Newly Developed Cloth Media for Low Phosphorus & Water Reuse Applications

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Outline

- Cloth media
- Chemical addition
- Jar testing
- Why conduct a pilot study?
- Pilot testing protocol
- Platteville Water Resource Recovery Facility
- Cloth media comparison
- Water reuse potential

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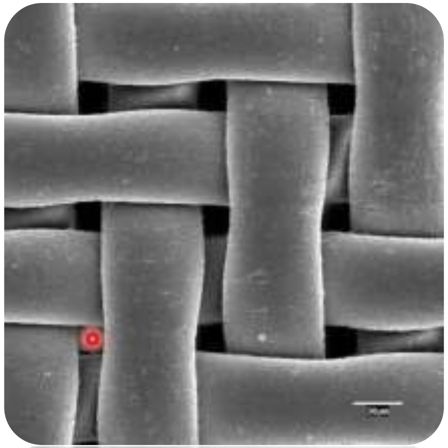
Surface Filtration

- Many technologies are available
- Media is evolving
  - Granular
  - Compressible
  - 10 µm
  - 5 µm
  - **2 µm - NEW**



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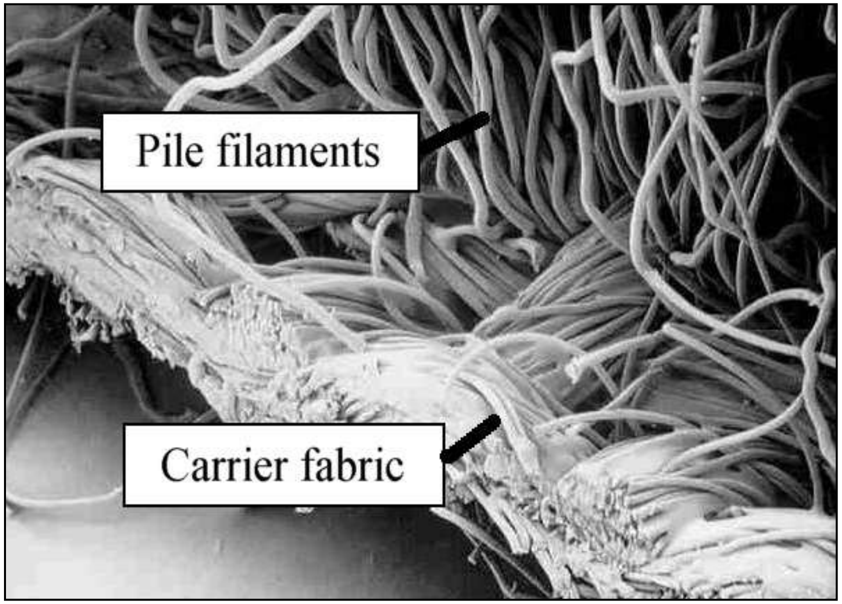
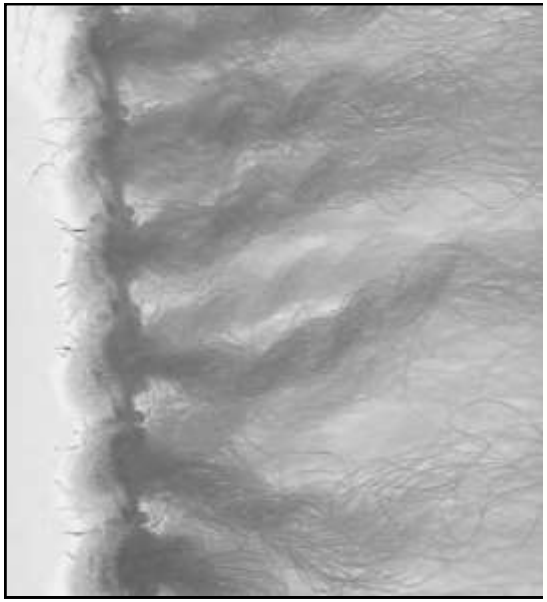
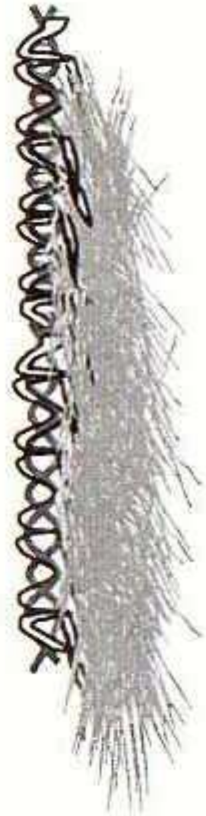
Cloth Media – The Basics

- Pile fibers create filtration area
- Backing and filament construction make a difference







Cloth Media - Ultrafiber

- Ultrafiber
  - Newly developed cloth – ultrafiber
  - Originally designed for water pretreatment systems
  - Clean feed source (5-10 mg/L TSS)
  - Designed to improve particle retention
  - “Filtration rating” of 2 micron
  - Fiber construction – 1/2 to 1/3 of microfiber

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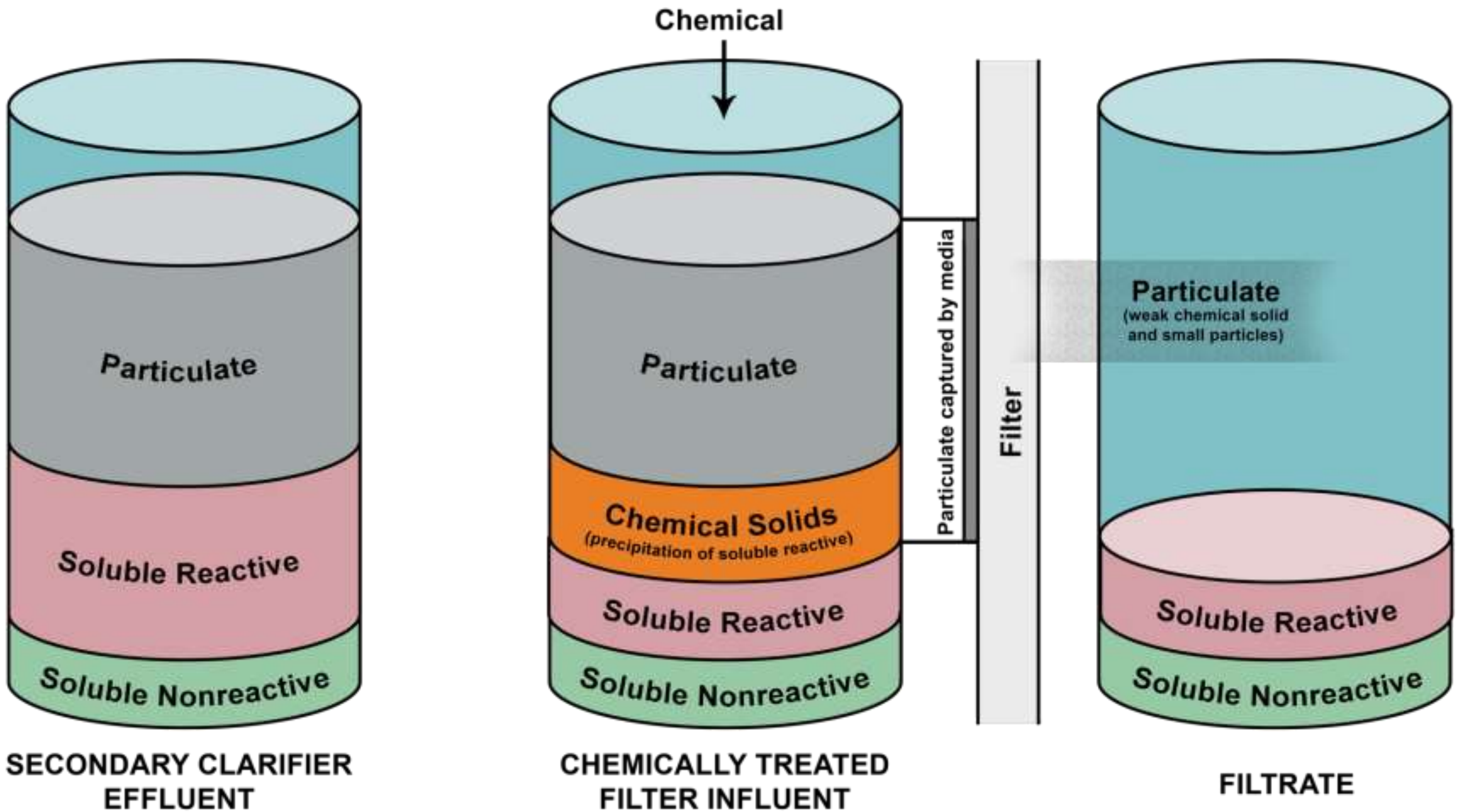
Filtration and Chemical Addition



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Where to Start – Jar Testing

- Should be tailored to closely match actual conditions
- Conditions
  - Sequence of chemical addition
  - Rapid mixing time and intensity
  - Flocculation time and intensity
- Visual Evaluation
  - Time of first floc formation
  - Floc size
  - Floc Quality
  - Settling Rate
- Settled Samples
  - Turbidity
  - Color
  - Particle count
  - Filtered turbidity
  - Phosphorus

