Stickney WRP Plant Upset – October 25, 2013

Process Control Observations

Stickney Water Reclamation Plant

October 26-31, 2013

October 25, 2013 (Permit NH_3 – 1.02 mg/L)

- Plant flow was 450 MGD, Batt. B was o/s from 9am to 3pm
- At ~10am NH_3 begins to rise in aeration tanks
- Battery B placed in service at 3pm
- At 3:53pm blower output increased due to rising plant NH_3 (Outfall @1.06 mg/L)
- Outfall ammonia continues to rise to 2.53 mg/L by 9pm

October 26, 2013 (Permit NH_3 – 9.44 mg/L)

- At 4:15am, SW pumps o/s and all flow sent to Batts A&B, believing that high NH_3 coming in through SW (outfall – 9.90 mg/L)
- Third blower i/s at 6:30am (outfall – 11.9 mg/L)
- IWD contacted to sample for toxic waste at 8:30am
- At ~6pm M&R takes MLSS samples and determines that nitrifiers are compromised.
- At 11:20pm OEs test North Side Sludge line for reseeding, leak discovered

Reseeding from the North Side Sludge Line

North Side Sludge Line Leak at Concentration

October 27, 2013 (Permit NH_3 – 18.10 mg/L)

- At 2:25am, “WAS only” solids leave North Side WRP plant- travel time is ~16 hours
- At 4am, outfall is 26.36 mg/L
- Trades mobilized to work on North Side sludge line overflow
- 5pm, reseeding starts at a rate of 1.4 MGD, 0.8 MGD to concentration
- 11pm, outfall **NH_3** is 20 mg/L

October 28, 2013 (Permit NH_3 – 14.43 mg/L)

- Microbiology recommends minimal wasting to rid zooglea masses while reintroducing nitrifiers
- 11am, 50 lbs of powdered bacteria introduced into Battery A aeration tanks
- At 11:45am TARP pumpback begins and is directed to Batts C&D, WS flows isolated to Batts A&B
- Battery **NH_3** effluents at noon A-10.32, B-10.93, C-19.42, D-19.18 mg/L

October 29, 2013 (Permit NH_3 – 9.24 mg/L)

- 12:55pm Battery A RAS sent to Battery D for reseeding
- 5:35pm reseeding of D ceased
- Draining of two Battery C aeration tanks for reseeding on Oct 30th
- Battery **NH_3** effluents at noon A-0.53, B-5.70, C-24.70, D-29.00 mg/L

October 30, 2013 (Permit NH_3 – 4.72 mg/L)

- Reseeding of Battery C starts at 7:50am
- By midnight the plant receives 0.47” of precipitation w/forecast of an EPE
- Battery effluents at noon A-0.25, B-4.16, C-19.54, D-13.71 mg/L

October 31, 2013 (Permit NH_3 – 1.78 mg/L)

