Region BNR Facility Examples

- Toppenish
- Kittitas
- Cashmere

Topics

- Toppenish design
- Operational changes used
- Performance review

- Overview on kittitas

EBPR Plant Modifications Tool Box

Function	Tools	A.S.	SBR	Ditch
Anaerobic Contact	Turn off some mixers	x		
	Divide/baffle tanks	x		
	Add external tank		x	x
	React/fill is anaerobic		x	
Minimize NO3 to Anaerobic Tank	Aeration on/off	x	x	x
	Aeration low DO	x	x	x
	Convert to anoxic/aerobic tanks	x		
	Convert to Bardenpho	x		
	Add anoxic contact tank	x	x	
	Provide anoxic zone for RAS (JHB Process)	x	x	x
	Step feed SBR		x	
Minimize DO to Anaerobic Tank				
	Check influent head drop/aeration	x	x	x

EBPR Plant Modifications Tool Box

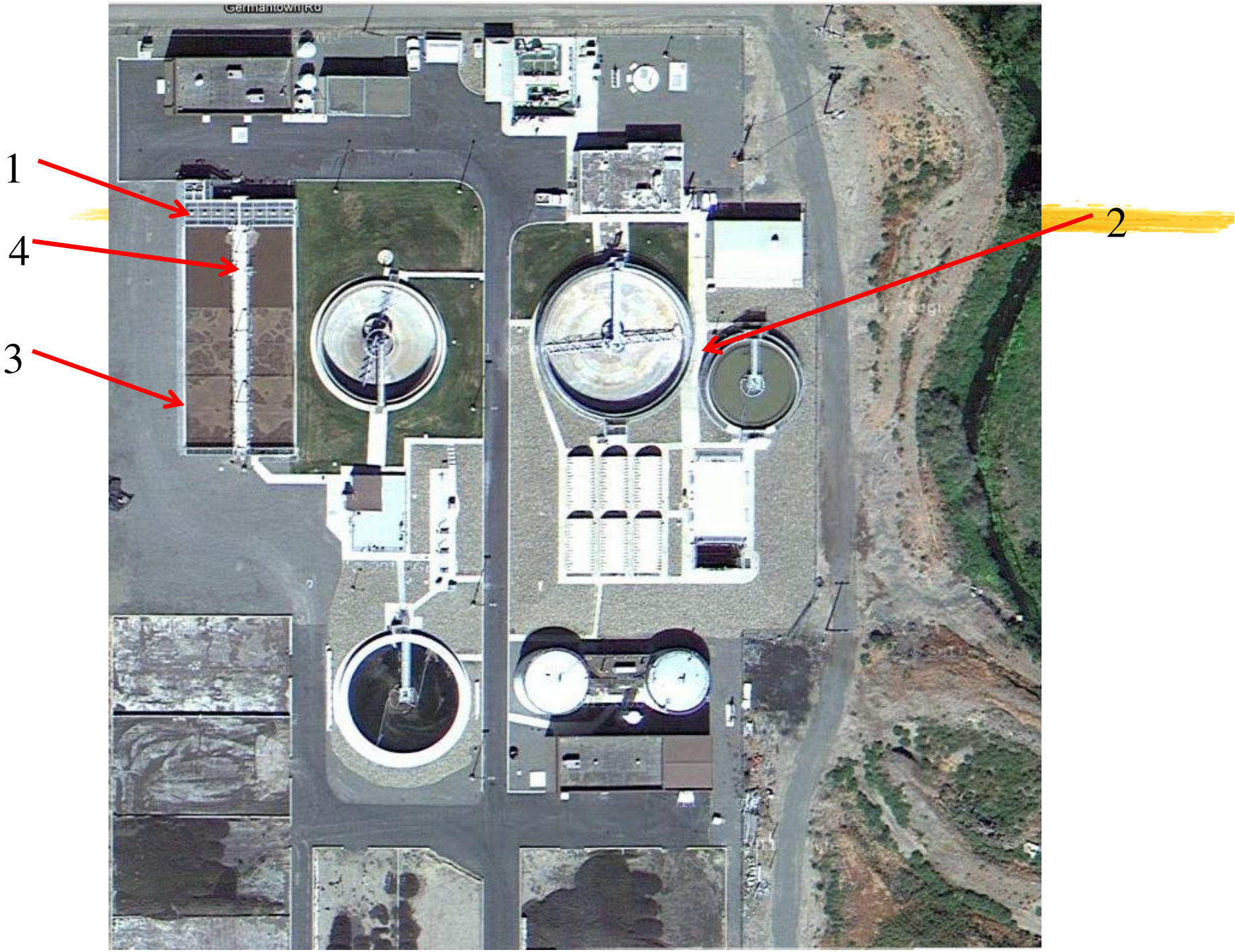
Function	Tools	A.S.	SBR	Ditch
Optimize SRT	Sludge wasting control	x	x	x
Get more food for PAOs	Create settlng periods in anaerobic	x		x
	Industrial sources	x	x	x
	Onsite fermentation of waste solids	x	x	x
	WAS, RAS or ML fermentation	x	x	x
Minimize P in recycle	Keep waste sludge aerobic	x	x	x
	Off site sludge processing	x	x	x
	Composting	x	x	x
	Anaerobic digester struvite recovery	x	x	x
Optimize P uptake	Provide sufficient aerobic time	x	x	x
	Provide sufficient DO	x	x	x
	Modify to staged kinetics	x		
	Waste sludge from aerobic zone	x	x	x

Toppenish WWTP

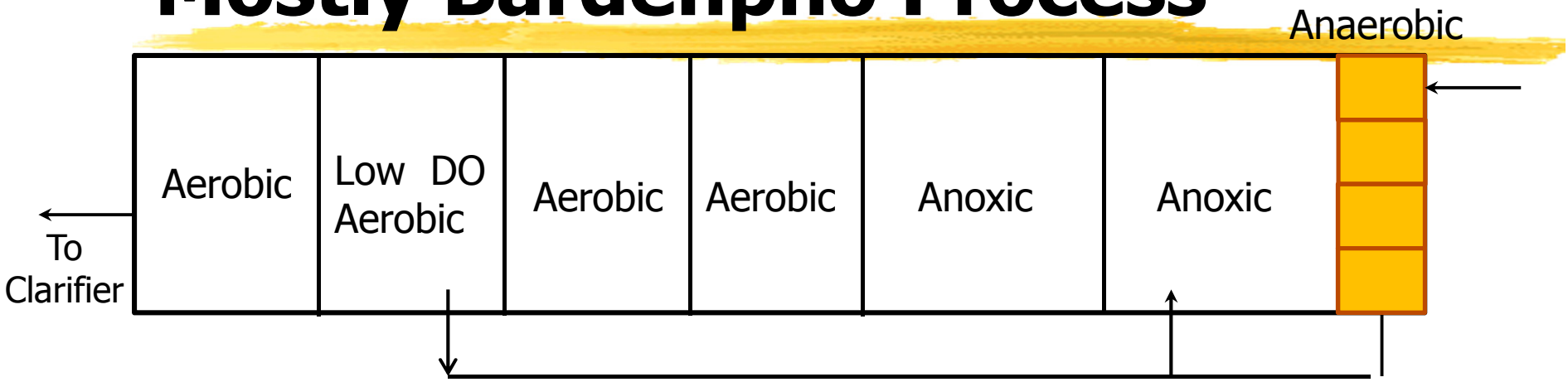
- Headworks
- Primary Treatment
- Bardenpho Process
- WAS to Rotary Drum Thickener
- Anaerobic Digestion
- Screw Press Dewatering

Design Criteria – Toppenish.

Parameter	Unit	Annual Avg.	Max. Month	Unit	Max. Month
Avg Flow	Mgal/d	1.23	1.67	Mgal/d	1.67
BOD	lb/d		2581	mg/L	185
TSS	lb/d		2634	mg/L	189
TKN	lb/d		516	mg/L	37
TP	lb/d	N/A	N/A	mg/L	N/A


1
4
3
2

Toppenish
Mostly Bardenpho Process



2-Train Volumes and Detention at Max Month Flow

Proces Step	Stages	Volume gallons	Detention Time, hrs
Anaerobic	4	84,000	1.2
Anoxic	2	293,000	4.2
Aerobic	4	512,000	7.4
Total		889,000	12.8

Toppenish Operational Changes to Improve EBPR

1. Mixers in anaerobic zone off/on
2. Lower SRT at warmer temperatures
3. Ferment in primary treatment
    - Increase sludge blanket
    - Recirculate sludge
4. During study lowered RAS recycle ratio