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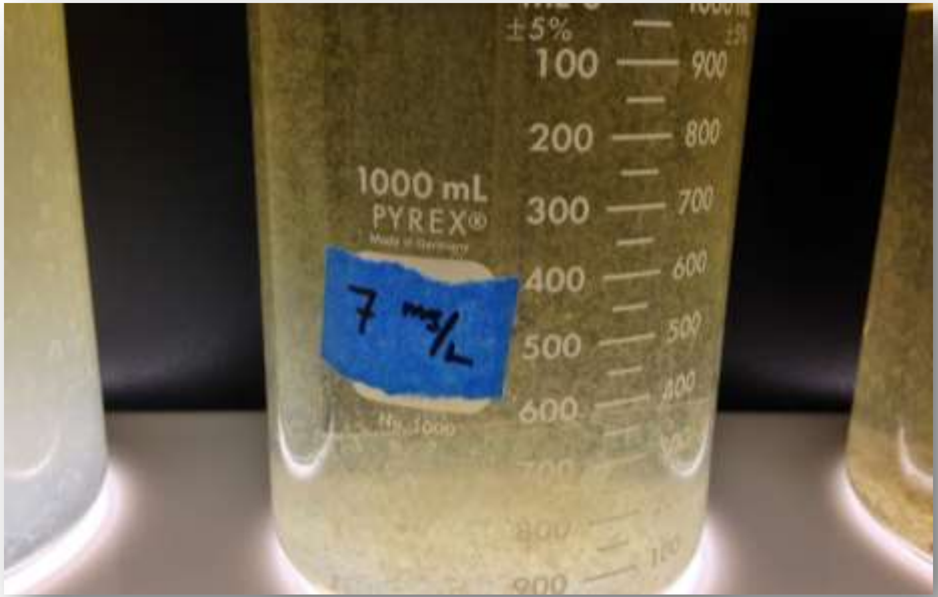
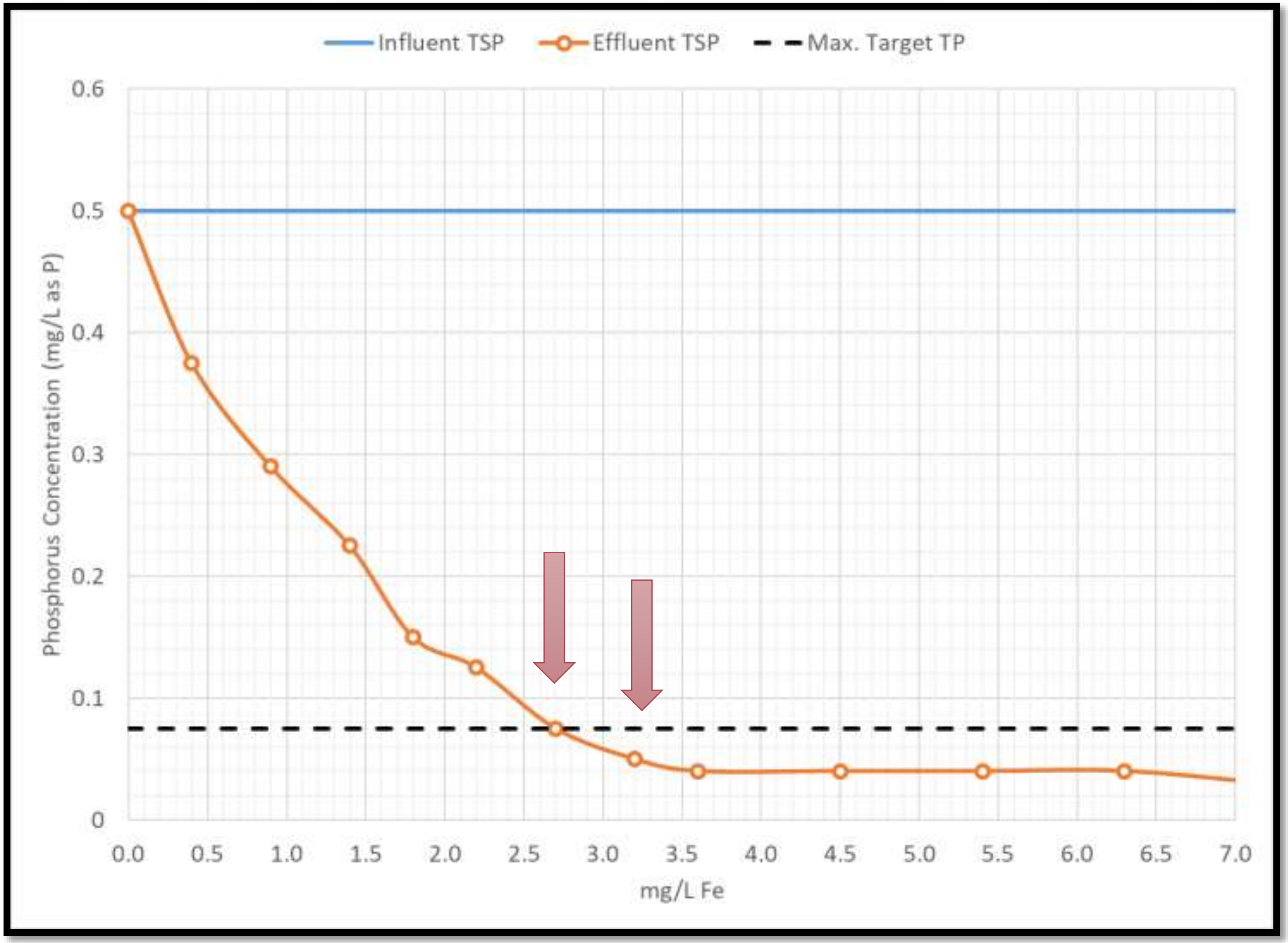
Jar Testing



Jar Testing – Dose Response Curve



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Pilot Study – Why?

- Advantages
  - New technology uneasiness
  - Hands-on experience
  - Performance assessment at different conditions
    - Influent and effluent constituents
    - High flows and solids loadings
    - Chemical usage – type and volume
    - Chemical contact time
    - Phosphorus speciation
    - Backwashing – frequency and volume
  - Improve startup activities
- Disadvantages
  - Costs: $5,000 - $40,000
  - Time

Pilot Study – Side by Side Comparison

Onsite Pilot Testing – The Protocol

- Agree on protocol
- Get the biggest bang for your buck
- Plan for normal or upset conditions
- Sampling schedule
- Lab testing requirements
- Daily schedule
- Staffing plan

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Protocol – Daily Schedule

Proposed Schedule

Day		Test	HLR (gpm/ft^2)
1	Mon	Equipment arrives on site and setup	N/A
2	Tues	Setup	N/A
3	Wed	Finish setup and start flow	3.25
4	Thur	Metal salt & polymer optimization	3.25
5	Fri	Metal salt & polymer optimization	3.25
6	Mon	Metal salt & polymer optimization	3.25
7	Tues	Steady State	3.25
8	Wed	Steady State	3.25
9	Thur	Steady State	3.25
10	Fri	Maximum Flow	6.5
11	Mon	Metal salt & polymer optimization	2.0
12	Tues	Metal salt & polymer optimization	2.0
13	Wed	Steady State	2.0
14	Thur	Steady State	2.0
15	Fri	Steady State	2.0
16	Mon	Maximum Flow	4.0

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Protocol – Sampling Requirements

Sampling Schedule

Influent	**Onsite Lab**	**3rd Party Lab**
TSS (pre chemical)	-	2 Composite/day
TSS (post chemical)	-	2 grab/day
Total Phosphorus	2 Composite/day 2 Grab/day	2 Composite/day
Soluble Phosphorus	2 Composite/day 2 Grab/day	
Soluble Reactive Phosphorus	2 Composite/day 2 Grab/day	
Particle Size Analysis	2 Composite/day	
Effluent		
TSS	-	2 Composite/day
Total Phosphorus	2 Composite/day 2 Grab/day	2 Composite/day
Soluble Phosphorus	2 Composite/day 2 Grab/day	
Soluble Reactive Phosphorus	2 Composite/day 2 Grab/day	
Particle Size Analysis	2 Composite/day	

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Platteville Water Resource Recovery Facility

- Located in southwestern WI
- Current population of 12,200
- Annual average of design flow = 2.05 MGD
- Current annual average = 1.0 MGD
- Integrated biological treatment system
  - Primary settlers
  - Trickling filters
  - Intermediate clarifiers
  - Aeration basins
  - Secondary clarifiers
  - Sand filters
  - Disinfection

Platteville WRRF – Aerial

Phosphorus Compliance Schedule

Required Action	Year Due
Year 1 – OER	2015
Year 2 – Status Report	2016
Year 3 – Preliminary Alternatives	2017
Year 4 – Final Alternatives	2018
Achieve Compliance – 0.075 mg/L	2023

Phosphorus Compliance

- Chemical phosphorus removal study
  - Multipoint chemical addition
    - Intermediate clarifier effluent
    - Sand filter influent
  - Results indicate that effluent phosphorus < 0.3 mg/L is possible
- Watershed
  - 3,000 lb annually
- WWTF upgrades – surface filtration
- MDV

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Testing Protocol

- Two types of cloth media
  - Standard cloth – microfiber
    - “Filtration rating” of 5 micron
  - Ultrafiber
    - “Filtration rating” of 2 micron
- Standard cloth – microfiber
  - Average HLR = 3.25 gpm/ft^2
  - Peak HLR = 6.5 gpm/ft^2
  - Design SLR = 2.0 ppd/ft^2
- Ultrafiber
  - Average HLR = 2.0 gpm/ft^2
  - Peak HLR = 4.0 gpm/ft^2
  - Design SLR = 1.0 ppd/ft^2

Pilot Trailer

- Commercial unit, full-scale, single disk
- 10.8 ft^2 of effective filtration area
- Chemical feed pumps
- Flocculation tanks
- Data monitoring
    - Influent and effluent turbidity
    - Influent and waste flow
    - Tank level
    - Influent and effluent ortho-phosphorus

