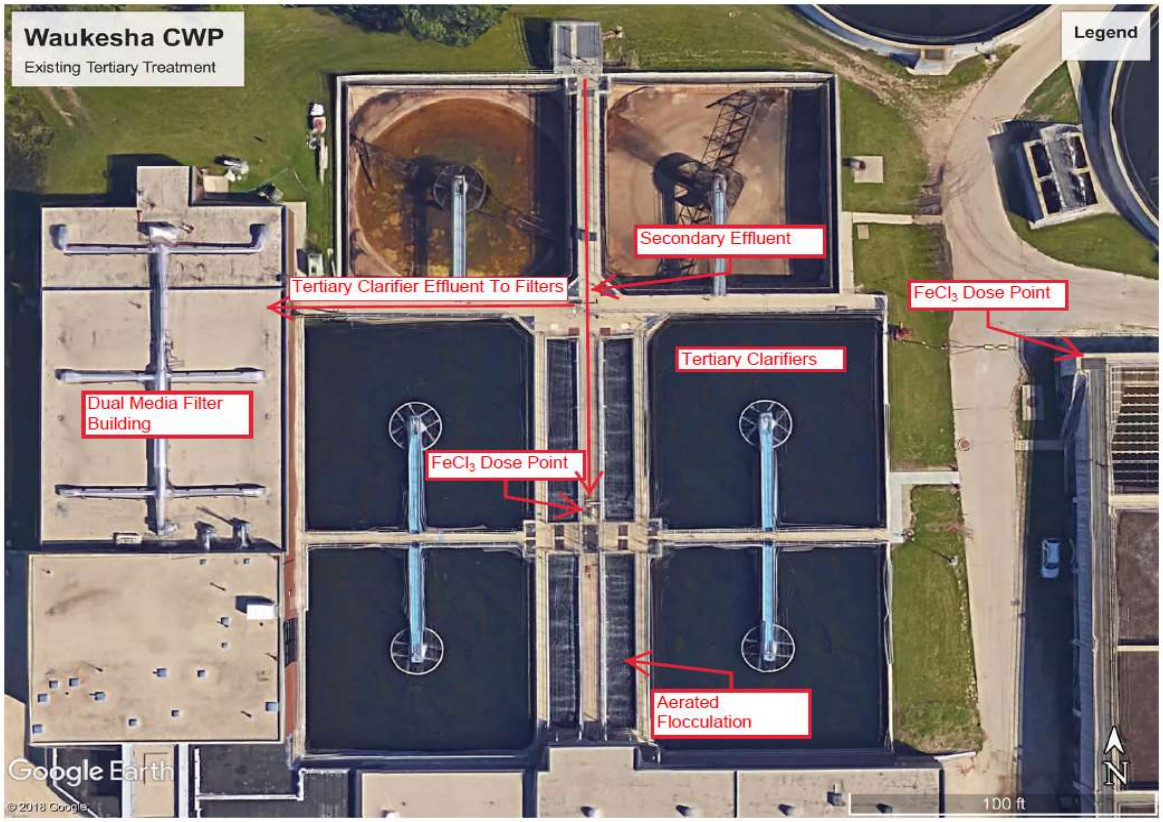


Regulatory Background

- Effluent discharged to the Fox River in Waukesha will be subject to the typical Water Quality-based Effluent Limitation (WQBEL) for stream discharges of 0.075 mg/L phosphorus (P)
- The City of Waukesha has natural radium contamination in their groundwater supply
- The City of Waukesha received approval to withdraw Lake Michigan water to replace the existing groundwater supply
- A portion of the treated effluent from the City of Waukesha Clean Water Plant (CWP), equal to the amount withdrawn from Lake Michigan, must be returned to the Lake Michigan watershed
- A stricter effluent limit of 0.06 mg/L P was set for the portion of the effluent discharged to the Root River in the Lake Michigan watershed.

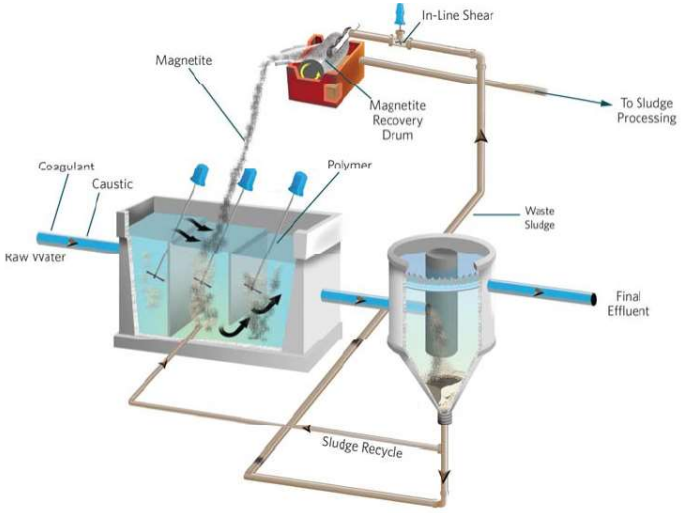
Existing Treatment for Phosphorus and TSS Compliance