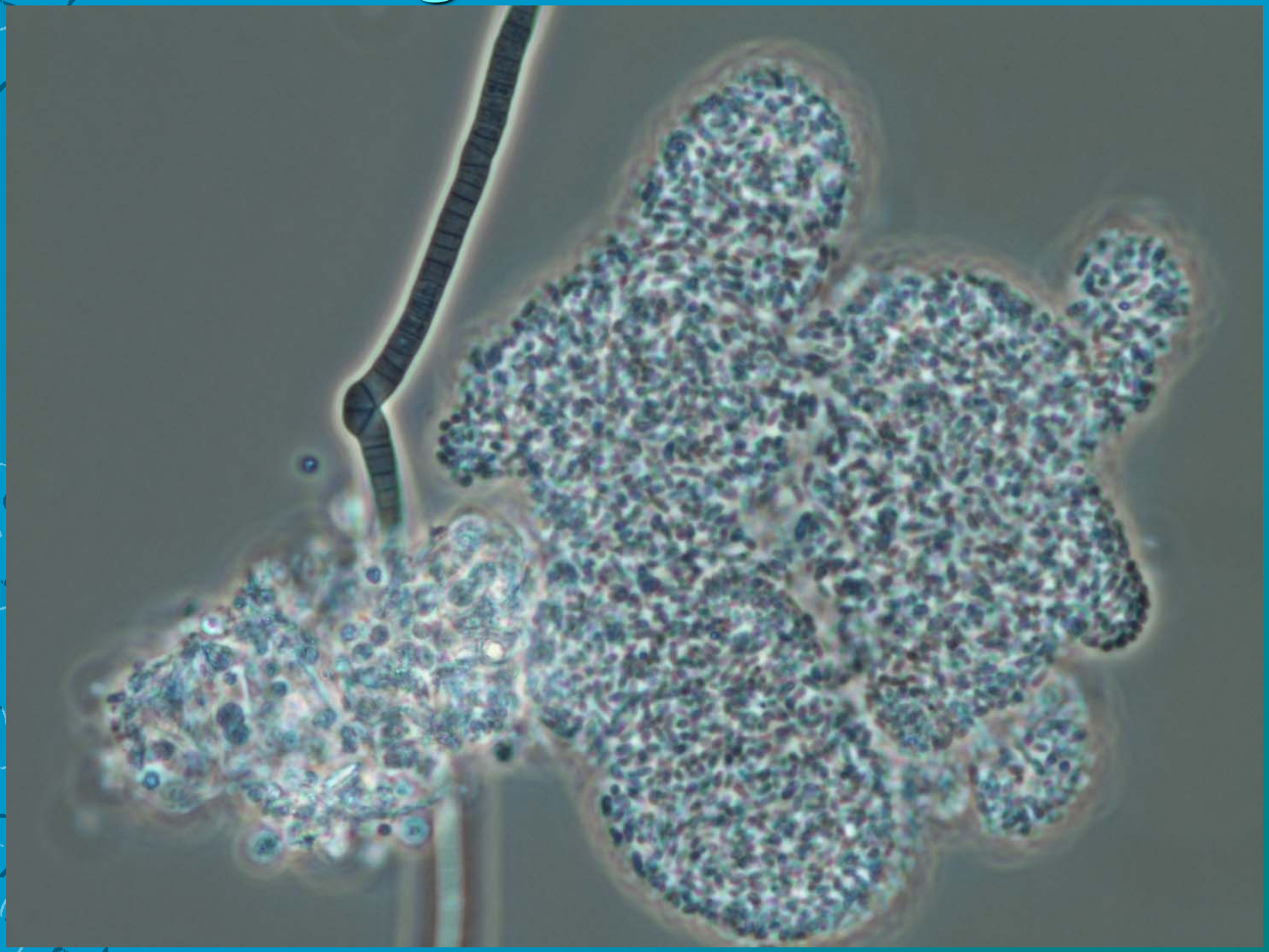
- Plant receives an addition 3.09” of precipitation, TARP full
- Battery effluents at 7:45am A-2.42, B-1.72, C-4.10, D-3.10 mg/L
- Battery effluents at 1pm A-0.33, B-0.46, C-0.28, D-0.13 mg/L