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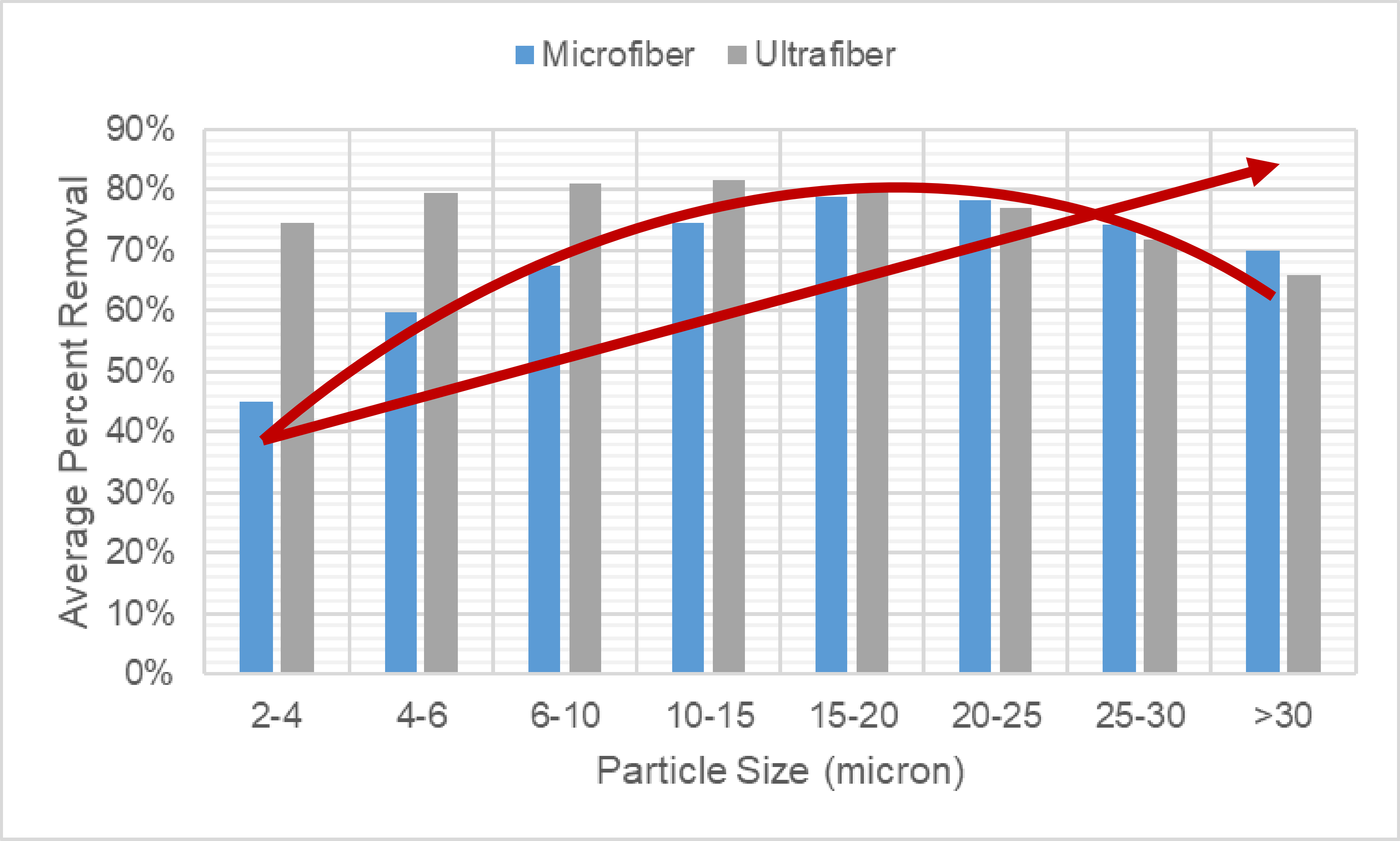
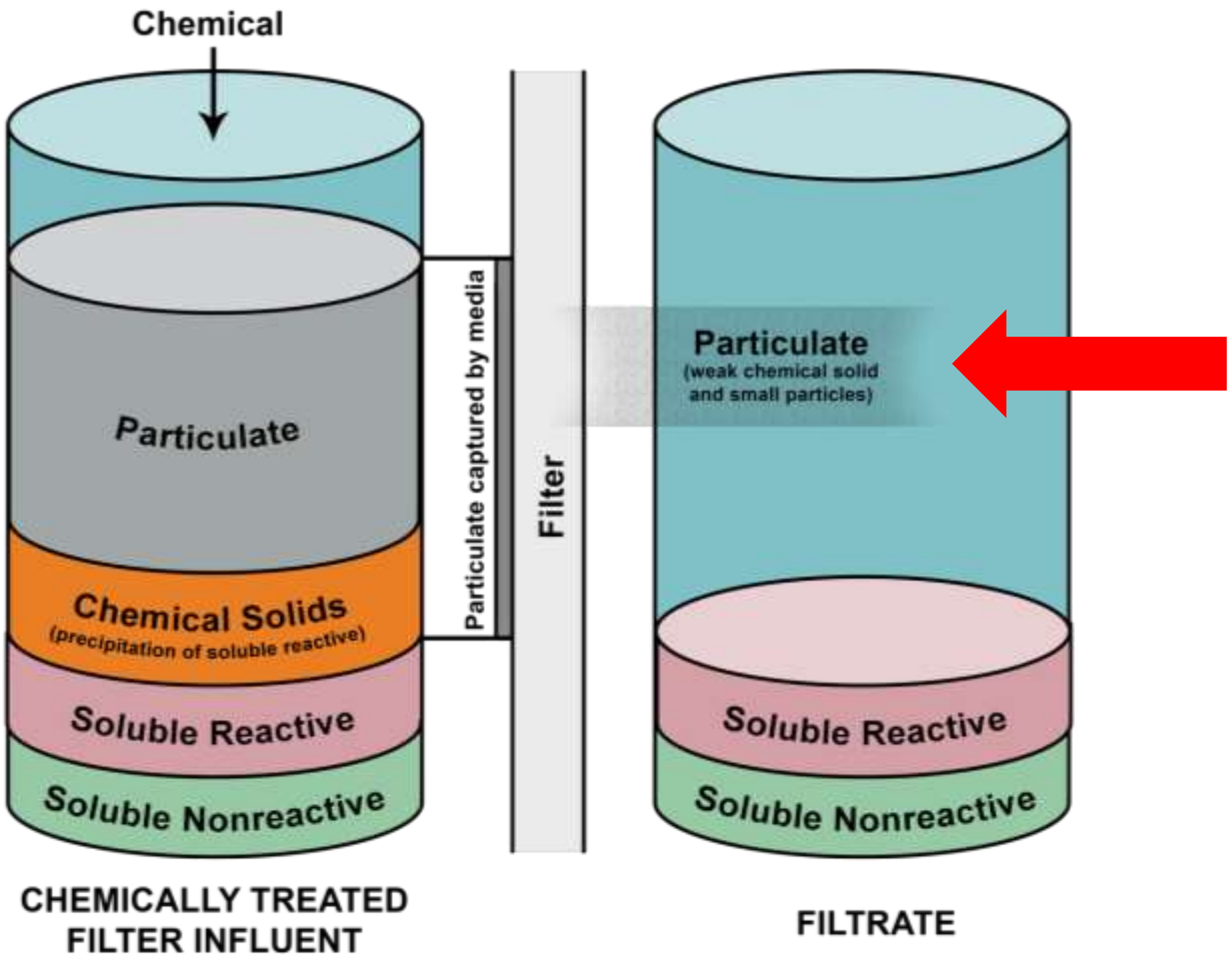
Results – Particle Removal



Particle Removal



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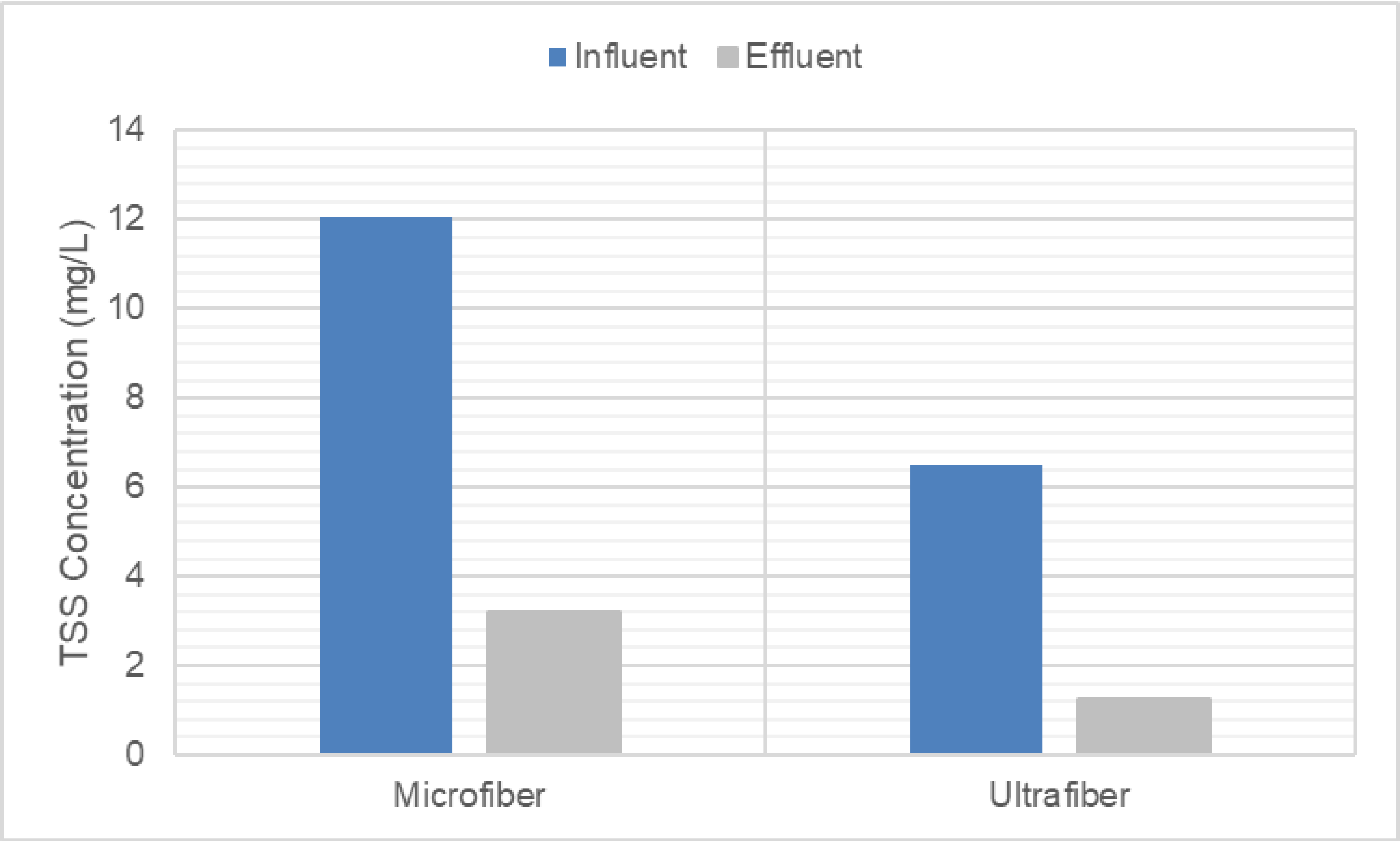
Results – Total Suspended Solids