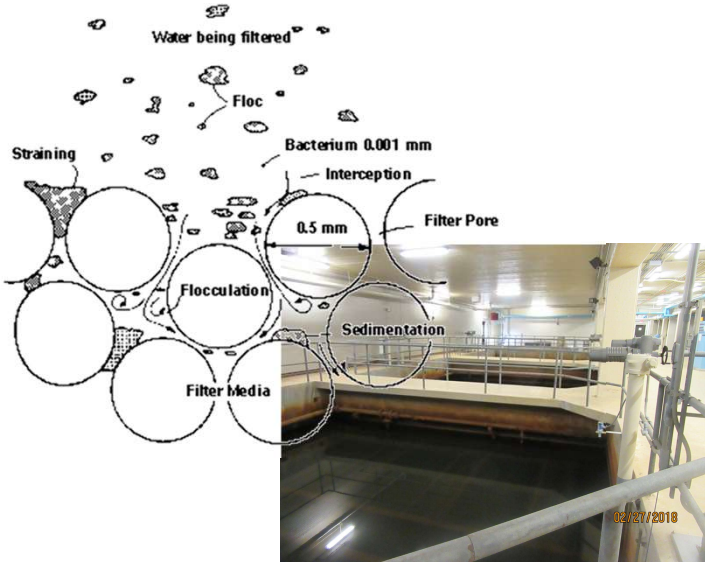
- The CWP's previous phosphorus and TSS limits were 0.6 mg/L P and 10 mg/L TSS
- Achieved with dual point ferric chloride dosing
  - Add to mixed liquor channel between aeration basins and secondary clarifiers
  - Add to secondary effluent upstream of tertiary treatment
- Tertiary treatment consists of a rapid mixer, air mixed flocculation channels, tertiary clarifiers, and dual media filters



Alternatives Identified for Evaluation

- Alternative 1 – Ballasted Flocculation and Settling (Comag) ~15 MGD (FCAP)
- Alternative 2 – Cloth Media Filtration Retrofit and Coagulation, Flocculation, and Tertiary Settling Improvements
- Alternative 3 - Granular Media Filtration Rehabilitation and Coagulation, Flocculation, and Tertiary Settling Improvements





Selected Approach

- Ballasted flocculation (Alt. 1) and conventional sand filtration rehabilitation (Alt. 3a) have similar capital costs.
- Conventional sand filtration rehabilitation (Alt. 3a) had lowest NPV and annual costs.
- Conventional sand filtration rehabilitation (Alt. 3a) yielded highest non-monetary score
- Conventional sand filtration rehabilitation selected for implementation.

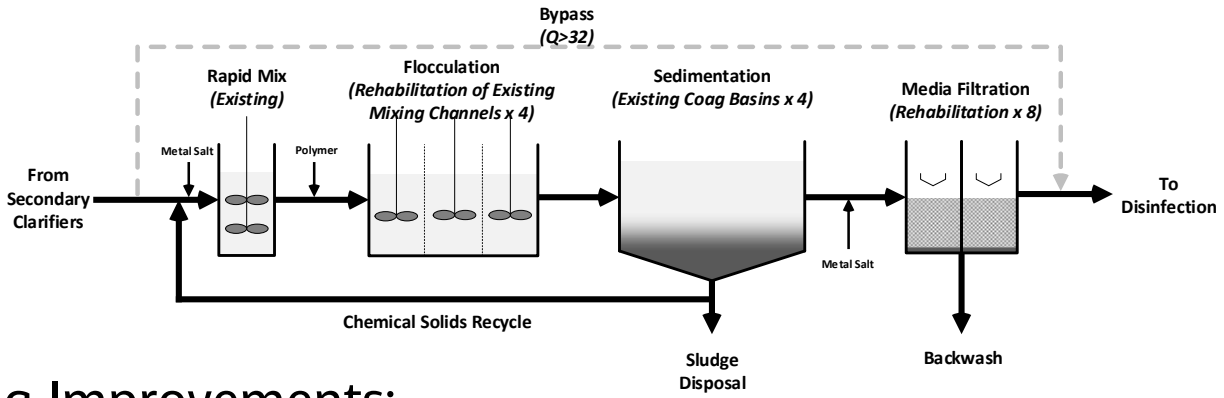
Alternative	Capital Cost	Year 1 Operating Costs	20 Yr Present Worth	Year 1 O & M + SRF Loan Payment
Alt 1 Ballasted Floc/Sed	$8,204,000	$308,000[2] ($353,000)[3]	$15,192,000	$855,000
Alt 2a Cloth with Conventional Clarification[1]	$10,346,000	$168,000[2] ($322,000)[3,4]	$16,747,000	$956,000
Alt 2b Cloth with Lamella Clarification[1]	$15,531,000	$183,000[2] ($281,000)[3]	$21,106,000	$1,231,000
Alt 3a Sand with Conventional Clarification	$7,449,000	$133,000[2] ($260,000)[3,4]	$12,600,000	$715,000
Alt 3b Sand with Lamella Clarification	$12,633,000	$148,000[2] ($218,000)[3]	$16,958,000	$991,000

[1]For 6 cloth filters.
[2]Includes chemical, solids handling, and energy cost only
[3]Includes Annual replacement and O&M costs in addition to chemical, solids handling, and energy
[4]Approximately $90,000/year of O&M accounts for replacement of existing clarifier mechanisms during the 20 year evaluation.