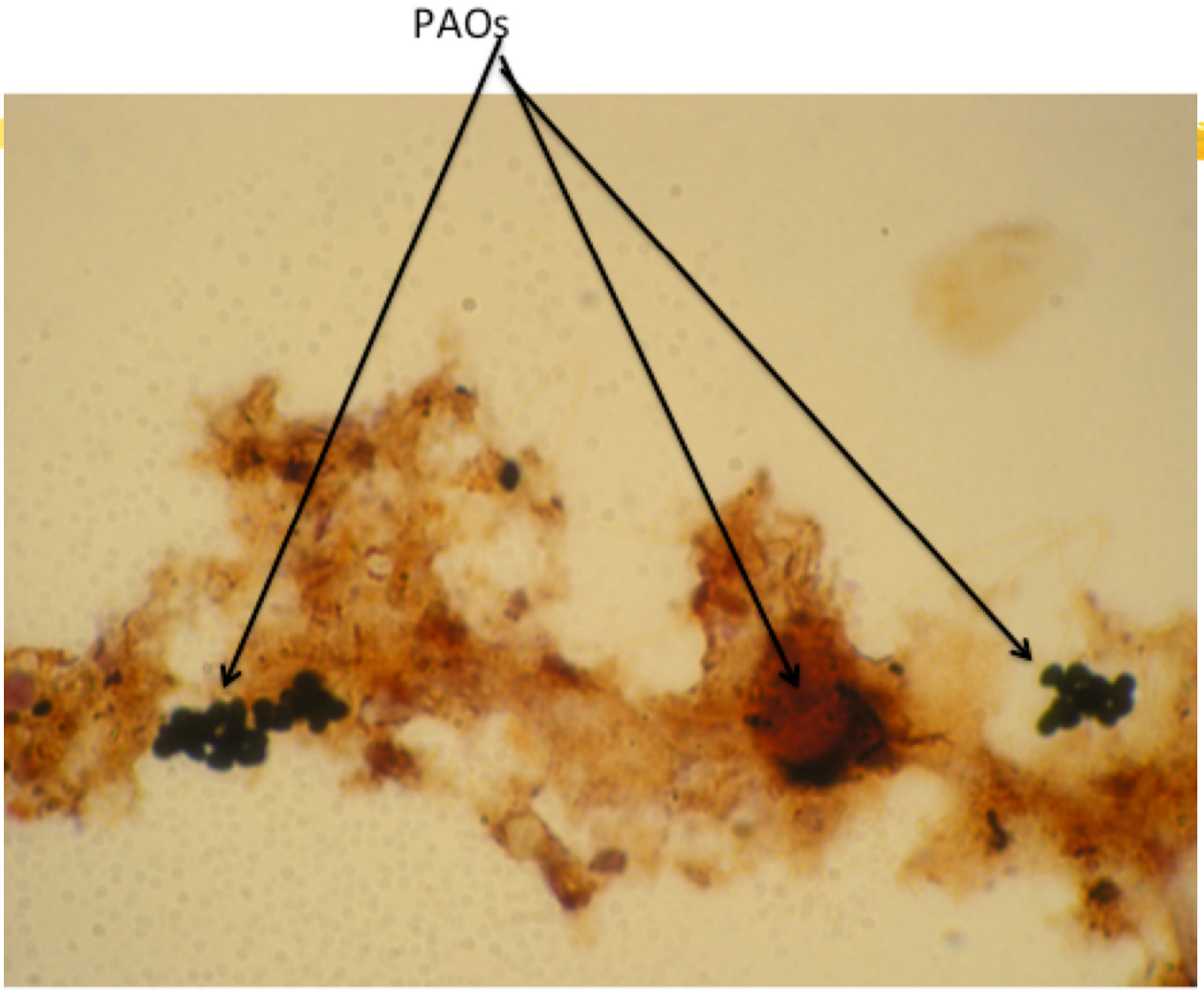


Figure 1. Toppenish, November 19, 2014, sample, Neisser Stain, 1000x

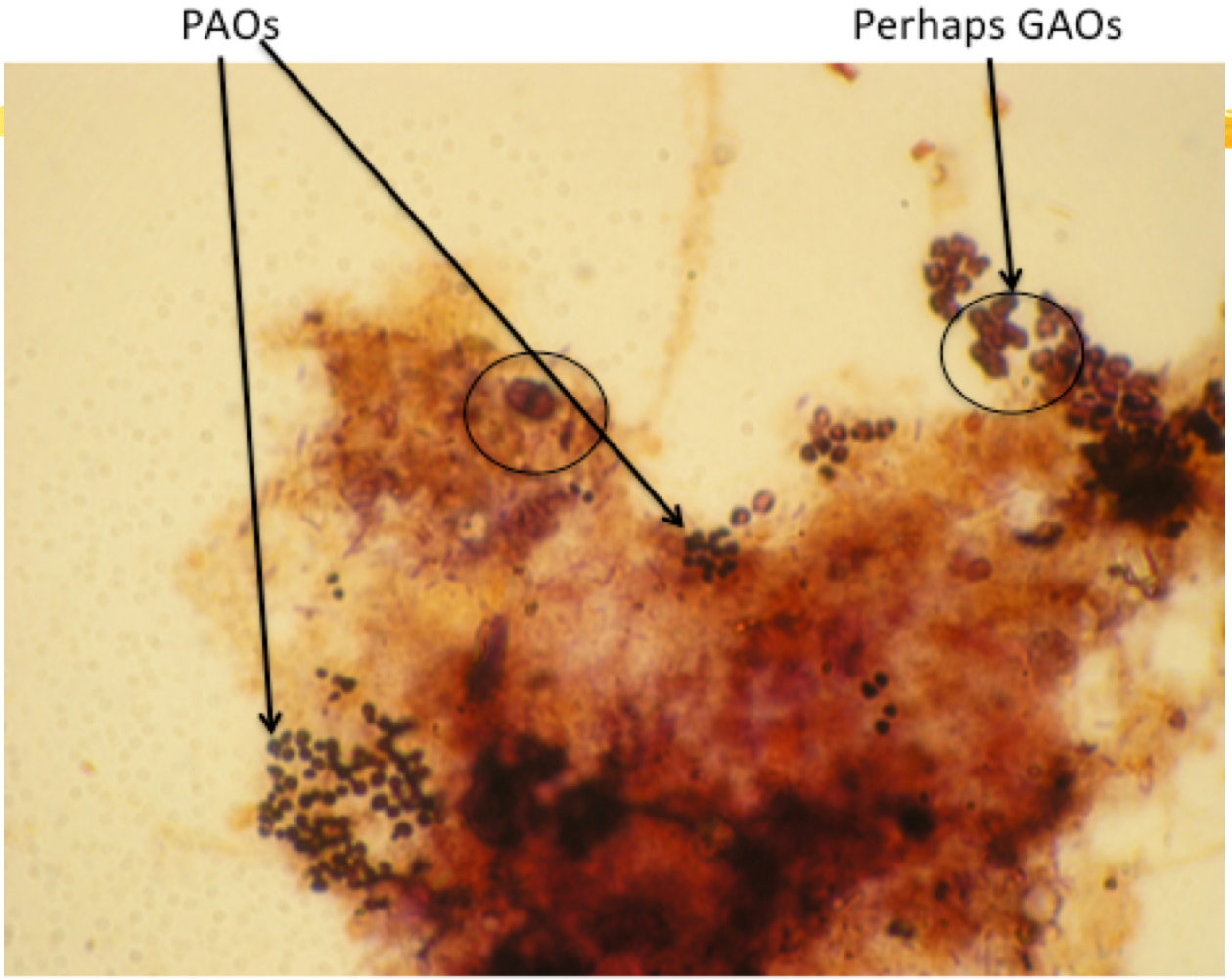
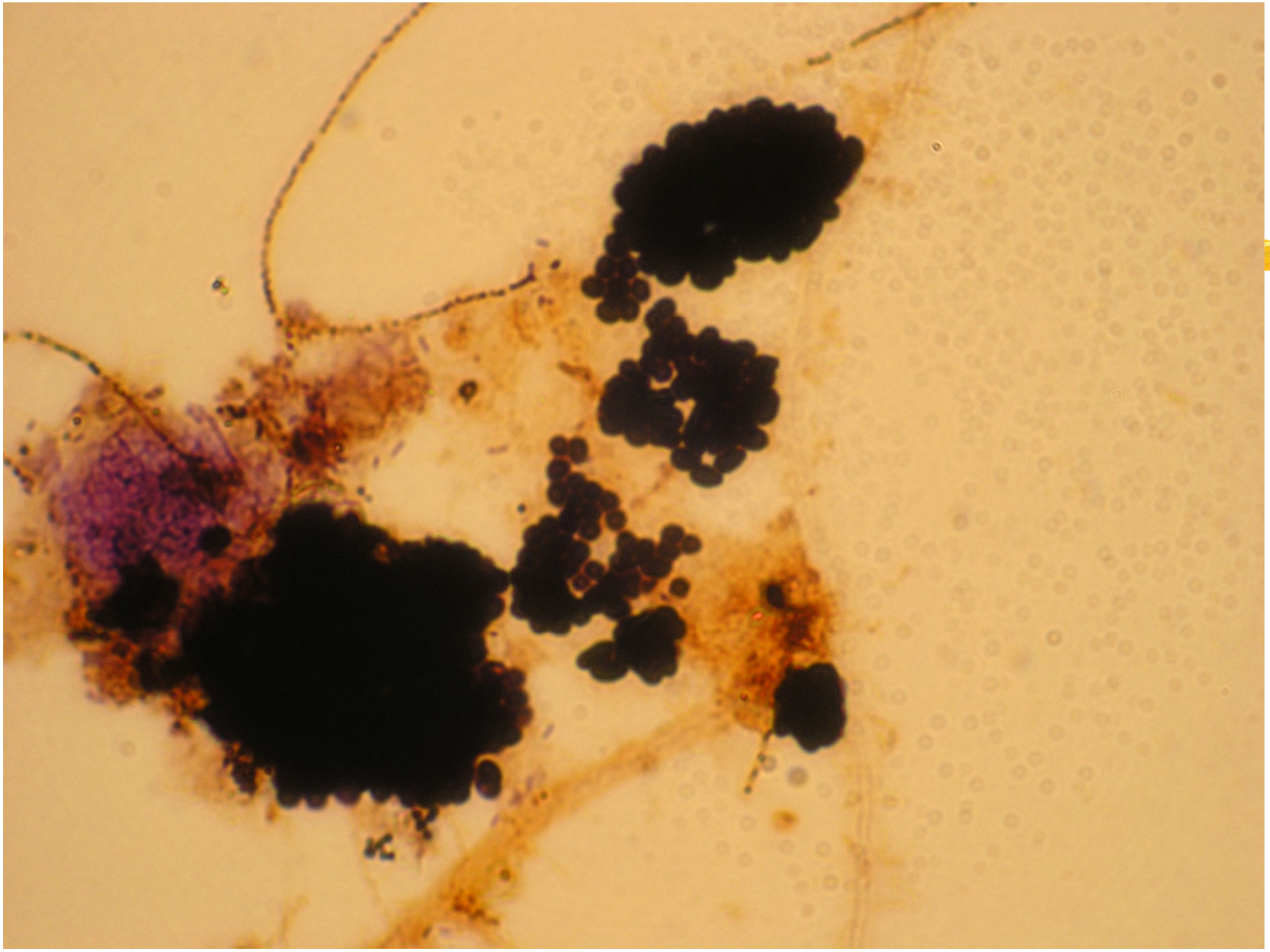
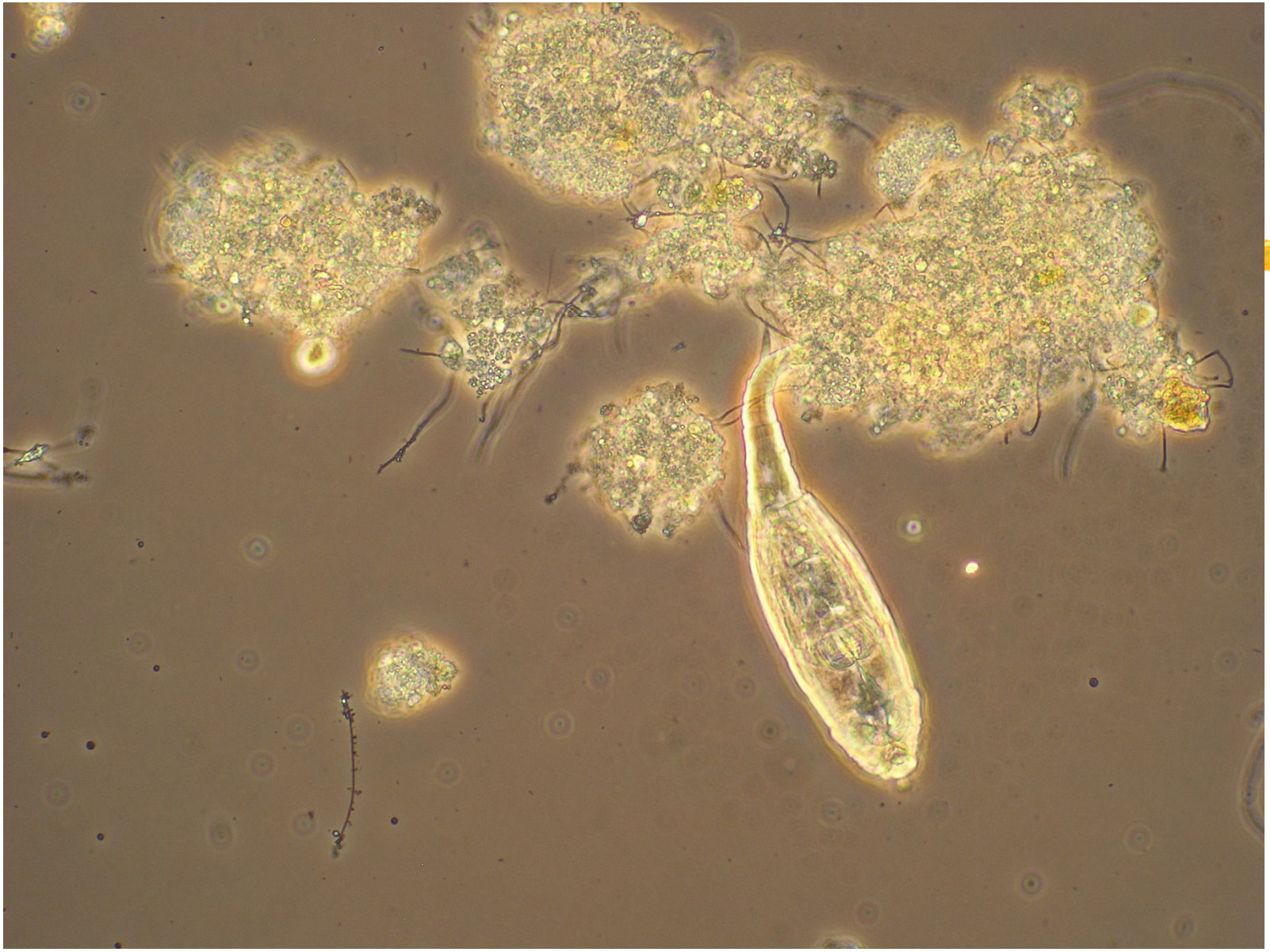