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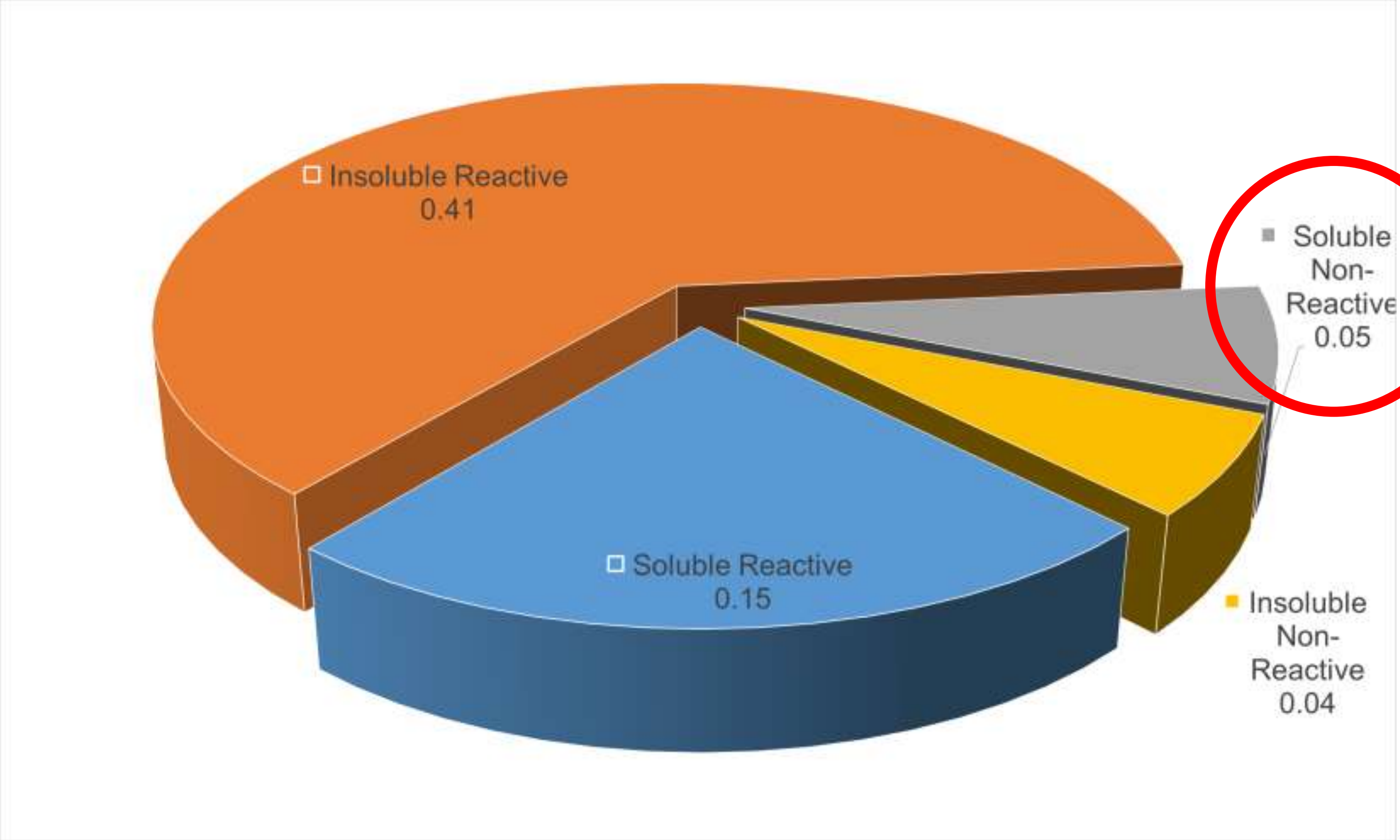
Phosphorus – Influent Speciation – SNRP



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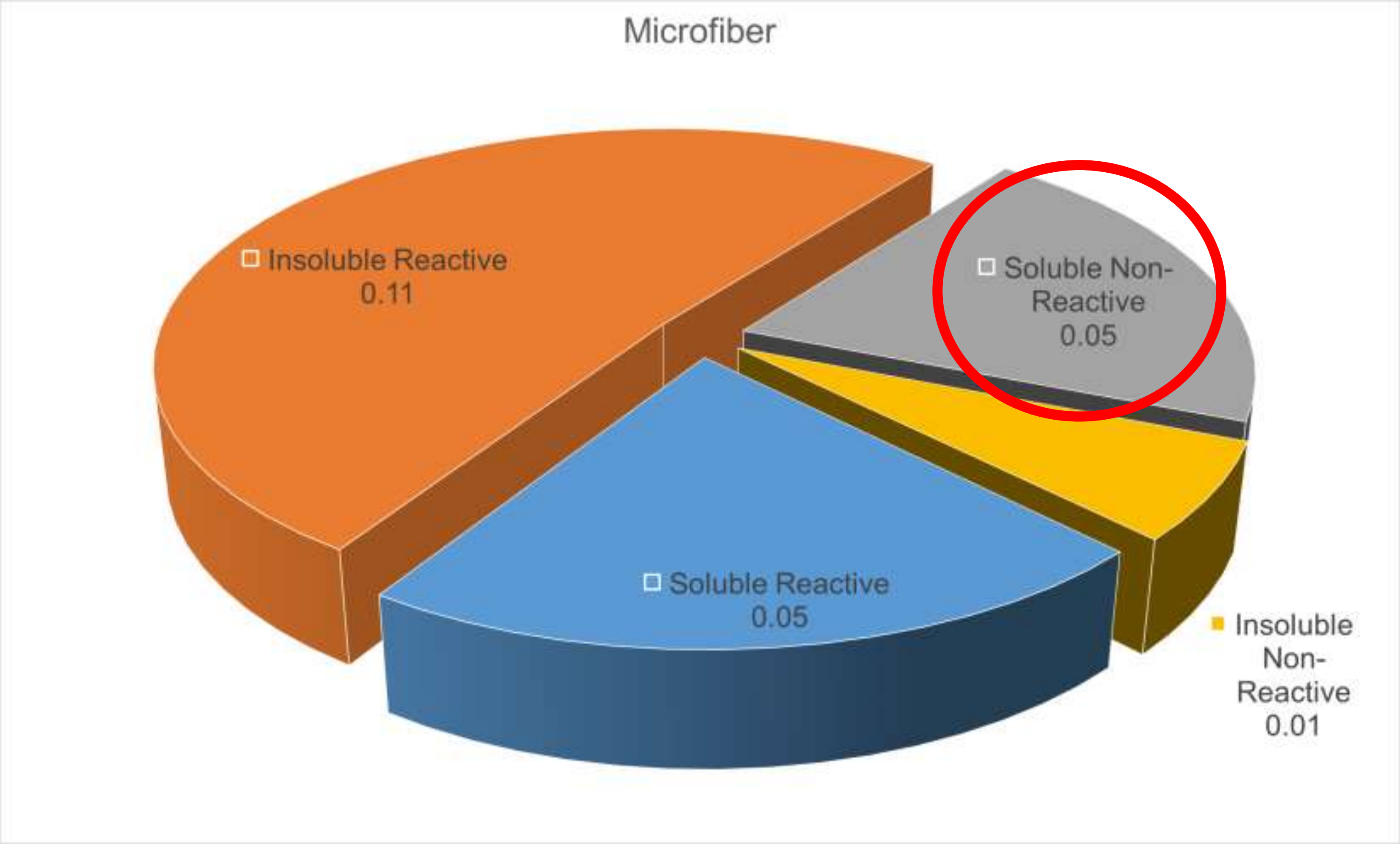
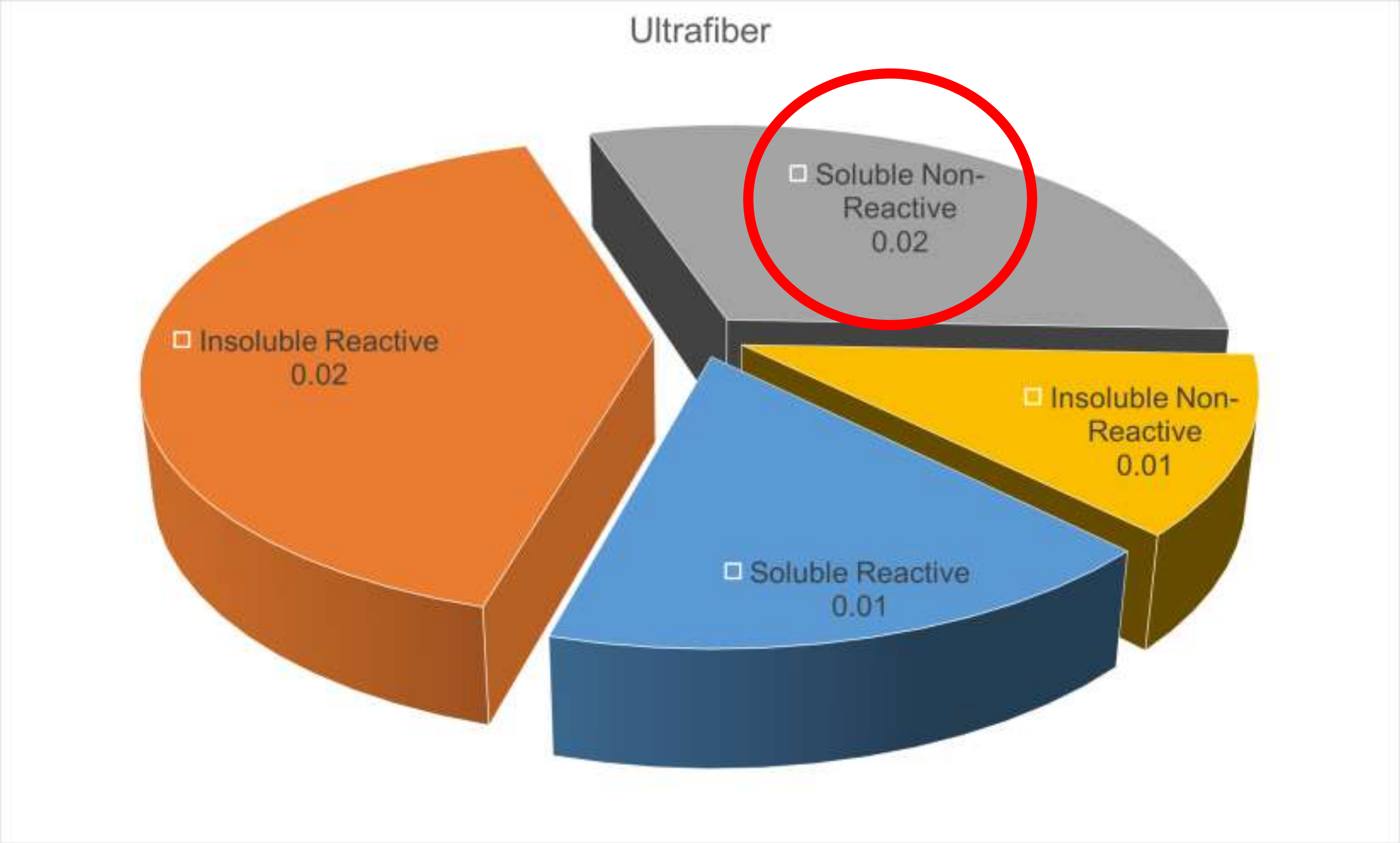