Clarification Filtration	Weight (1 to 10)	Alt 1 Ballasted None	Alt 2a Conventional Cloth	Alt 2b Lamella Cloth	Alt 3a Conventional Sand	Alt 3b Lamella Sand	(Bad) **Zero**	(Good) **Five**
Iron Handling	2	2	3	3	3	3	Highest	Lowest
Polymer Handling	3	2	3	2	4	3	Highest	Lowest
Reliability	10	3	4	3	5	4	Hard to Meet	Best
Redundancy	9	3	4	3	5	4	Least	Most
Lower P Limit (<0.06)	5	2	2	2	4	3	Hardest	Easiest
Ease of Operation	8	3	3	2	4	3	Hardest	Easiest
Maintenance	8	3	4	3	4	3	Most	Least
Ease of Adoption	5	3	3	3	5	4	Hardest	Easiest
Constructability	2	4	3	3	5	4	Hardest	Easiest
Const. Phasing	3	5	3	3	4	4	Hardest	Easiest
Solids Handling	3	3	4	4	4	4	Most	Least
Score		172	199	161	256	206	Highest Score is best	

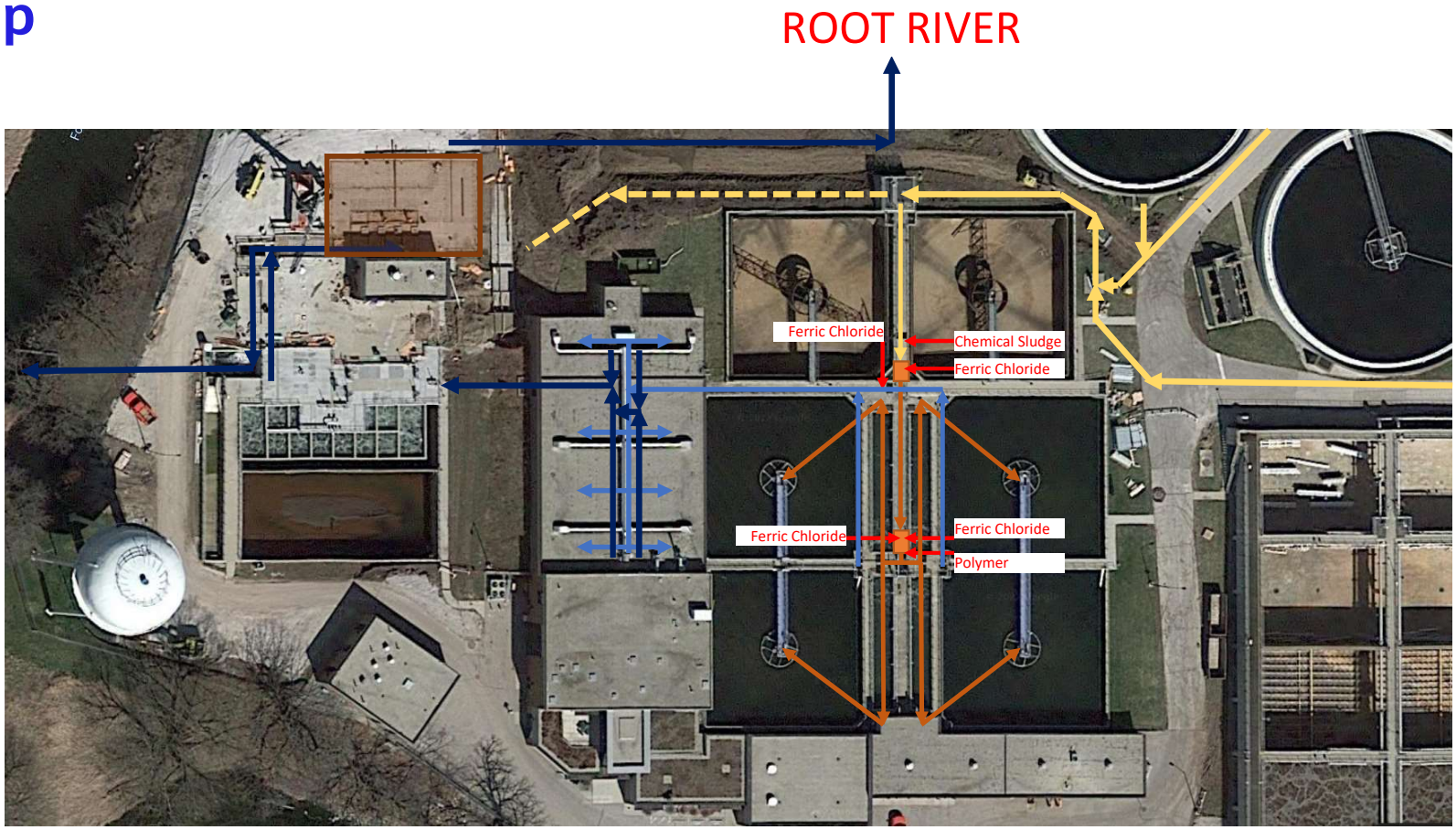
Selected Approach

Tertiary Project Scope



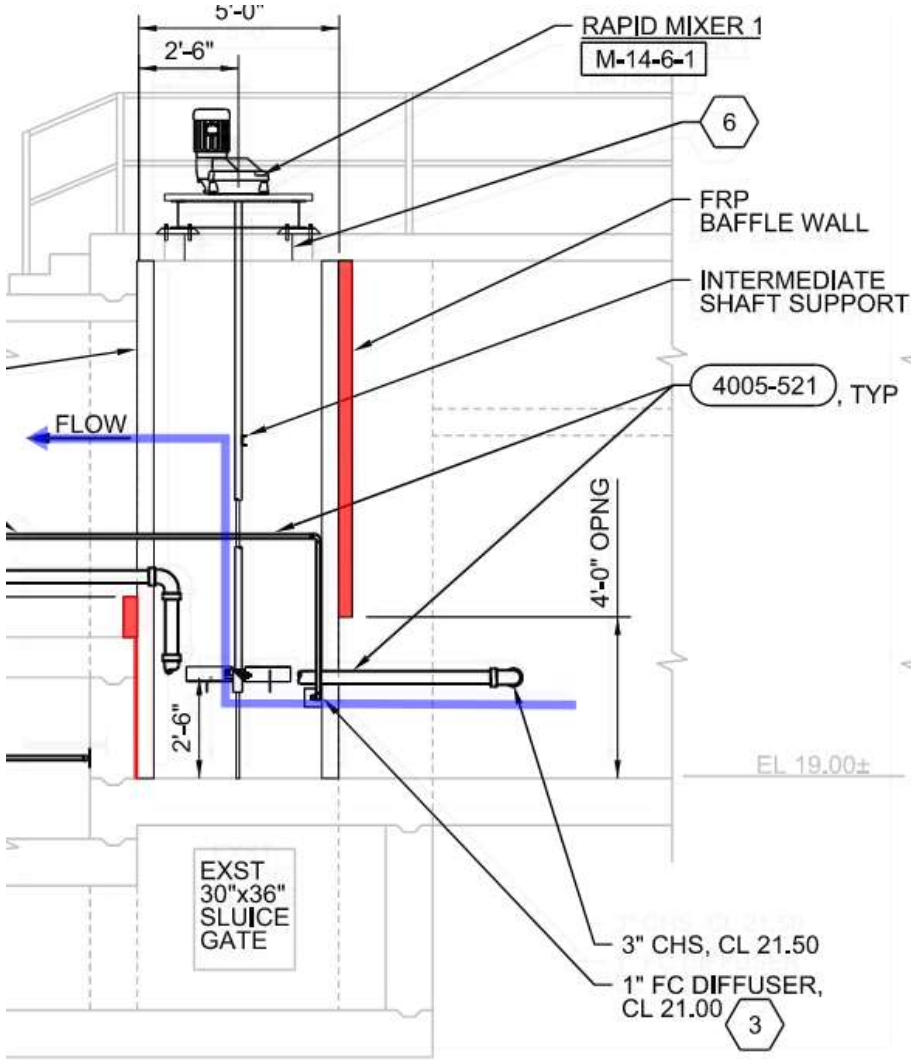
- Tertiary Flocculation/Settling Improvements:
  - Replacement of air flocculation with vertical paddle wheel flocculators
  - Addition of settled chemical solids recycle to promote floc formation/optimize chemical use
- Filtration Improvements
  - Incorporation of air/water backwash (new blower)
  - Addition of media retaining baffles to backwash troughs and replacement of underdrains with AWI stainless underdrains to maximize bed depth
  - Media replacement with medium-coarse mono-media sand
  - Influent/effluent piping and valve improvements