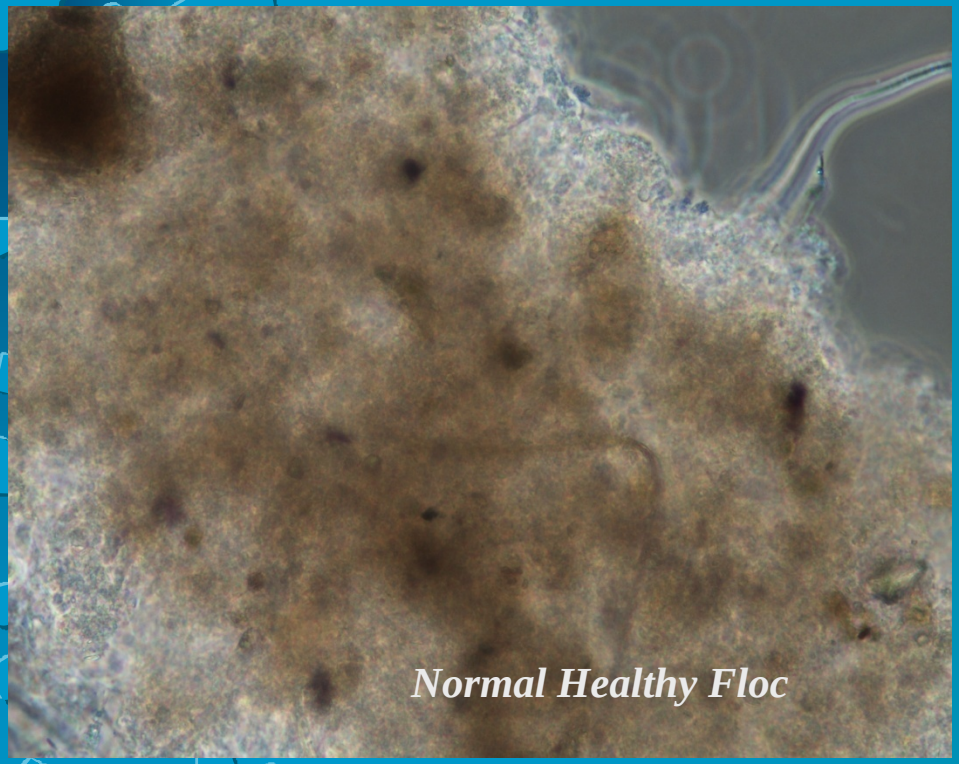
Microscopic Observations

Stickney Water Reclamation Plant

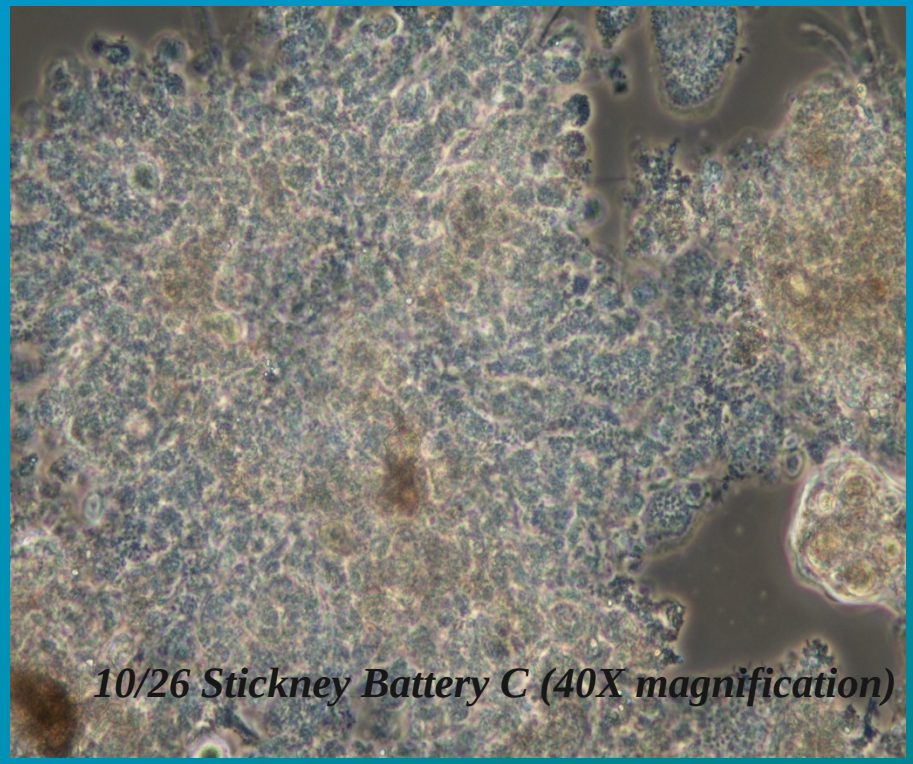
October 26-November 1, 2013