Phosphorus – Effluent Speciation – SNRP



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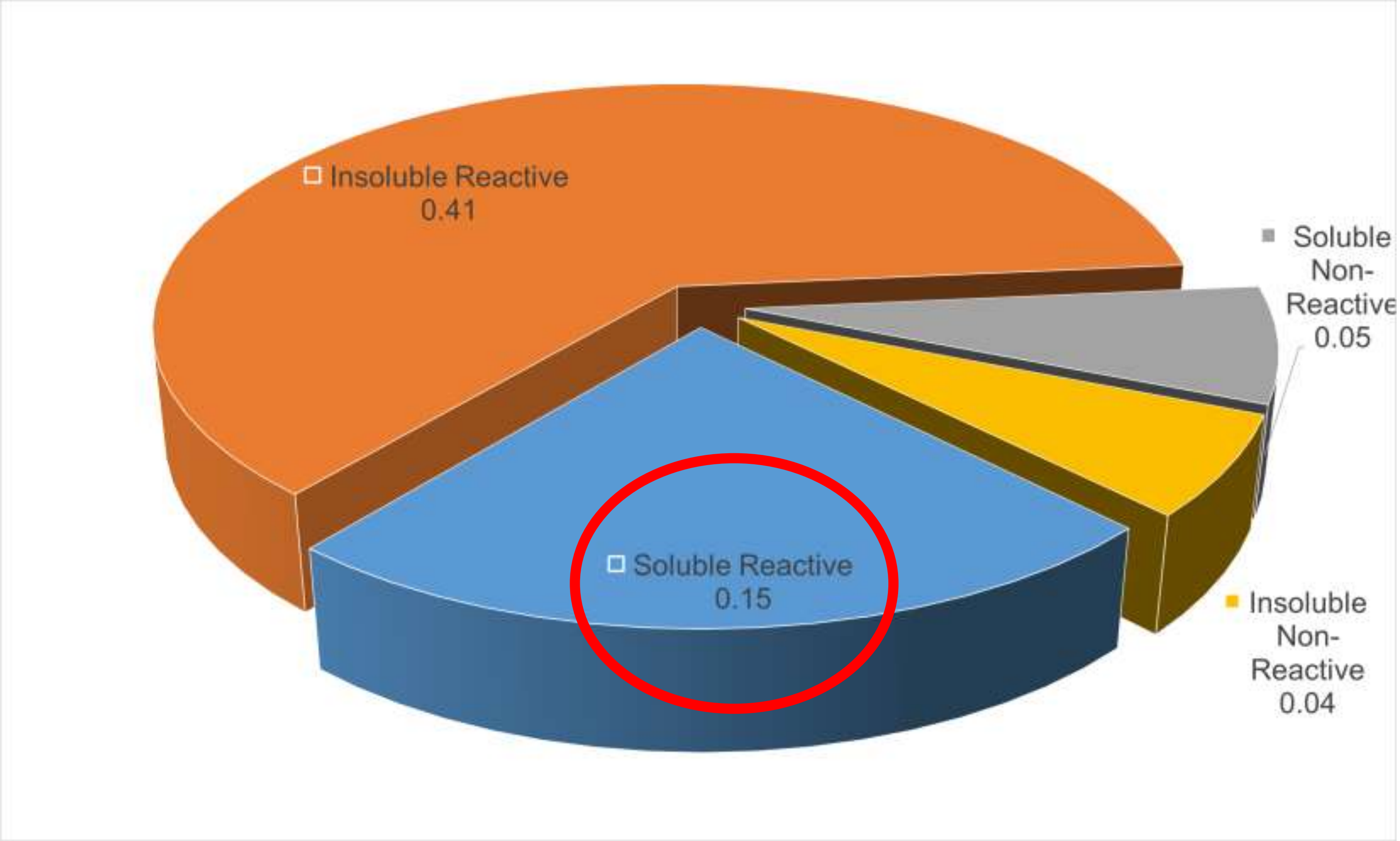
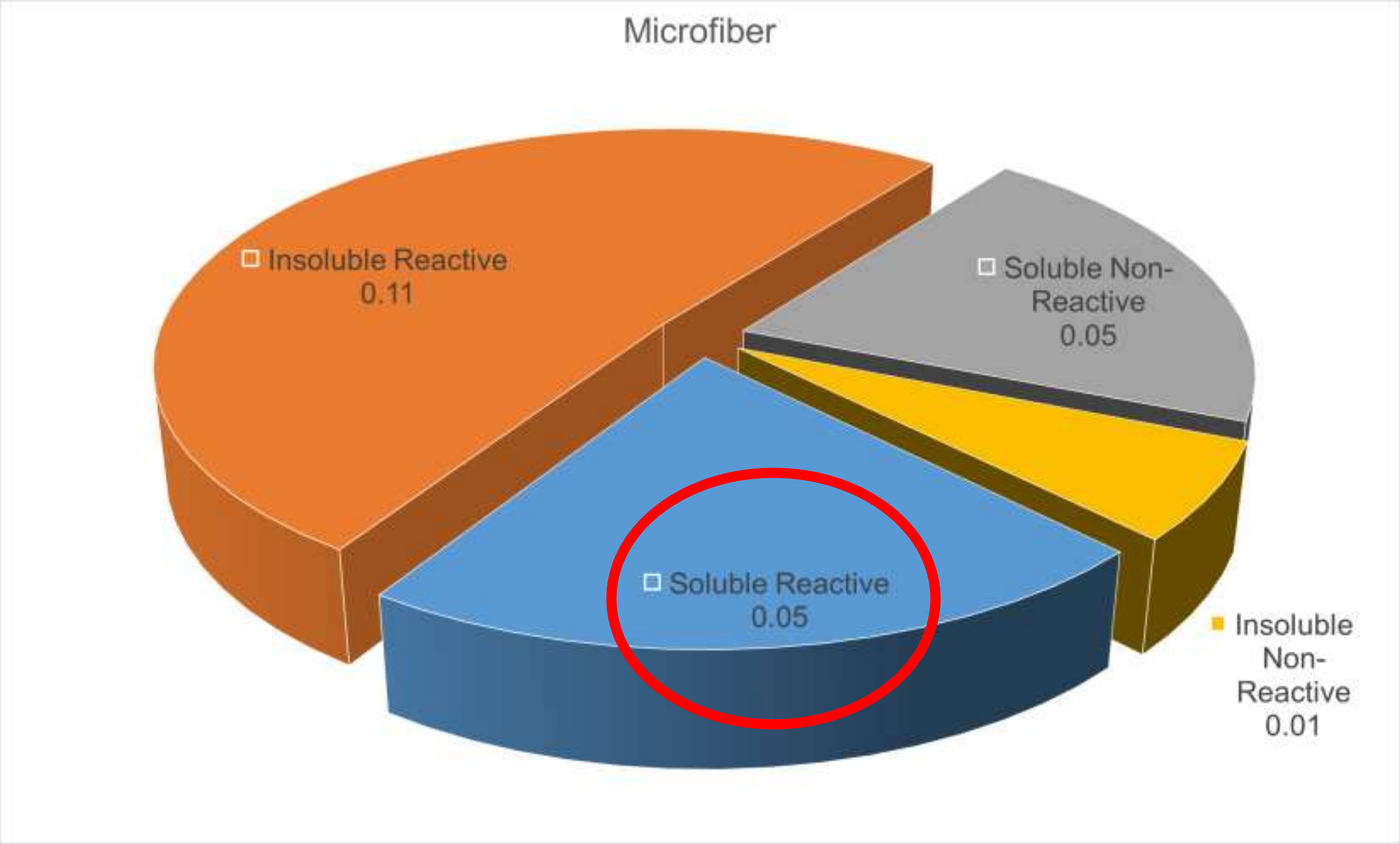
Phosphorus – Influent Speciation – Orthophosphate



Phosphorus – Effluent Speciation – Orthophosphate



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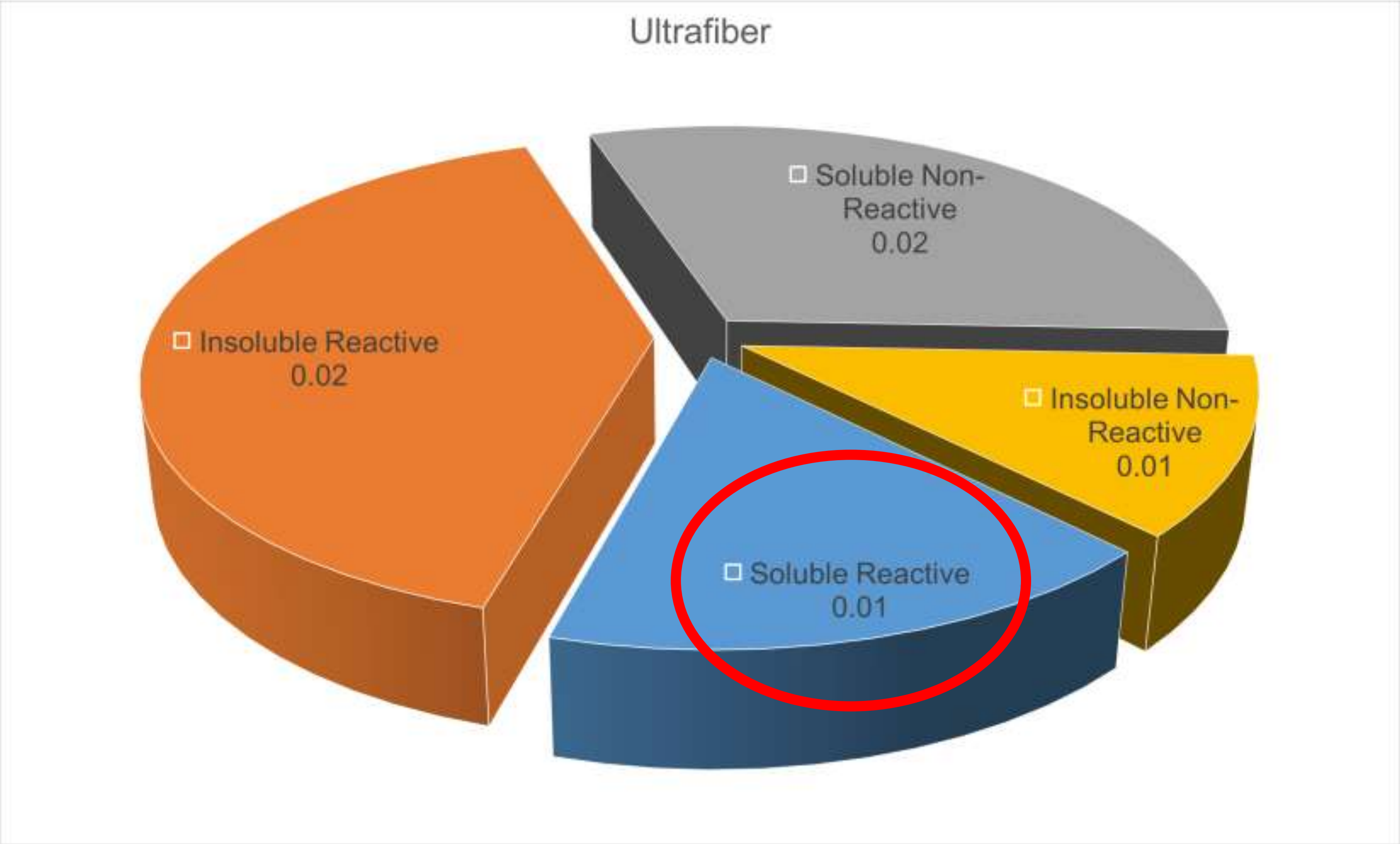
Phosphorus – Effluent Speciation – Orthophosphate