Site Map



Rapid Mix Design Criteria

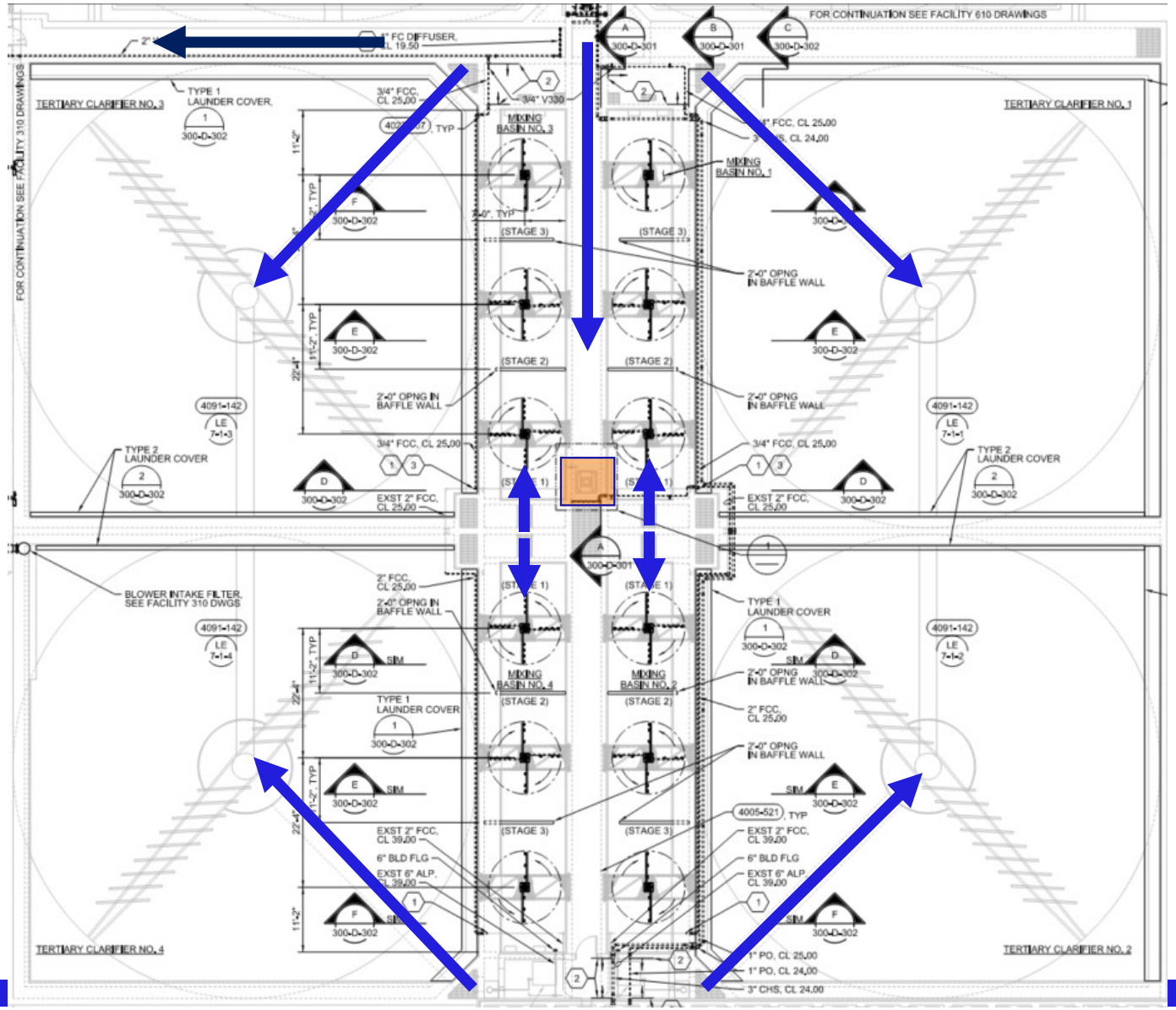
Item	Value	Units
Ferric rapid mix no.1, mixing volume	1,500	gallons
Ferric rapid mix no.1, mixing intensity	400	sec^{-1}
Ferric dose, minimum	5	mg/L
Ferric dose, average	18	mg/L
Ferric dose, max	66	mg/L



Flocculation Design Criteria

Item	Value	Units
Flocculation/sedimentation trains, number of basins	4	—
Flocculation basins, number of stages	3	—
Flocculation basins, dimensions (l x w x side water depth)	14 x 65 x 12.5 14 x 21.67 x 12.5	Feet (total) Feet (each zone)
Flocculation basins, detention time (at 14 MGD)	35.3	minutes
Flocculation basins, detention time (at 31.46 MGD)	15.4	minutes
Flocculation basins, stage 1 mixing intensity	40-70	sec^{-1}
Flocculation basins, stage 2 mixing intensity	20-50	sec^{-1}
Flocculation basins, stage 3 mixing intensity	5-30	sec^{-1}
Polymer dose	0.25 – 1.0	mg/l
Flow Path	Serpentine, Baffled	—