Figure 2. Toppenish microscopic observations with Neisser staining 1000X



June 10, 2015 sample- good PAO presence



June 10, 2015 sample, compact dense floc

SVIs are great - commonly 70-95 mL/g

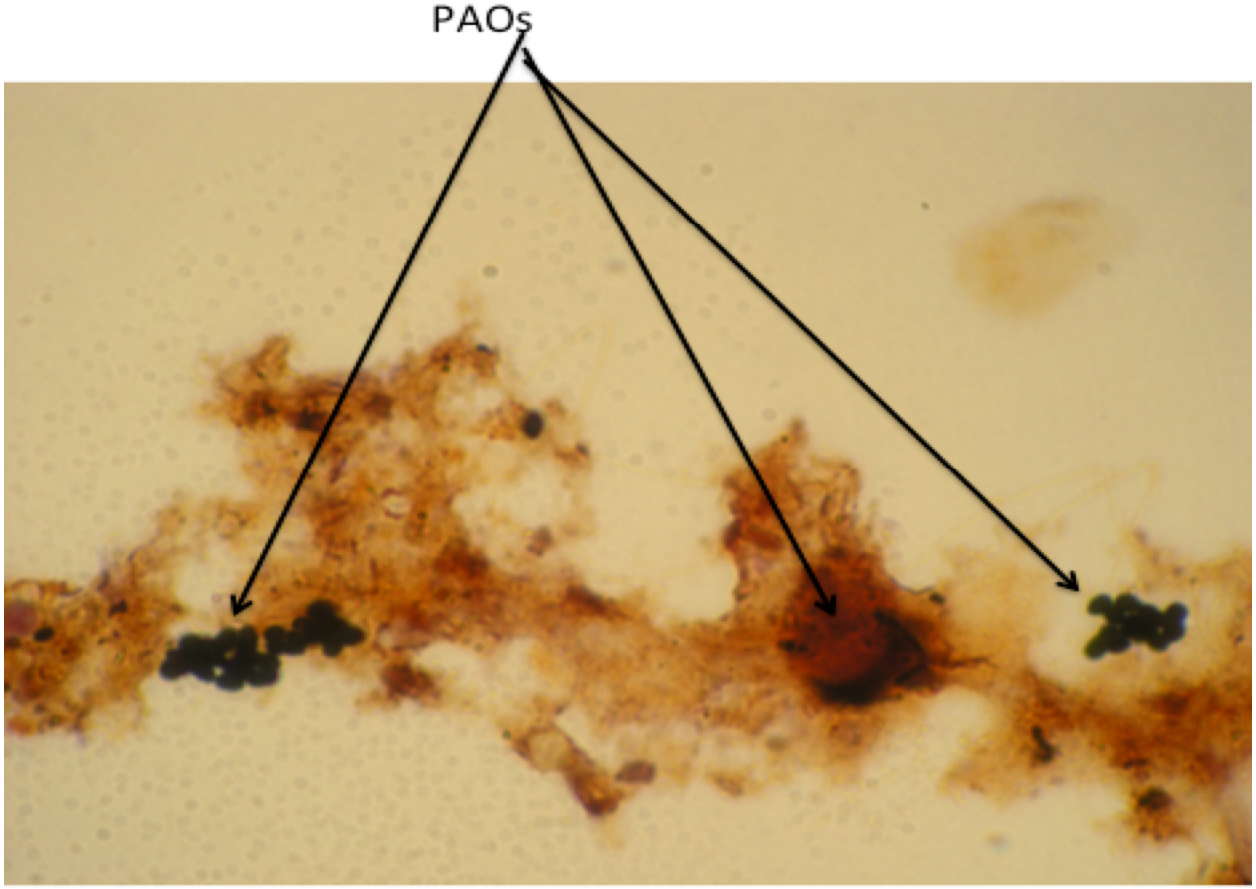
Operational changes made

PHASE	DATE	SRT	RAS RATIO	MIXERS ON TIME	PRIMARY ELUTRI.
1	AUG6-SEP10		0.3	ON-	8
2	SEP18-OCT1		0.4	30/d	13
3	OCT8-NOV6		0.6	30/d	21
4	NOV12-JAN7		0.8	ON	17
5	JAN14-MAR4		0.8	2/WK-30	
6	MAR18-APR22	15	0.4	3/WK-15	
7	MAY7-JUL23	18	0.3	3/WK-15	
8	JUL30-AUG12	12	0.35	3/WK-15	