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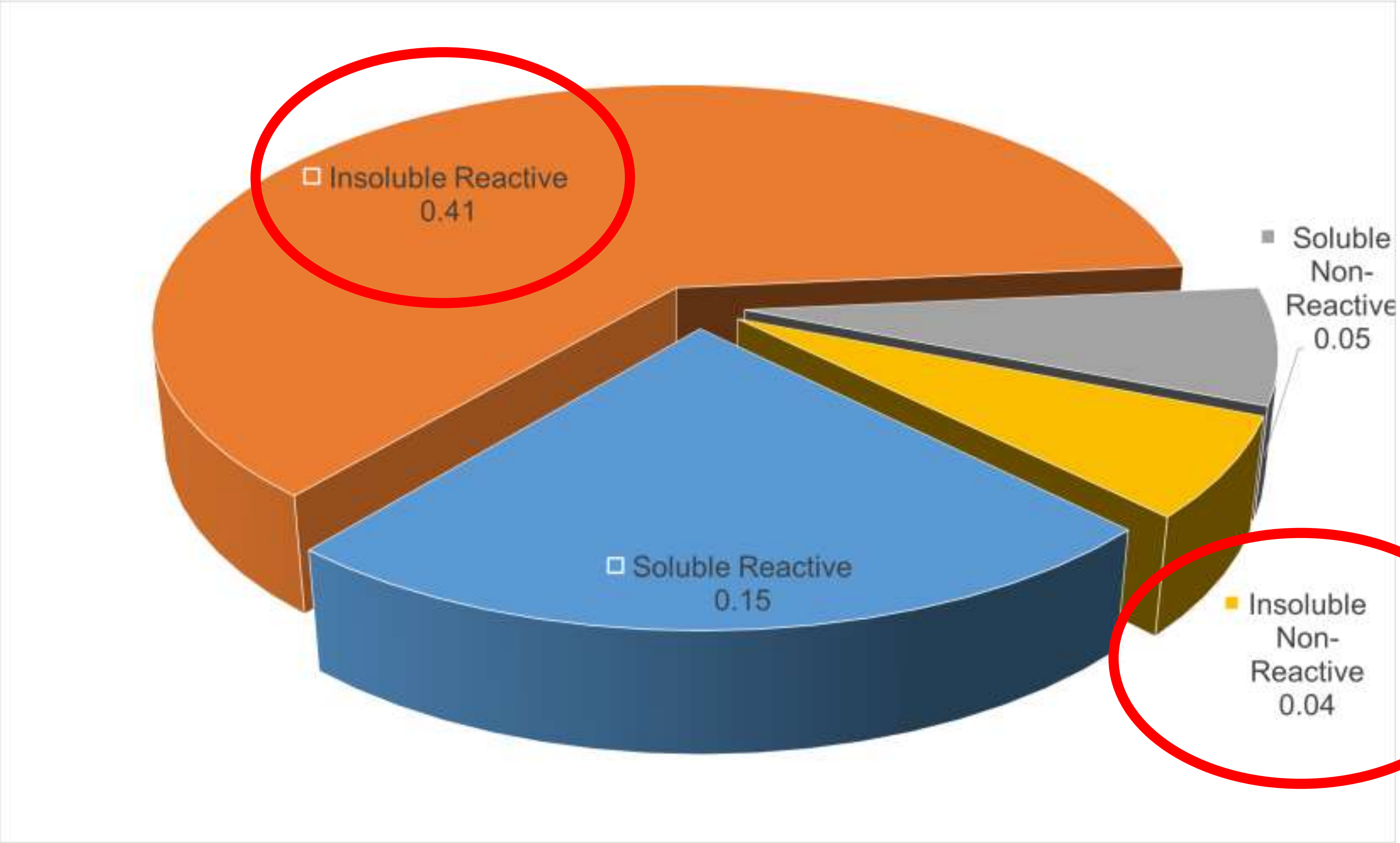
Phosphorus – Influent Speciation – Insoluble Forms



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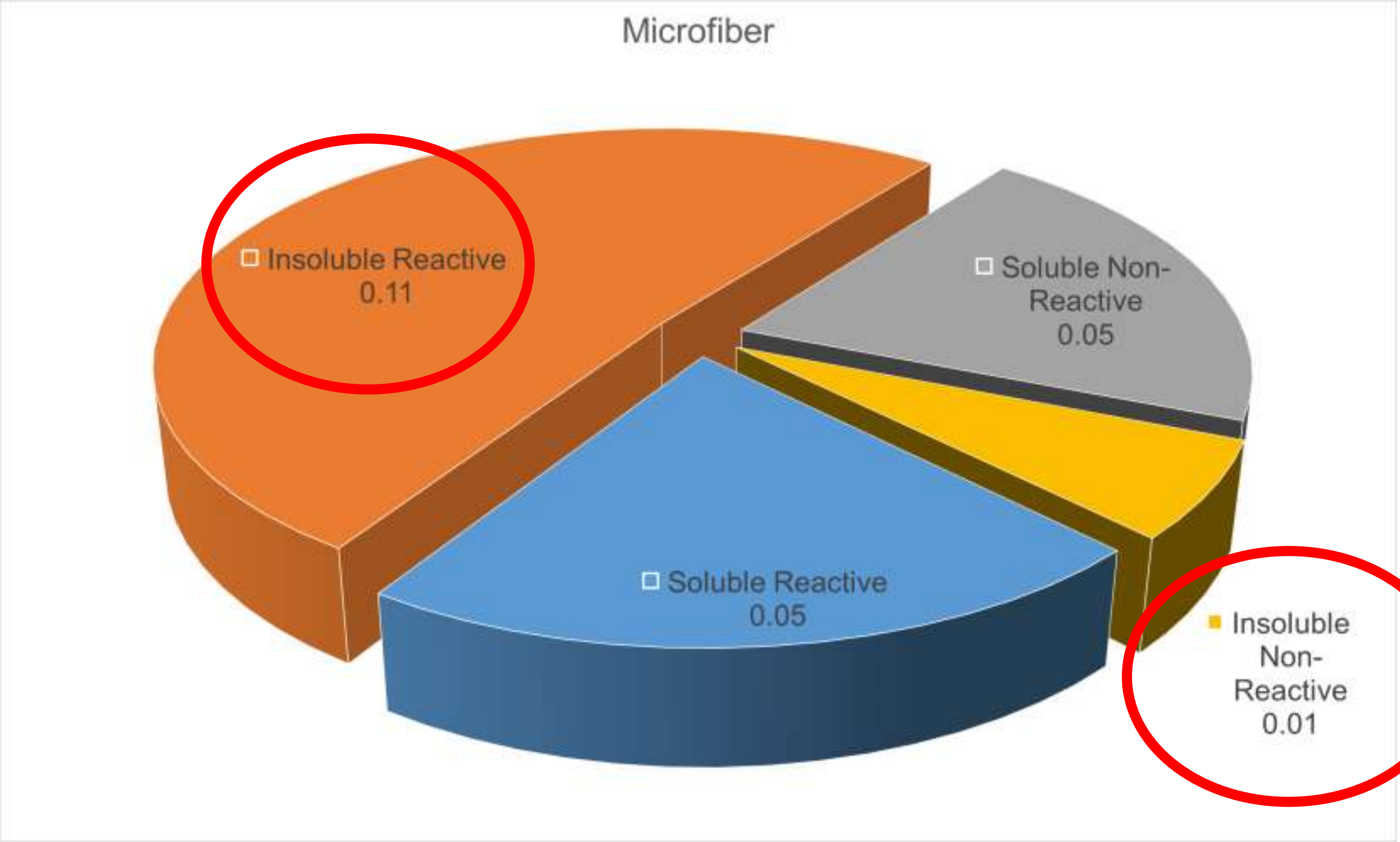
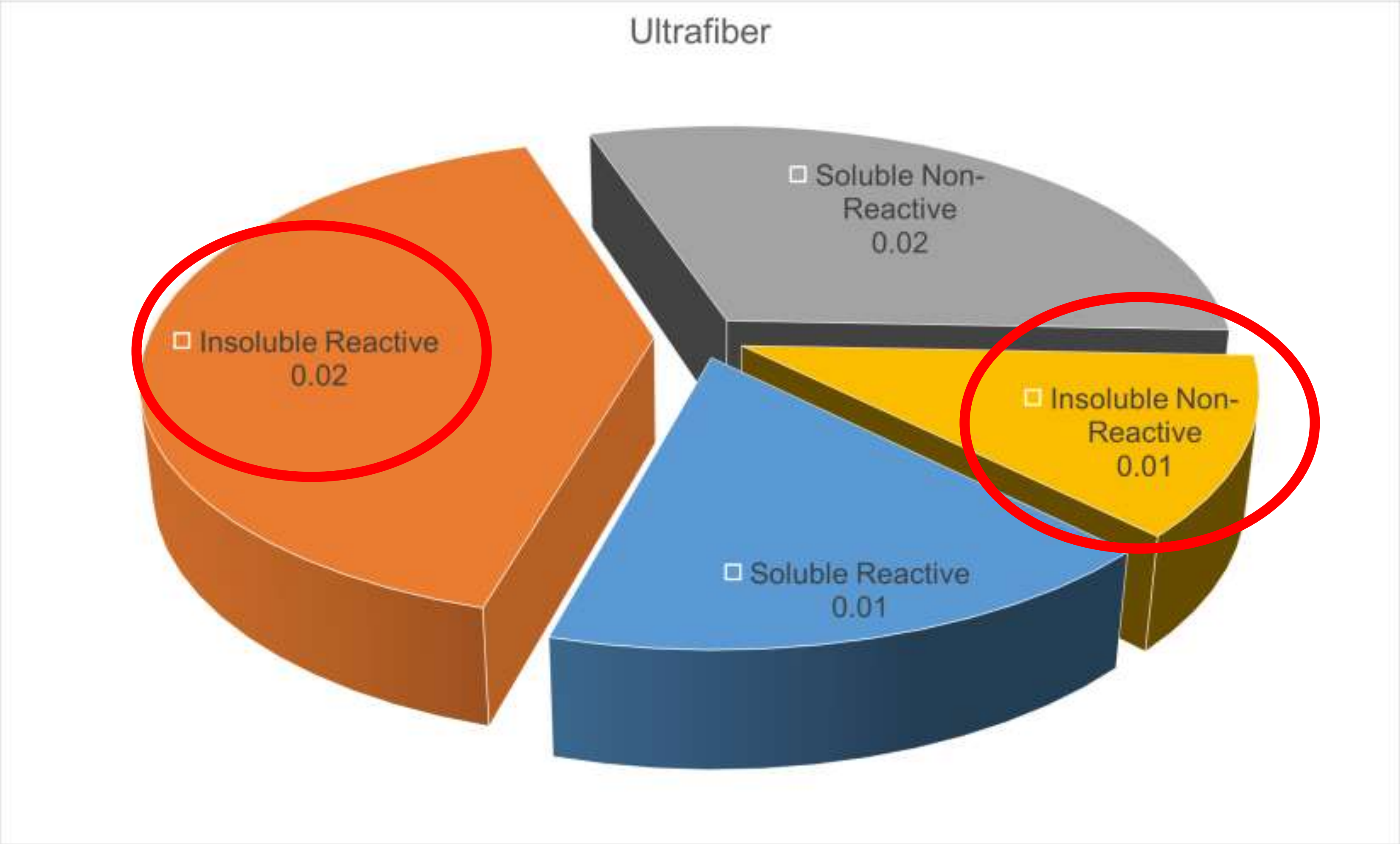
Phosphorus – Effluent Speciation – Insoluble Forms