Flocculation Design Criteria



Flocculation Photos

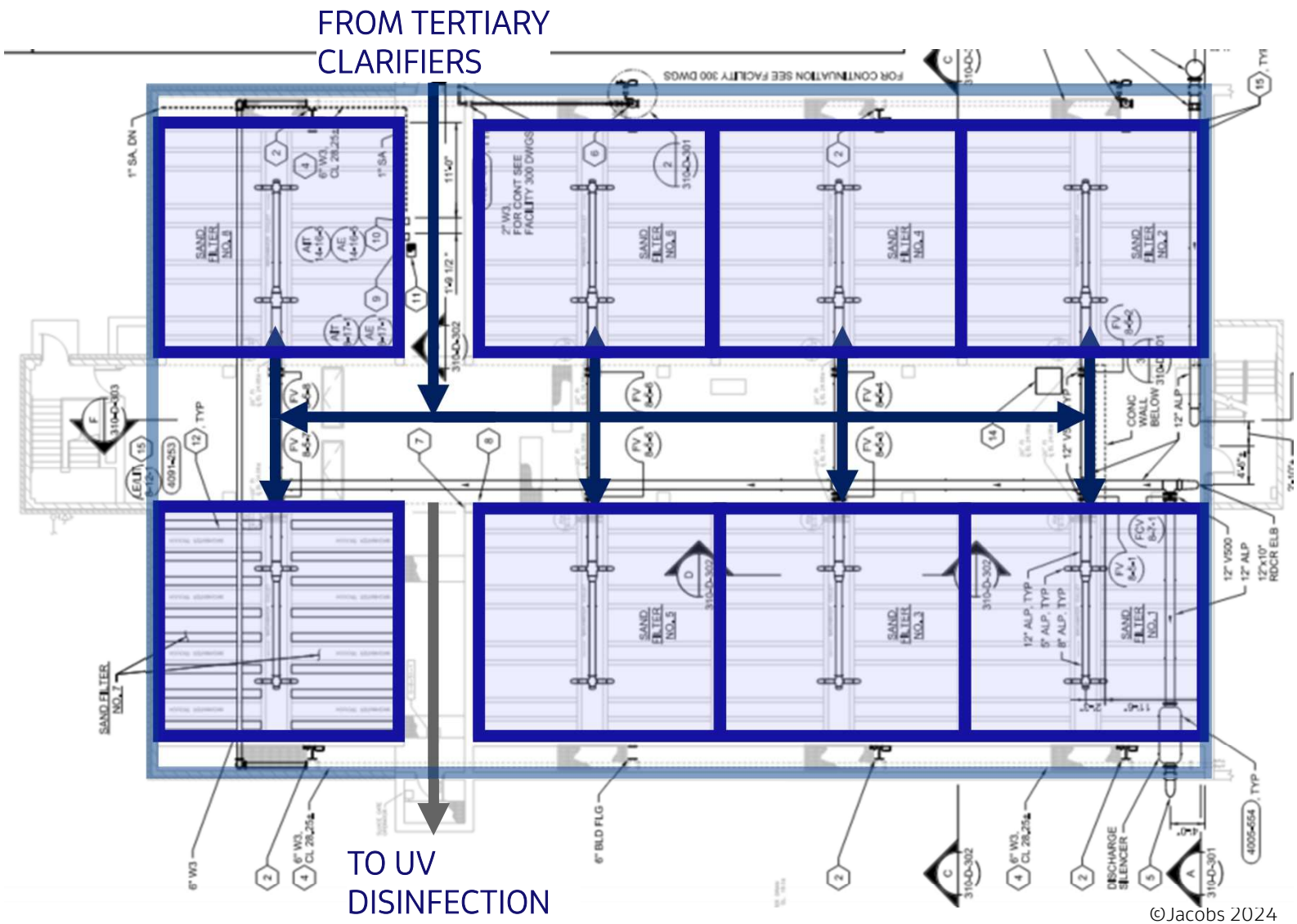
Tertiary Clarifiers

Tertiary Filters – Design Criteria

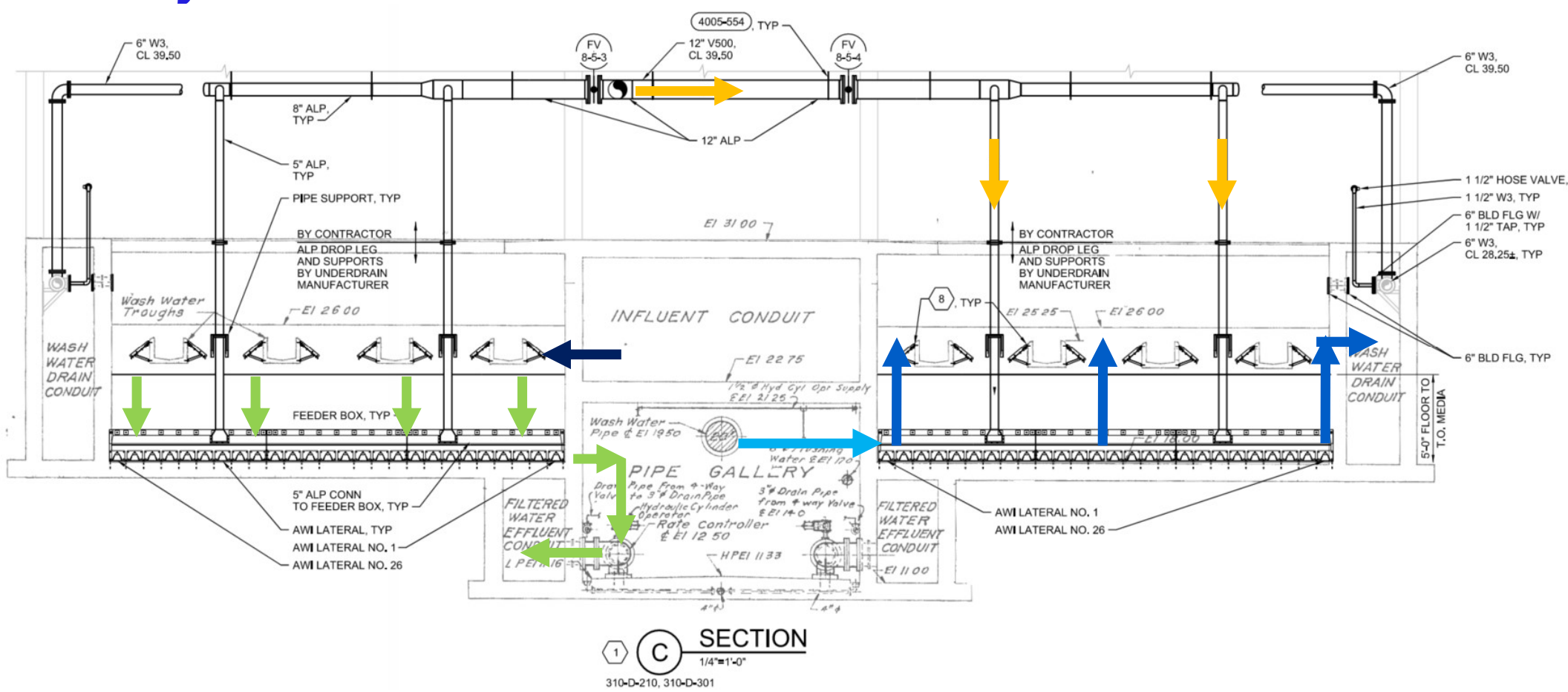
Item	Value	Units
Individual cell area	312	ft^2
Individual filter area	624	ft^2
Cell Dimension **Filter Dimension**	**12x26** **24x26**	**ft** **ft**
Number of filters (7 duty + 1 standby)	8	#
Peak loading rate (one filter out of service)*****	5.0	gpm/ft^2
Capacity per filter	4.49	mgd