Sampling and analyses

Parameter	Primary Effluent	Secondary Effluent
COD	X	X
BOD	X	X
TOTAL, P.	X	X
SOLUBLE, P.	X	X
TSS	X	X
VSS	X	X
TKN	X	X
pH	X	X
NH3-N		X
NO3-N		X

EBPR was occurring



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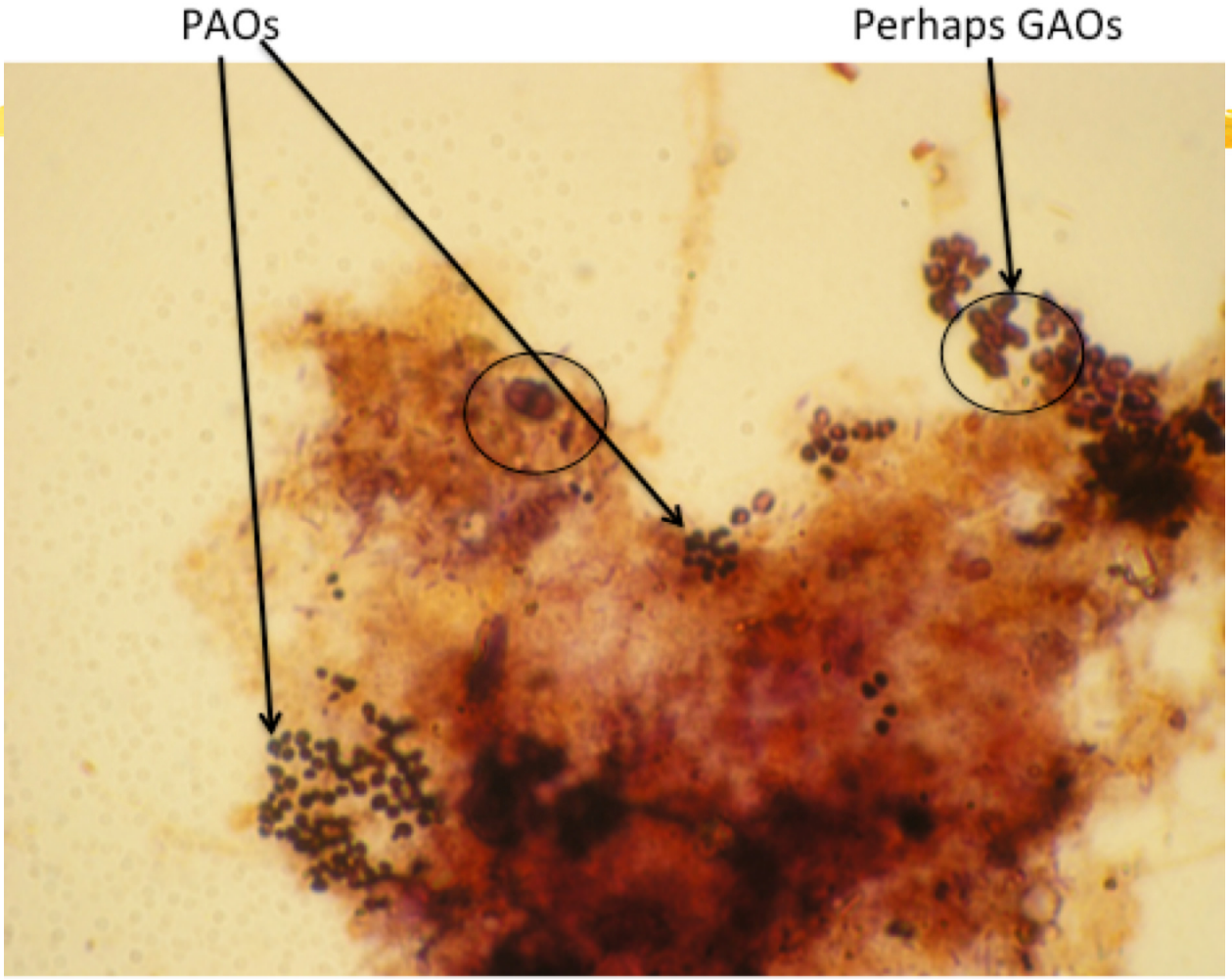

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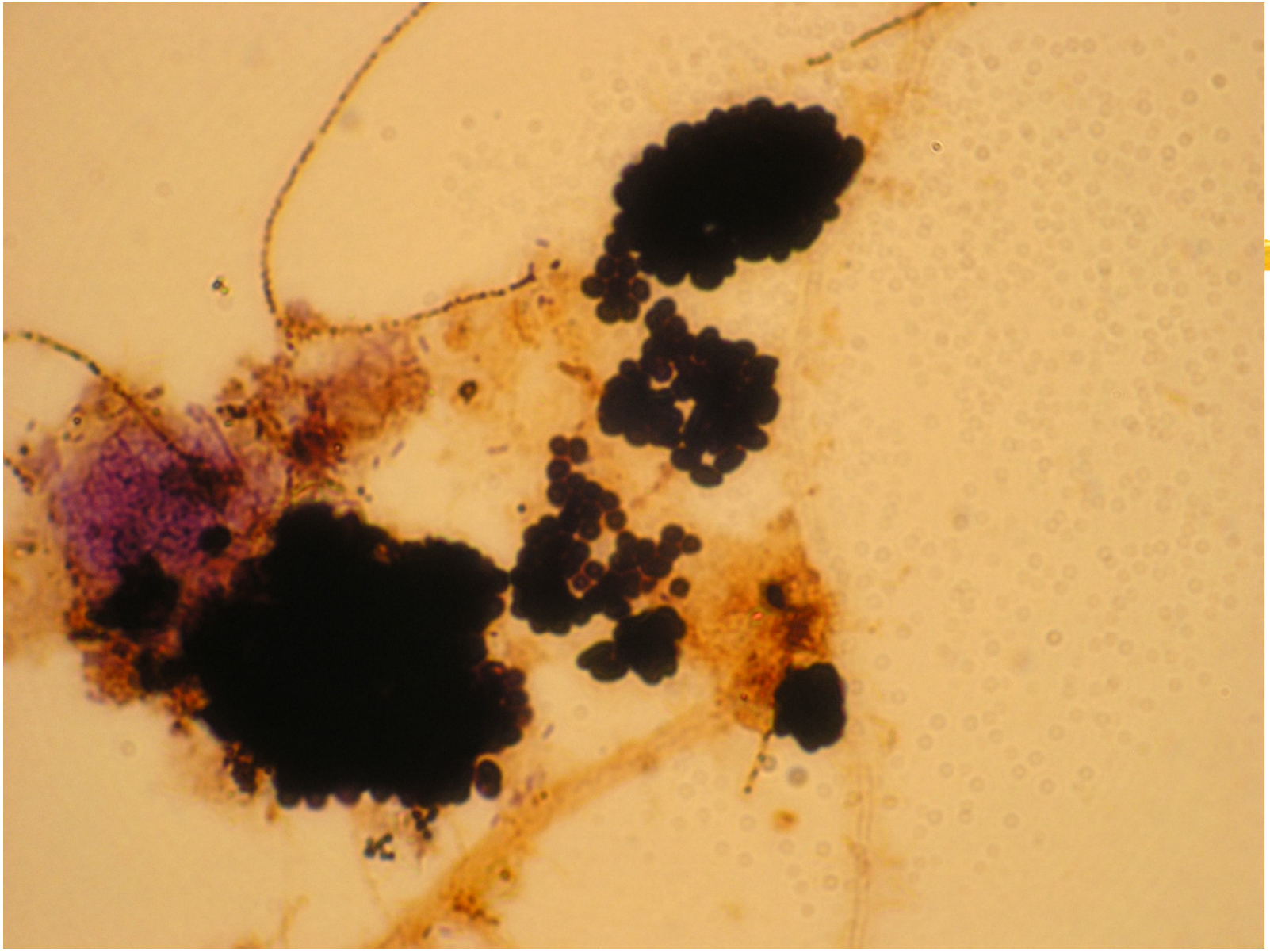