Phosphorus – Effluent Speciation – Insoluble Forms



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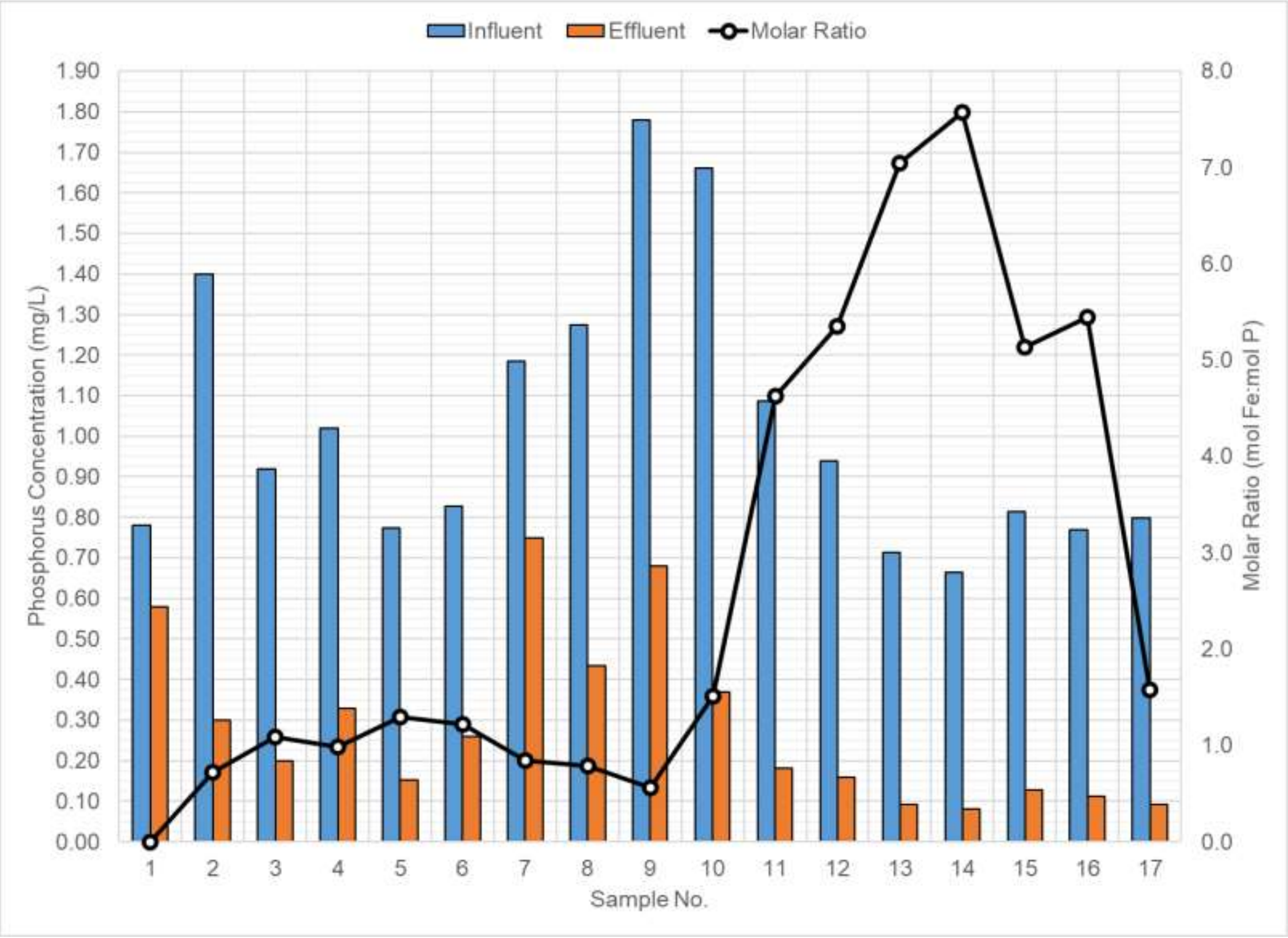
Results – Microfiber Adjustment Period



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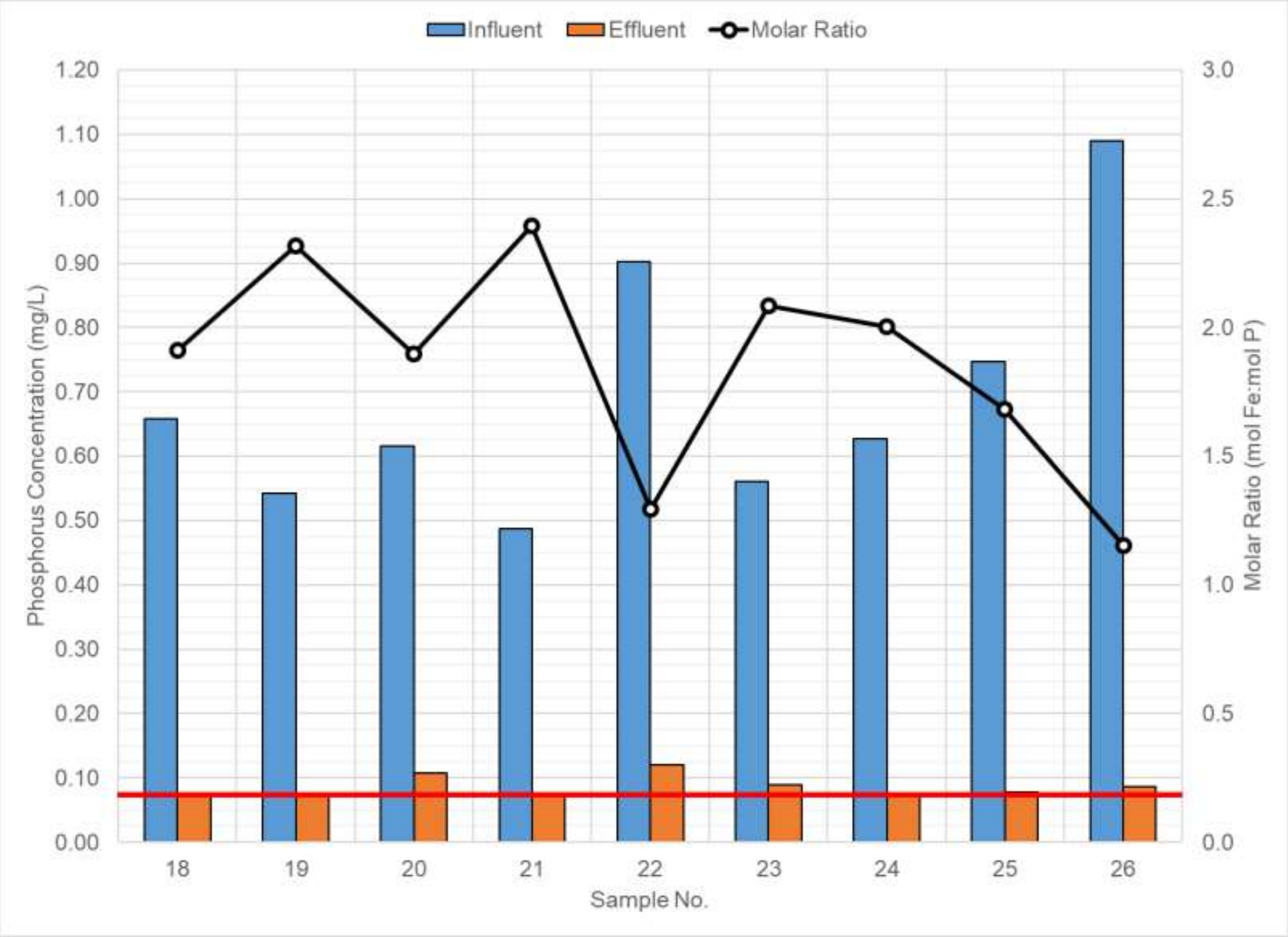
Results – Microfiber Optimization