*****With coagulation/flocculation and tertiary clarifiers, we typically design filter loading rate at >8 gpm/ft^2. Capacity per filter would then be >=7.19 MGD.

Tertiary Filters



Tertiary Filters



1 C SECTION
1/4"=1'-0"
310-D-210, 310-D-301

Backwash System – Design Criteria

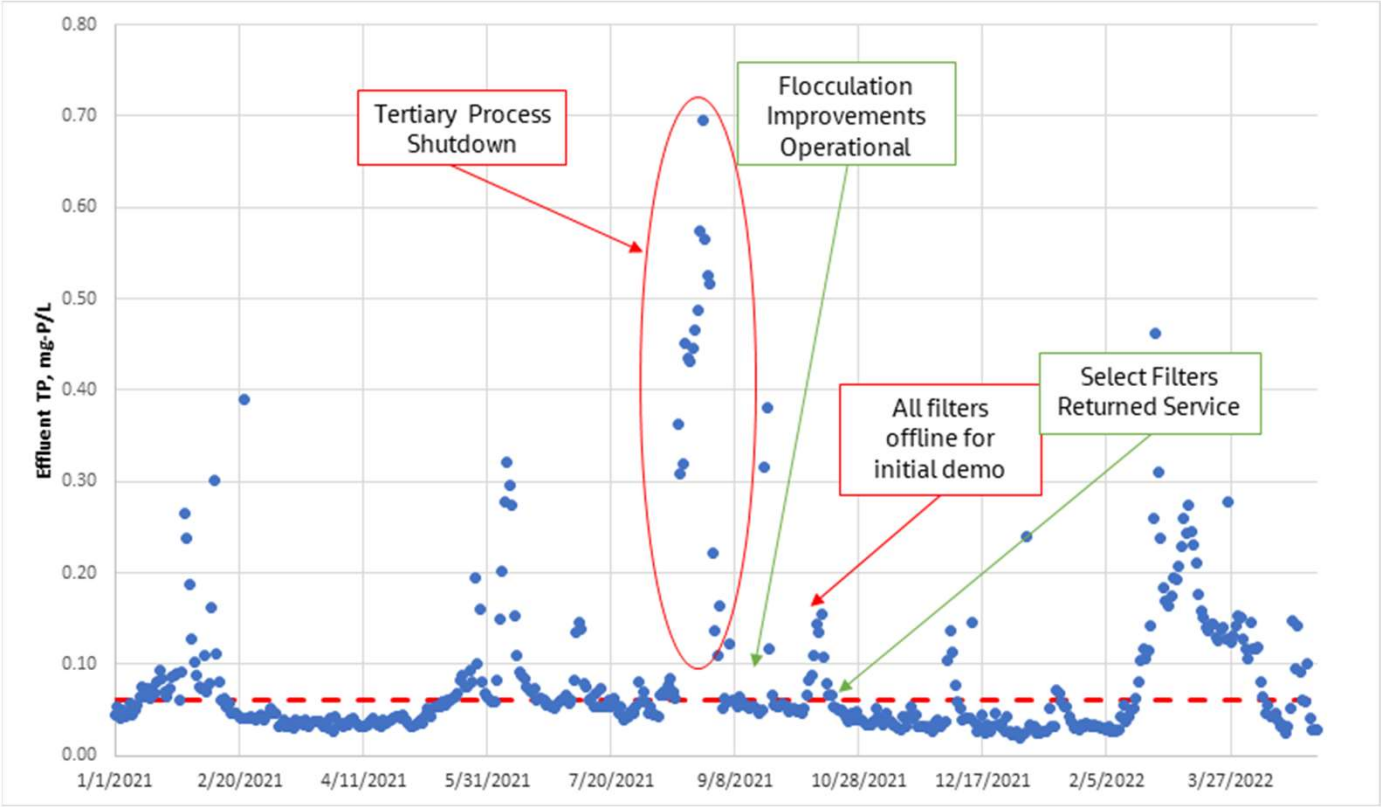
- Air Scour
  - 2-4 scfm/sf (2,496 scfm)
  - 2-5 minutes
- Concurrent Wash
  - 3-6 gpm/sf (3,744 gpm)
  - 10-15 minutes (12 minutes)
- Water Wash
  - 6-12 gpm/sf (7,488 gpm)
  - 3.5-8 minutes
  - Water wash volume should be >1 bed volume (23,341 gallons minimum)