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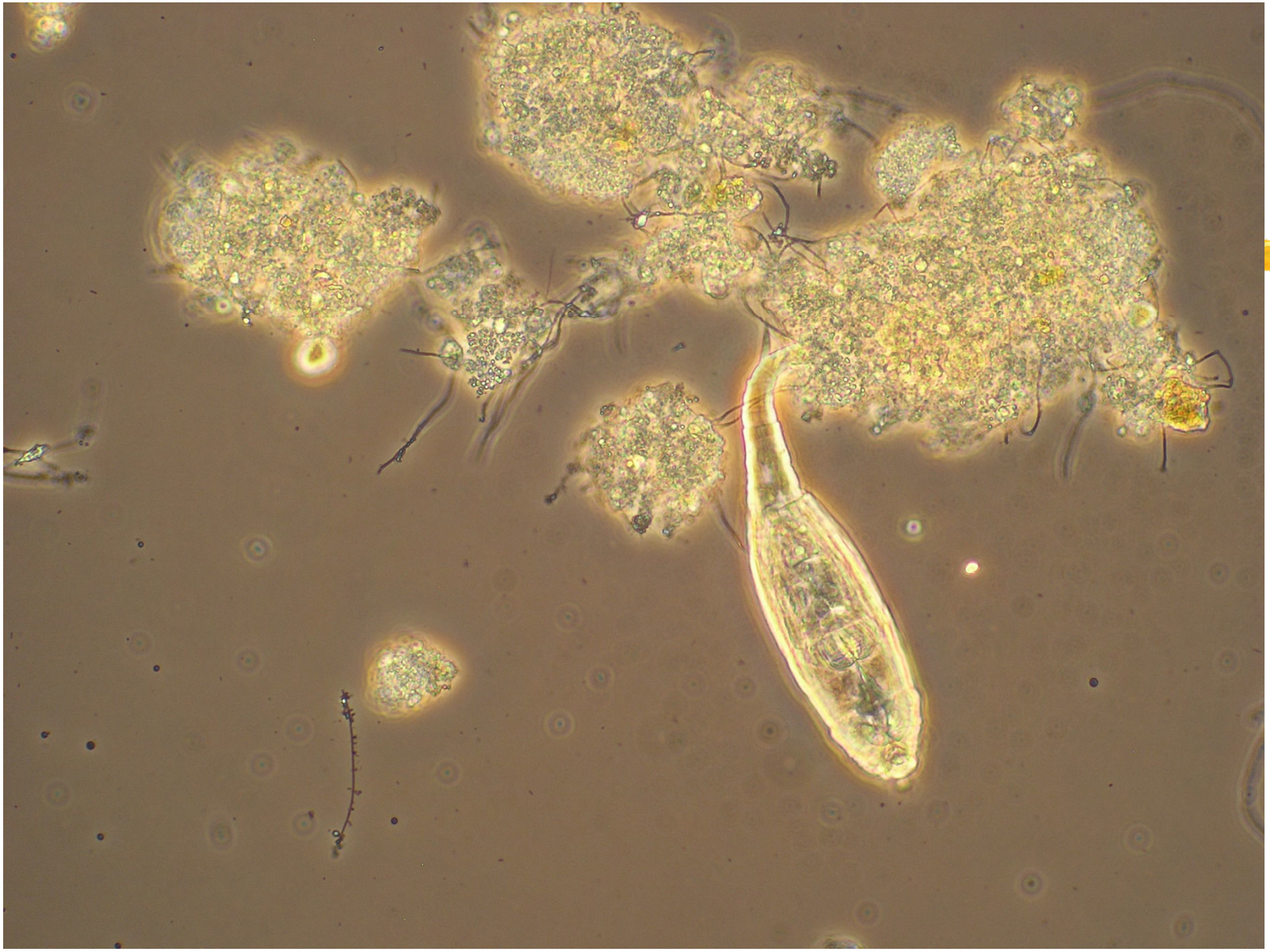
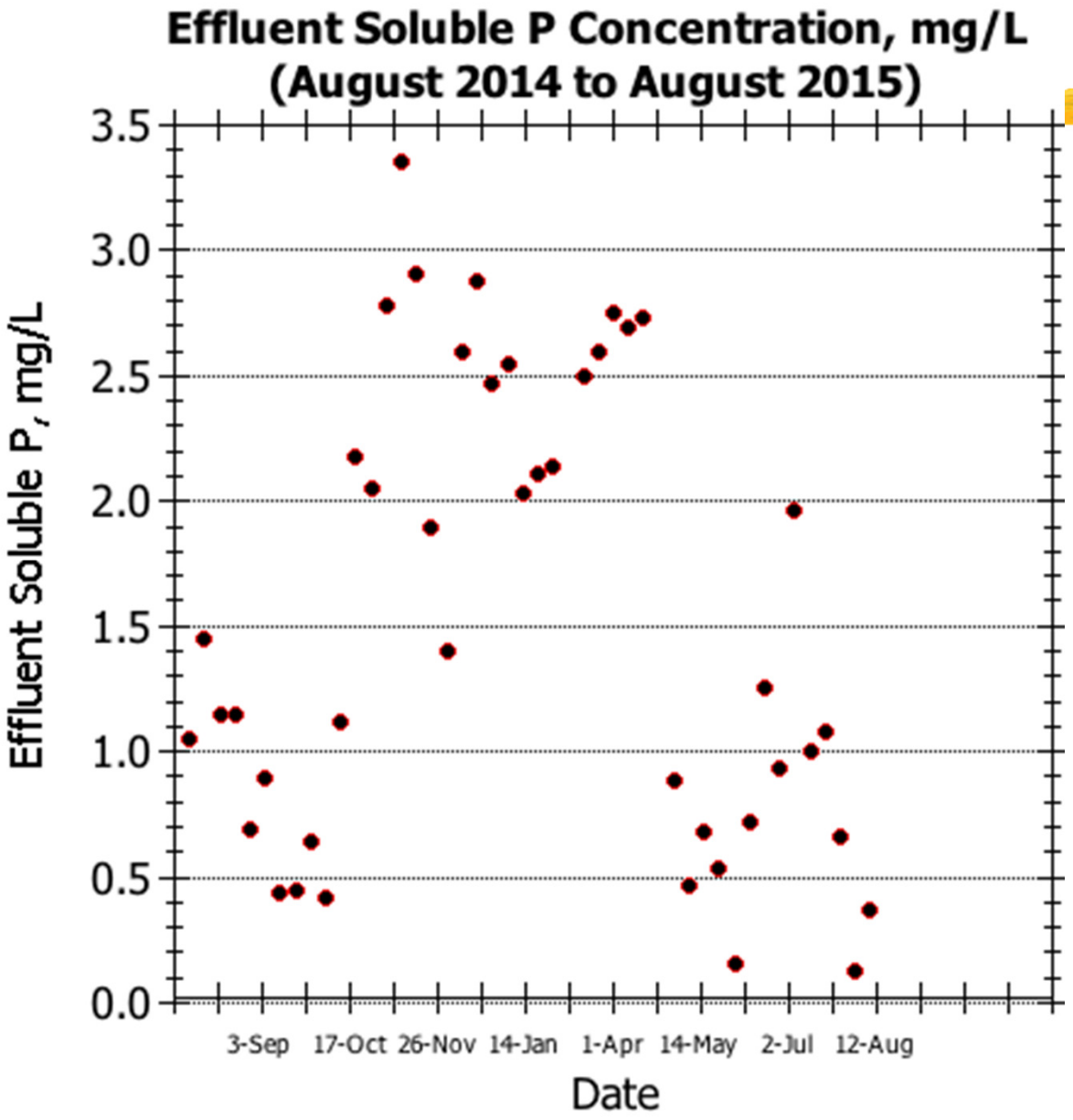


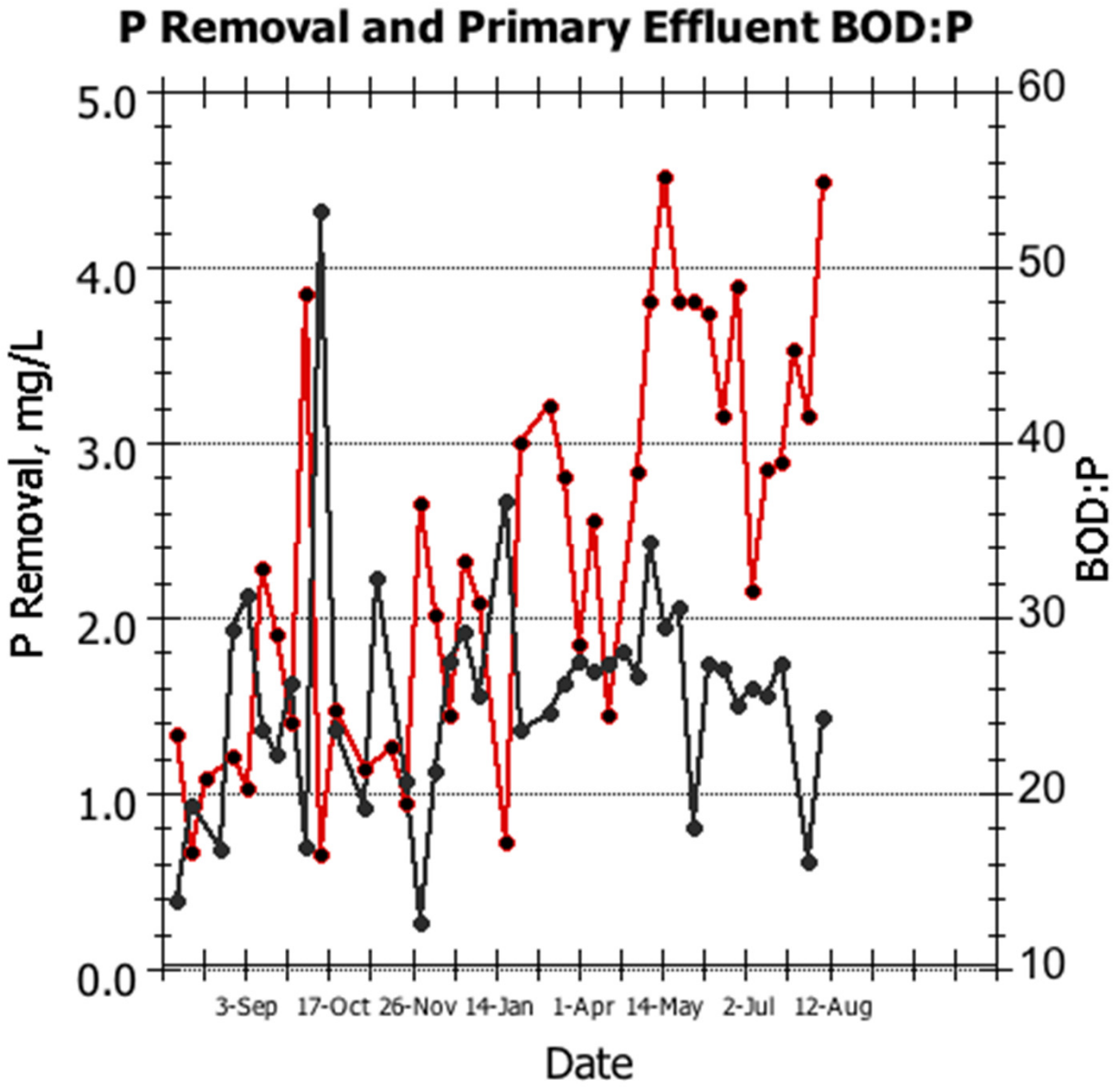
June 10, 2015 sample, compact dense floc