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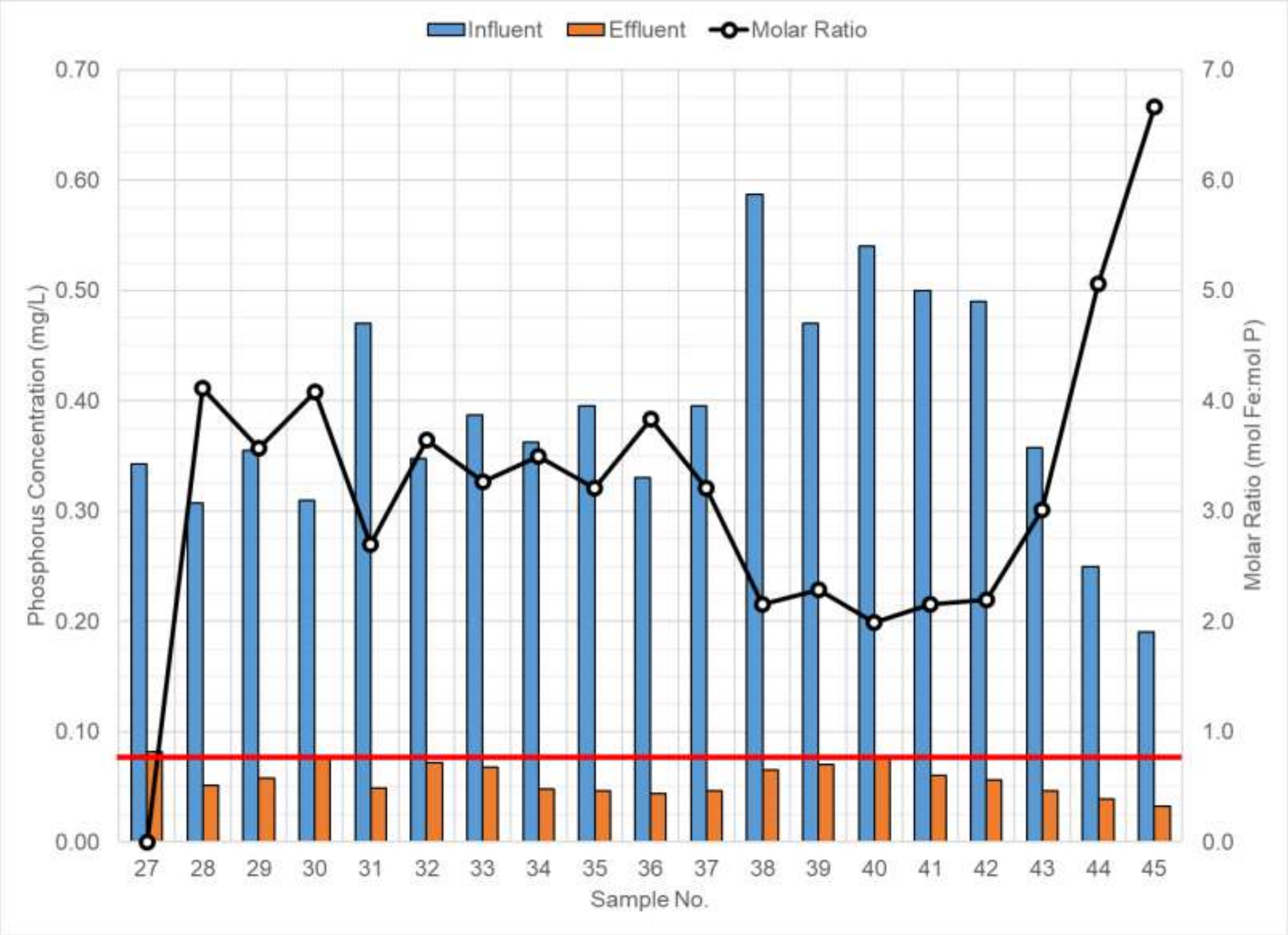
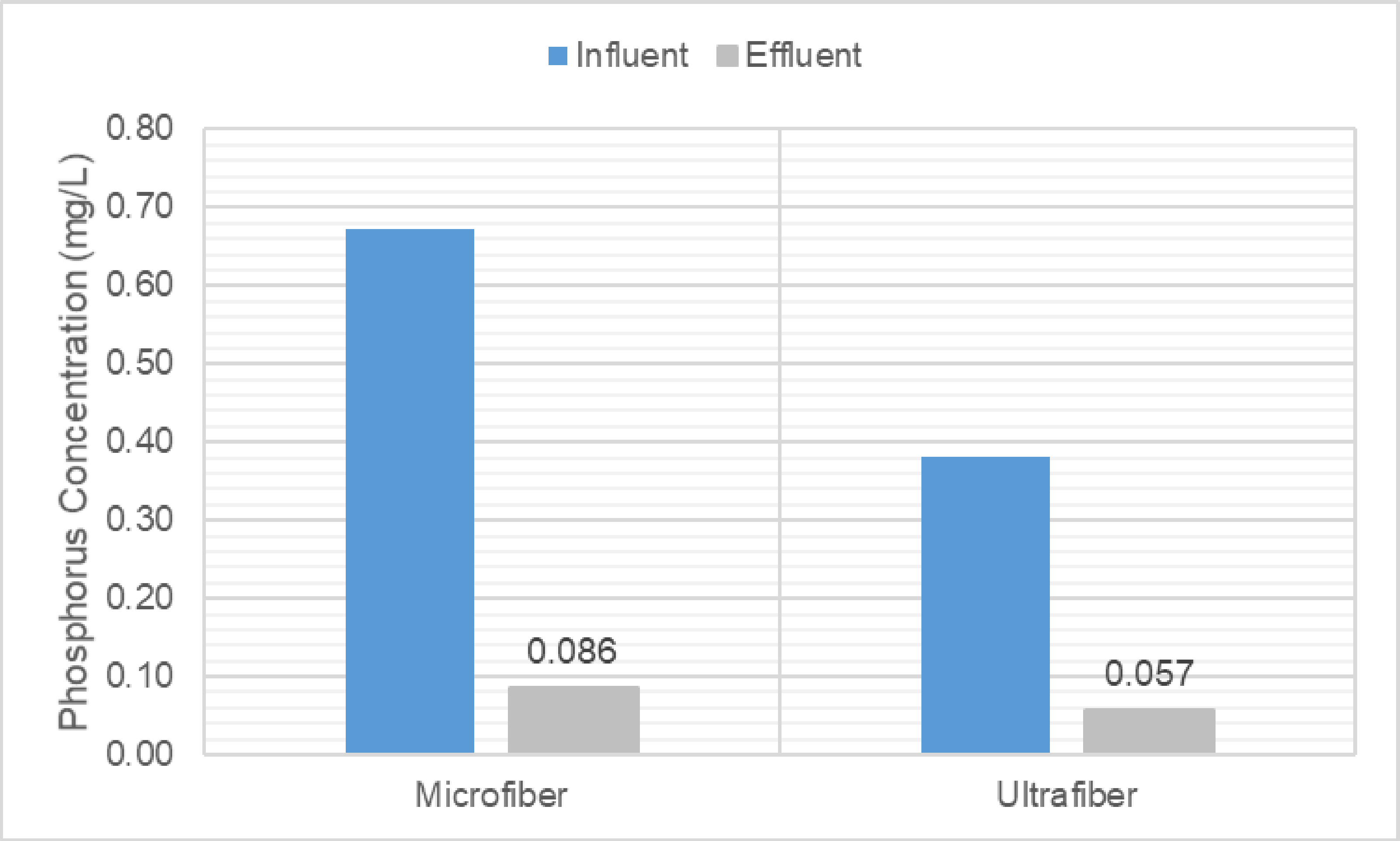
Results – Ultrafiber Optimization



Overall Summary of Results – Phosphorus



Results – Avg. and Peak HLRs

Cloth Type	HLR (gpm)	Avg. Molar Ratio (mol Fe:mol P)	Average Total Phosphorus (TP)		
			Influent (mg/L)	Effluent (mg/L)	Removal (%)
Microfiber	3.25	1.81	0.73	0.077	89.1
	6.50	1.92	0.64	0.098	84.5
Ultrafiber	2.0	3.77	0.36	0.053	84.7
	4.0	2.33	0.47	0.062	86.9

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Results – Total Waste Flow

- Automatically initiated at 12” differential
- Cleans by drawing filtrate backwards through cloth
- Solids at bottom of tank are wasted using same backwash pump

Cloth	No Chemical	Ferric	Ferric + Polymer	High Solids
Microfiber	-	3%	3.5%	-
Ultrafiber	7%	10%	11%	12.5%

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Results – Laboratory Analysis

- Results from Lab 2 were suspiciously low compared to the other labs
- On average, influent data from onsite and Lab 1 were 27% and 31% greater than Lab 2, respectively
- Effluent results showed greater differences
  - Onsite and Lab 1 were 60% and 44% greater than Lab 2
- All of Lab 2 data was removed from the data analysis

Sample Location	Laboratory		
	Onsite	Lab 1	Lab 2
Influent	0.59	0.61	0.47
Effluent	0.121	0.109	0.076

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Results – Upset Conditions & High Solids

- High solids sources: MLSS, recycling backwash
- Backwash recycled at 3% of forward flow
- Could recycling solids reduce effluent concentrations and the need for chemical?

Cloth	Influent TSS (mg/L)	Effluent TSS (mg/L)	Influent Phosphorus (mg/L)	Effluent Phosphorus (mg/L)
Microfiber	19	2	0.95	0.087
Ultrafiber	11	1	0.60	0.060

Potential for Water Reuse

- Testing completed in Saint Johns County, FL
- Filter influent was spiked with inactivated cryptosporidium and giardia lamblia
- 2.2 log removal of cryptosporidium
- 3.5 log removal of giardia

	Cryptosporidium (oocysts/100 L)	Giardia (cysts/100 L)
Influent	13,600	6,800
Effluent #1	103	4
Effluent #2	98	1
Effluent #3	67	2
Average Effluent	89	2.3

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Summary

- Onsite piloting can provide valuable hands-on experience for operators
- Critical aspects of onsite testing
  - Protocol agreement
  - Laboratory requirements
- Upstream performance is critical
- Chemical and SNRP play a critical role
- Tighter media construction results in better removal rates
- Ultrafiber appears to have potential for water reuse applications
- Disadvantages of tighter media construction include higher wasting rates and lower design flow and solids loading rates

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