Filter Improvements

Performance

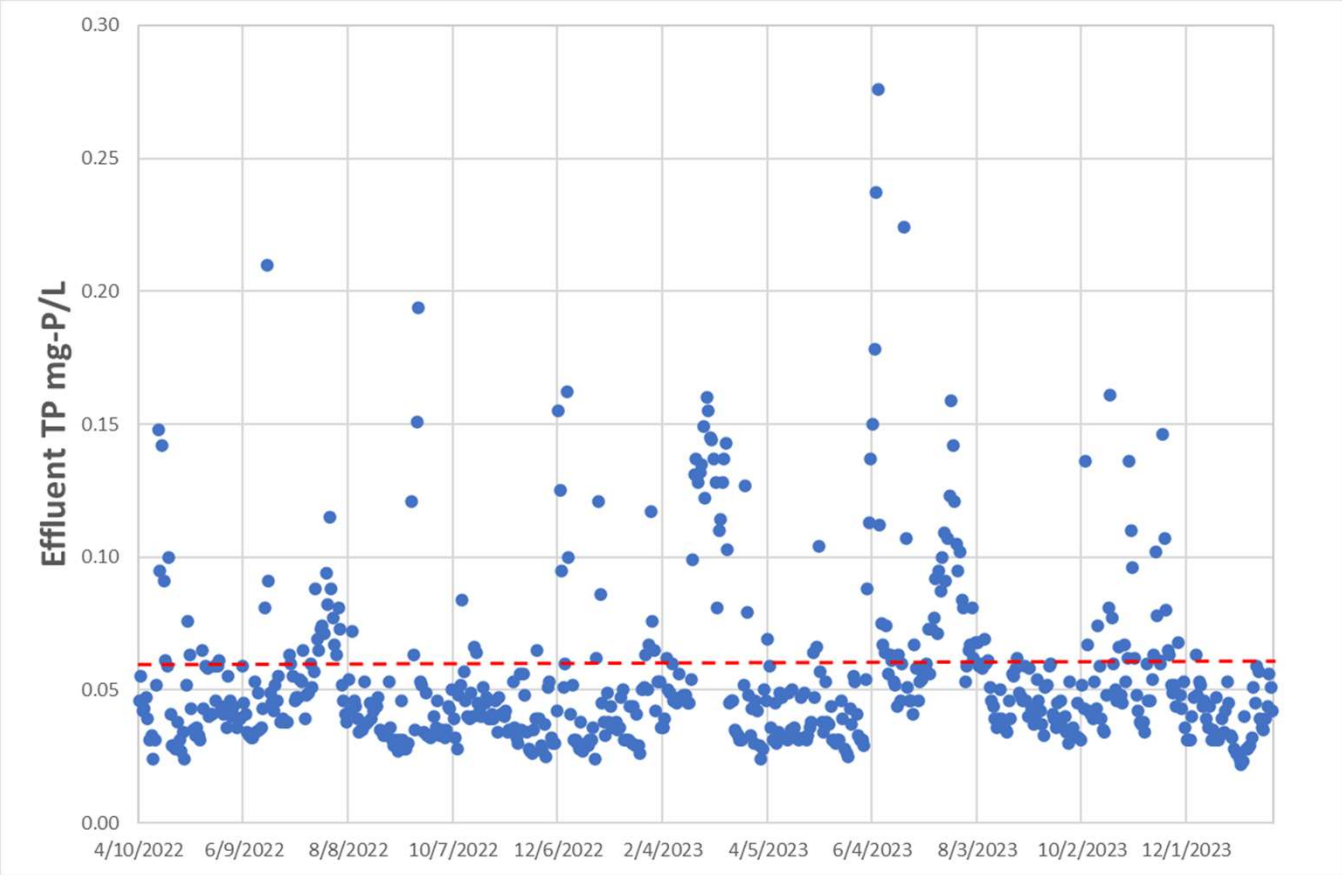
Implementation

- August 2021:Coagulation, flocculation, and sedimentation improvements operational.
- Filter Improvements:
  - October 2021: 3 of 8 rehabilitated filters on-line
  - February 1, 2022: All filters operational
- Impacted groundwater >25% of plant capacity
- New controls in service
- Back on track April 2022



Implementation

- April 2022 to present:
  - 0.056 mg-P/L
  - June 30, 2022 0.075 mg-P/L limit
- October 9, 2023:
  - Discharge to Root River
  - 0.06 mg-P/L limit
  - 0.051 mg-P/L
- Ferric chloride dosing optimization
  - 20 mg/L Fe each dosing point, 40 mg/L Fe total
  - 450 gpd at average flow
- Maintain minimum ferric chloride tank level or pump capacity drops



Questions?

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