SVIs are great - commonly 70-95 mL/g

Some days with P <1.0 mg/L

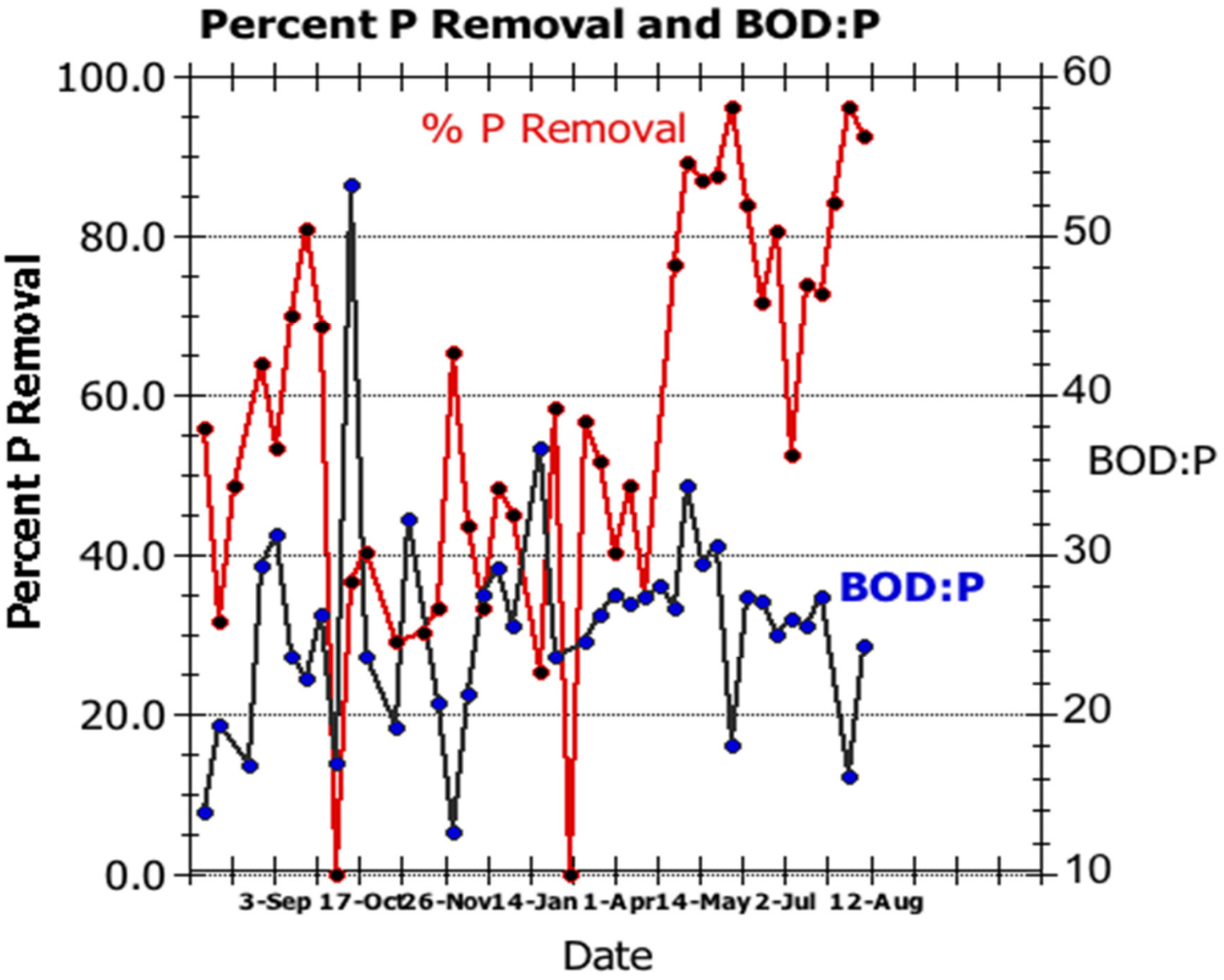


P removal not just f(BOD:P)
BOD:P ratio is low



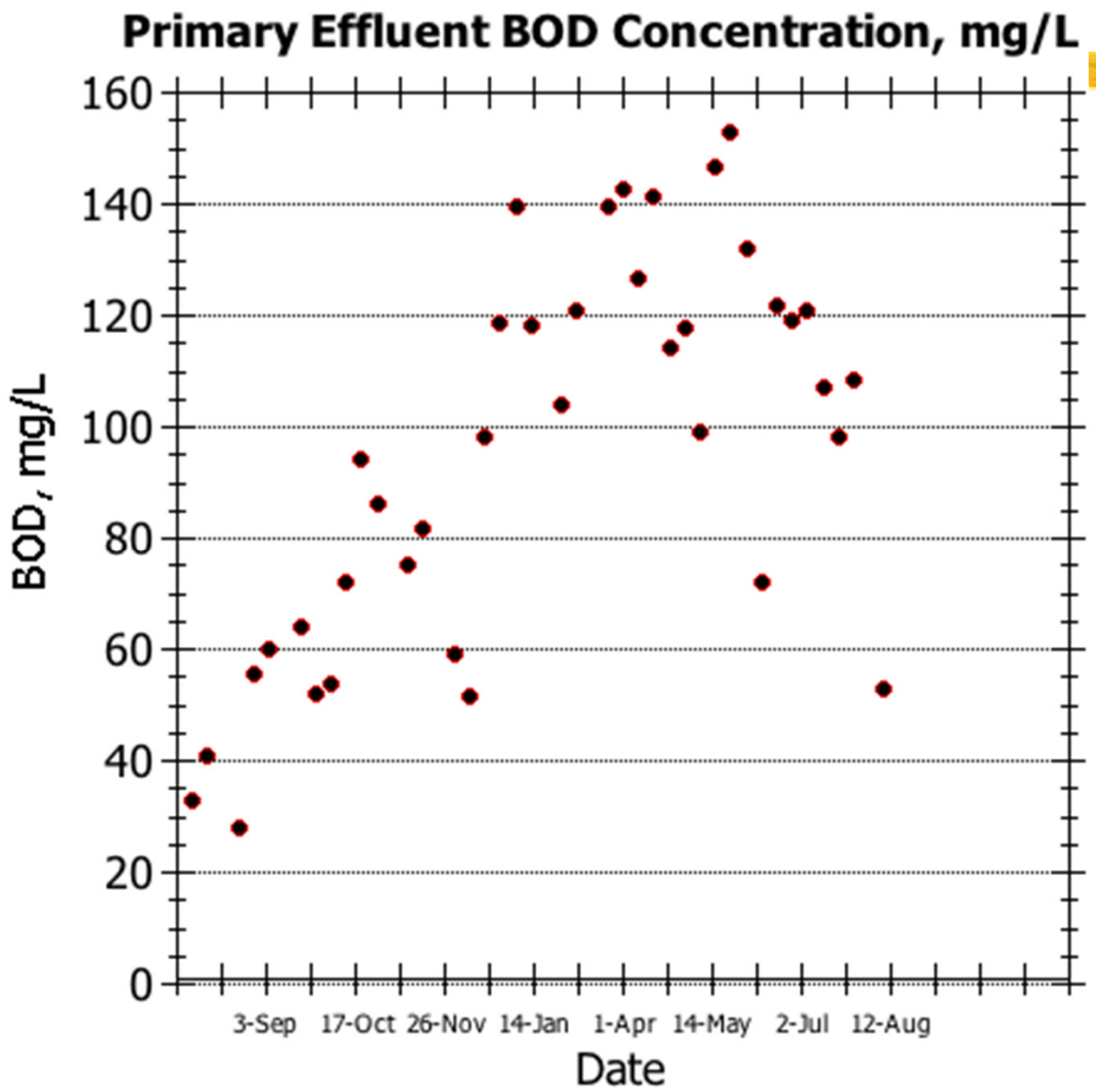
September

Best removal in last 3.5 months



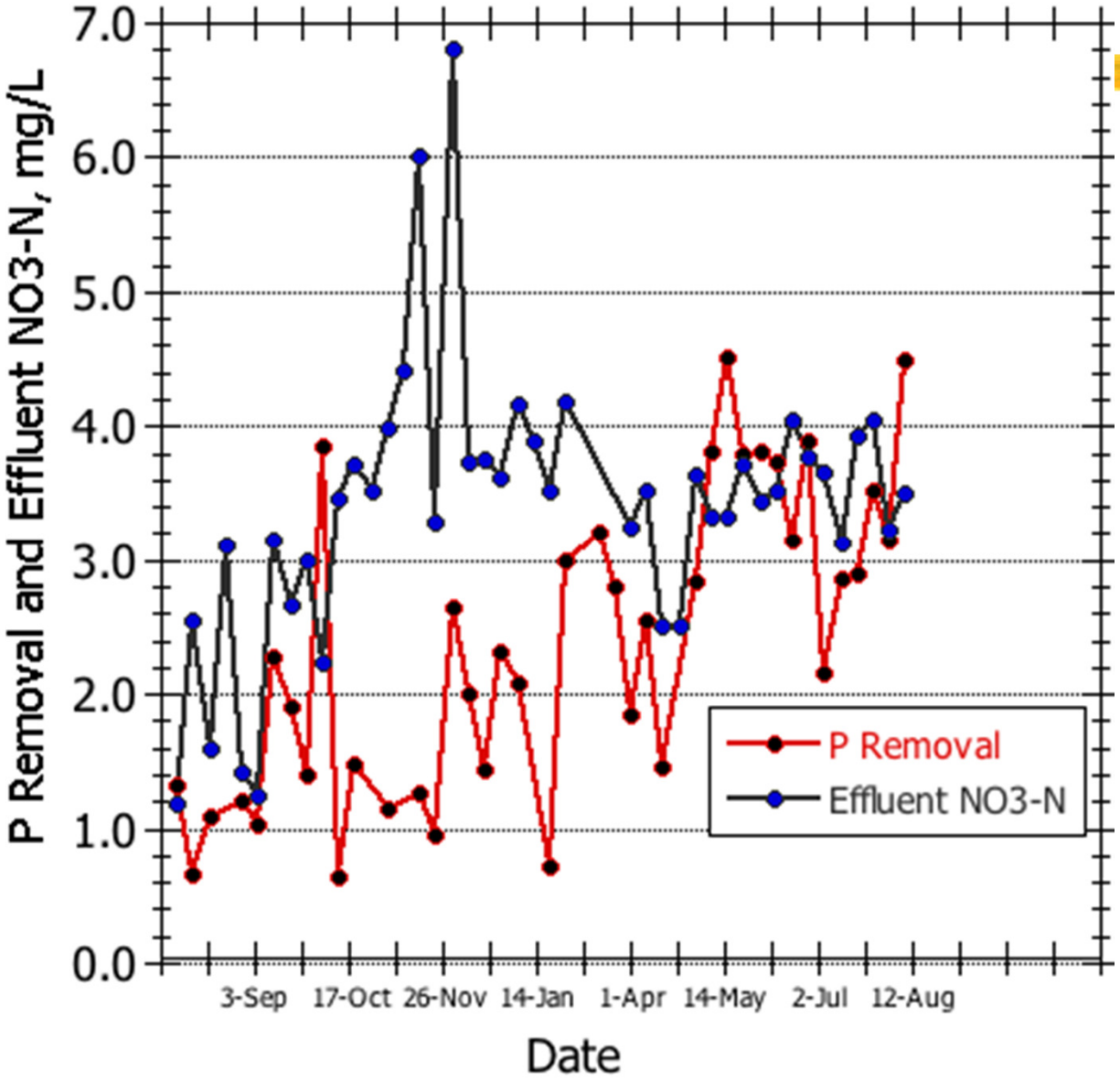
Sep

Not because higher BOD



September

Not related to recycle NO3-N



Operating conditions may have affected performance

PHASE	DATE	SRT	RAS RATIO	MIXERS ON TIME	PRIMARY ELUTRI.	% P REMOVAL
1	AUG6-SEP10		0.3	ON-	8	51
2	SEP18-OCT1		0.4	30/d	13	73
3	OCT8-NOV6		0.6	30/d	21	36
4	NOV12-JAN7		0.8	ON	17	43
5	JAN14-MAR4		0.8	2/WK-30		42
6	MAR18-APR22	15	0.4	3/WK-15		46
7	MAY7-JUL23	18	0.3	3/WK-15		73
8	JUL30-AUG12	12	0.35	3/WK-15		91

What may have helped improve P removal performance?

- More food from solids hold up in anaerobic tanks due to minimal/no mixing
- RAS fermentation?
- Lower RAS recycle ratio – possibly less dilution of soluble readily available COD and more sludge hold up
- Lower SRT
- Performance seems limited by available BOD for PAOs

Acknowledgements

- Not possible without Eric Bakker and Staff!
- Awsome effort!
- Thank you to Nancy Wetch (G&O) for plant design information
- Thank you to Yakima Valley Community College students and Dr. Tanya Knickerbocker for special plant testing
- Ryan Anderson, Melanie Tucker, Dr. James Barnard

Kittitas – SBR Facility

Kittitas

Parameter	Unit	Max. Month	Avg. Month	Unit	Avg.
Avg Flow	Mgal/d	0.5	.25	Mgal/d	0.25
BOD	lb/d	-	430	mg/L	206
TSS	lb/d	-	433	mg/L	212
TKN	lb/d	-	96	mg/L	46
NH4-N	lb/d	-	54	mg/L	26

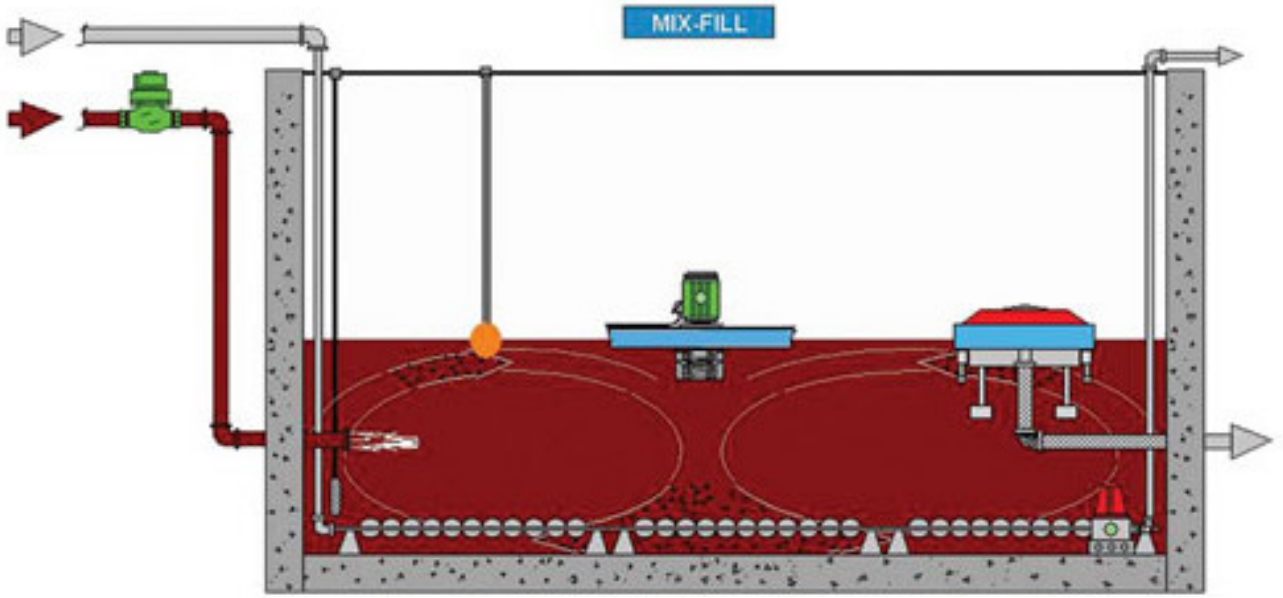
TREATMENT SCHEME – KITTITAS.

SBR					
Aeration Type	Number of Tanks	Full Volume (Mgal) per Tank	Nominal Detention Time (hrs) per Tank	Depth	
				High (ft)	Low (ft)
Fine Bubble	2	0.71	34.1	16	11

SBRs have set cycle duration and timed sequences

- Fill/Mix – The EBPR Anaerobic Contact
- Fill/Mix/Aerate
- Aerate
- Settle
- Decant

- "Time" vs volume



Kittitas SBR 6 hour cycle steps based on nitrification

Function	Time, hours
Fill	0.50
Fill, Mix	0.50
Fill, Aerate	2.00
Aerate	1.80
Settle	0.90
Decant	0.30

Designed mainly for nitrification
Anoxic time? Anaerobic contact?

We pushed limit on time needed for nitrification
Get more time for fill without aeration
- Anoxic
- maybe some BOD left for EBPR?

Need to remove NO3 before anaerobic fill

- Aerate at low DO for nitrification/NO3 removal**
- Provide mixing and NO3 removal before settling period –ORP control**
- Mix and allow NO3 removal after settling and decant and before fill
- If not enough time add an external anaerobic tank and pumps
- Add external anoxic RAS tank and Pumps
- Likely need higher MLSS to make these work in existing designs
  - How to get higher MLSS –
    - Granular sludge – stay tuned

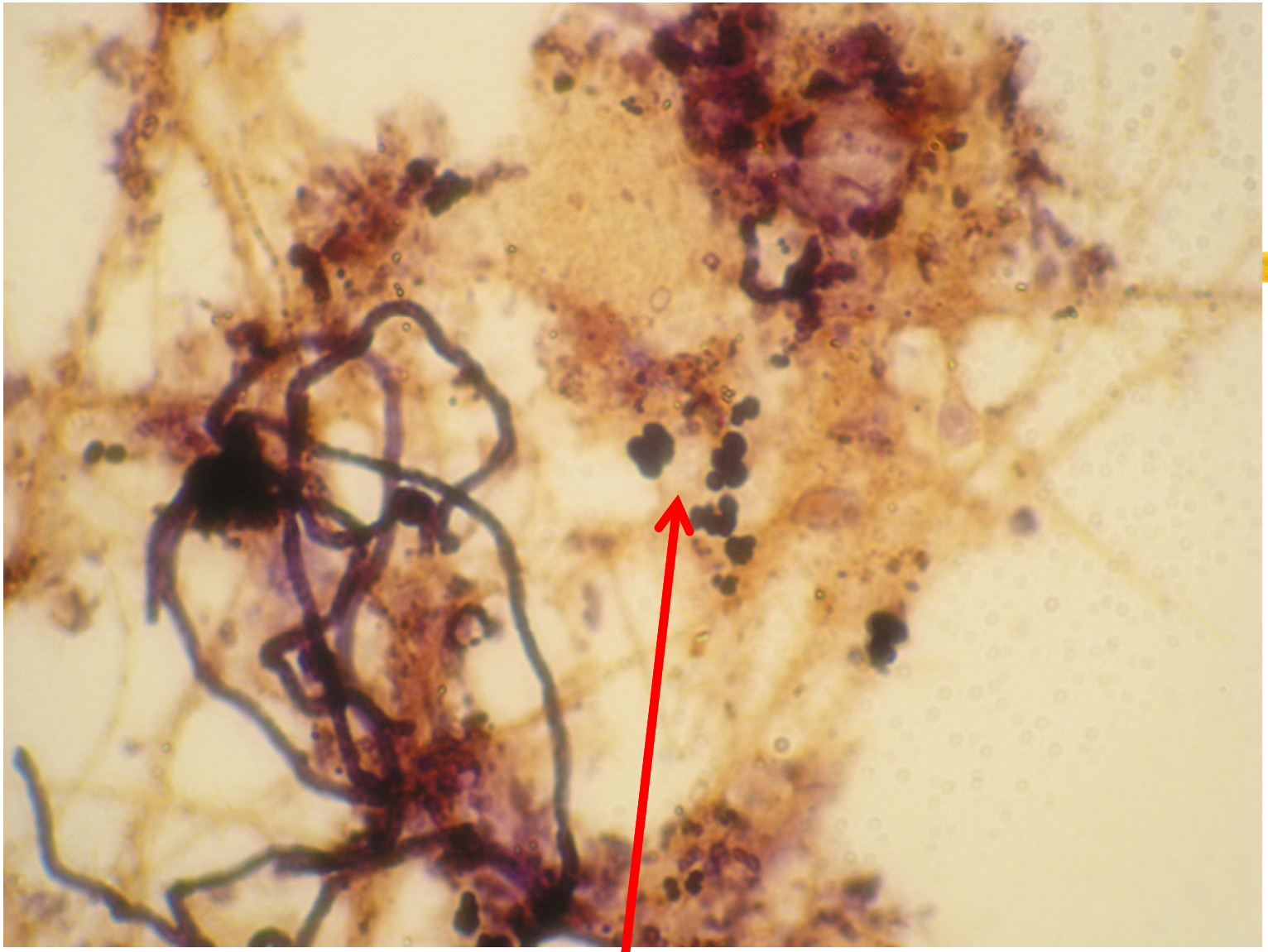
Kittitas efforts

1. Extend fill without aeration –
2. Experiment with DO set points -
3. Fill during decant

Modified Operation did improve SVIs but only a little EBPR

Function	Time, hours
Fill/Decant	0.30
Fill	1.00
Fill/Mix No Air	1.00
Fill/Aerate	0.70
Aerate	2.10
Settle	0.90

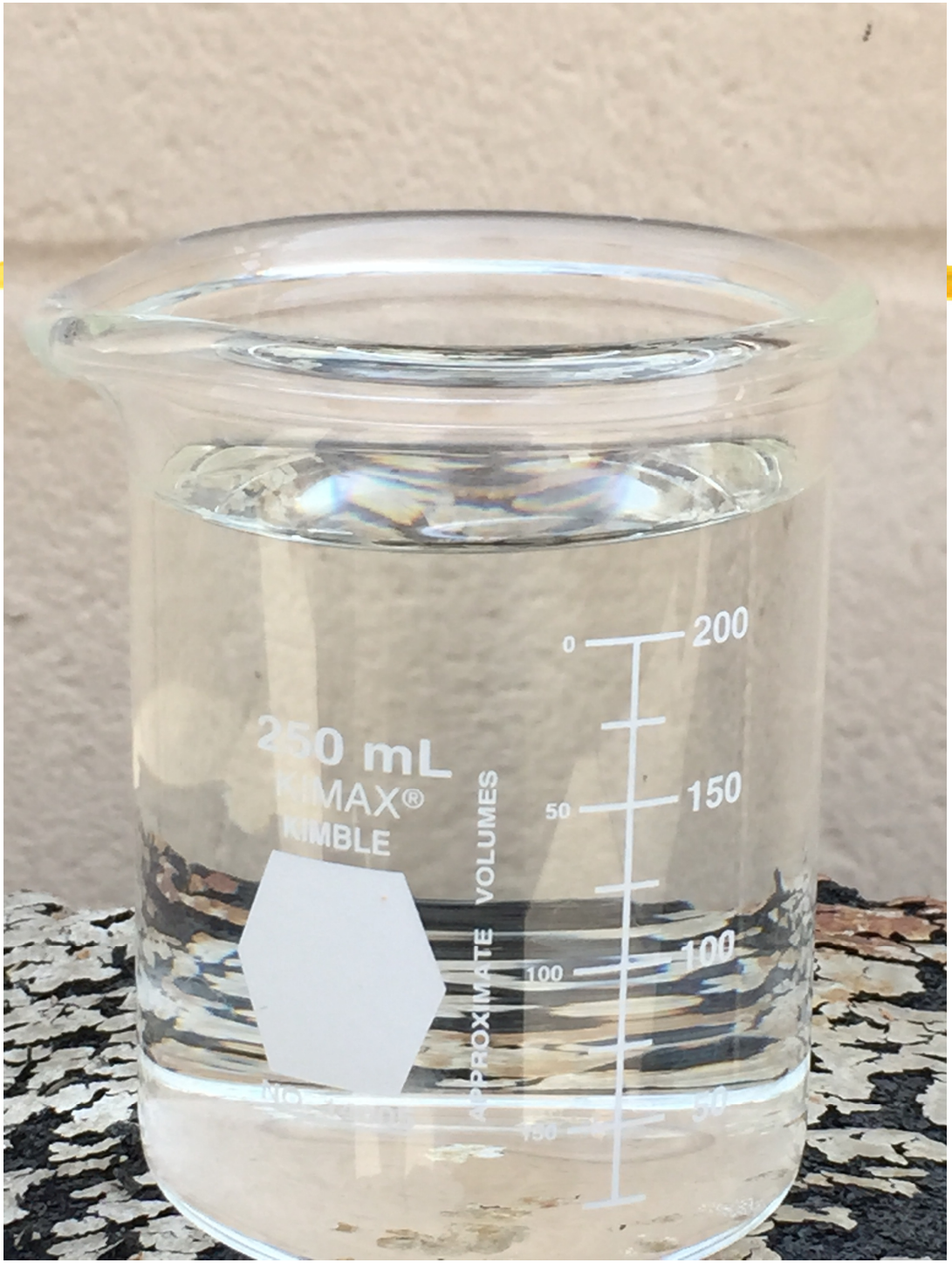
2014-2015	MLSS	SVI	SRT
SBR # 1	mg/L	ml/g	d
Aug-14	1368	332	18
Sep-14	1466	485	17
Oct-14	1044	469	27
Nov-14	1184	271	13
Dec-14	1748	152	24
Jan-15	2108	145	27
Feb-15	2440	148	45
Mar-15	2490	165	15
Apr-15	2028	225	20
May-15	2386	210	25
Jun-15	2258	264	17
Jul-15	1956	302	12
Aug-15	**Tank down for maintanence**		



Kittitas
Apr 30
SBR
Neisser
Stain

At least a few Phosphorus accumulating organisms (PAOs)

Phosphorus results
Variable – some evidence of EBPR
Plant effluent is sparkling


250 mL
KIMAX®
KIMBLE
APPROXIMATE VOLUMES
0
200
50
150
100
100

Acknowledgements

- Thanks to Brenda Bach doing whatever is possible and good spirit!