Zoogleal Mass Index

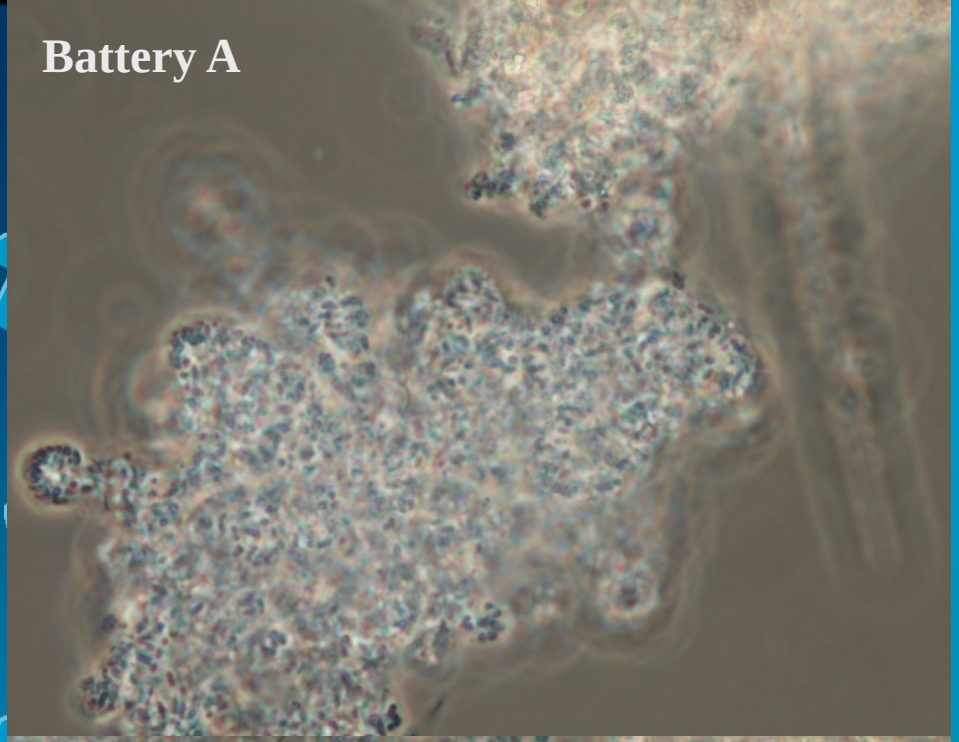


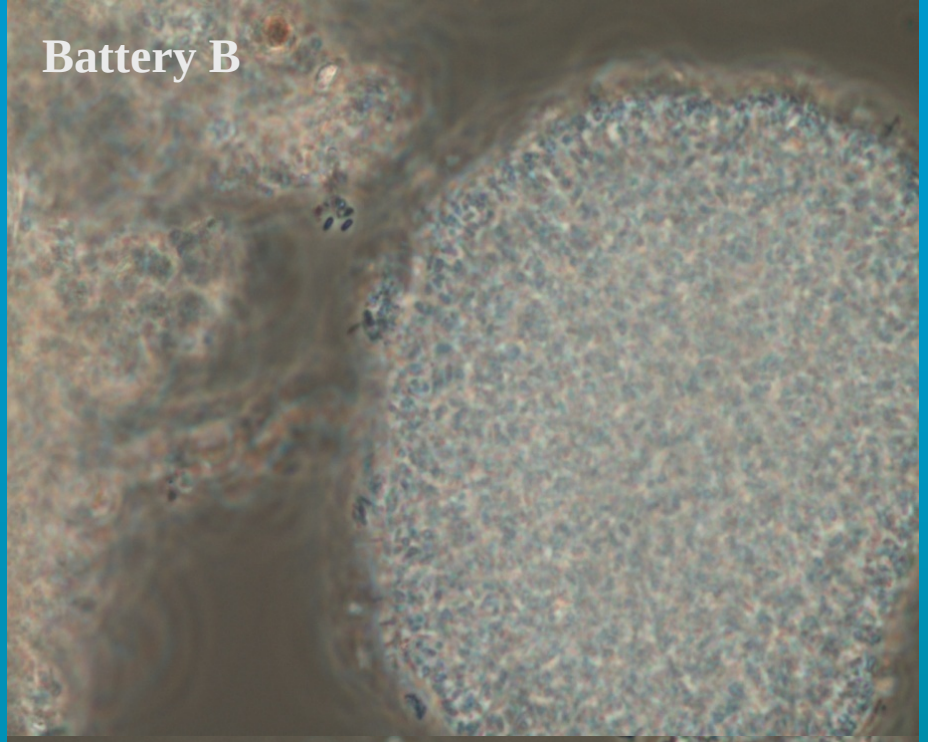


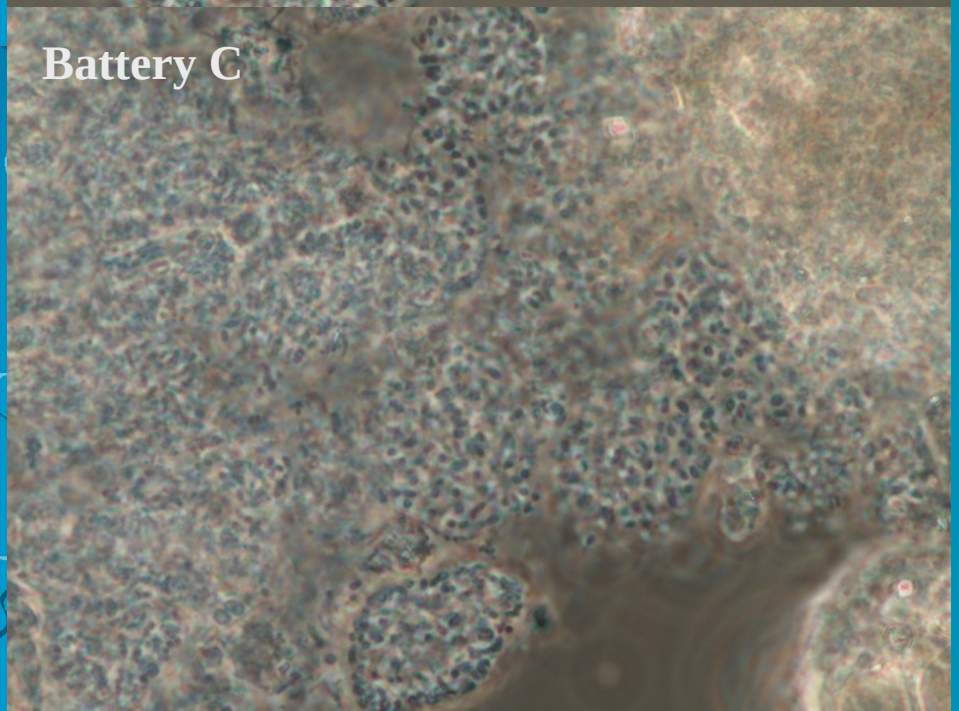
Normal Healthy Floc

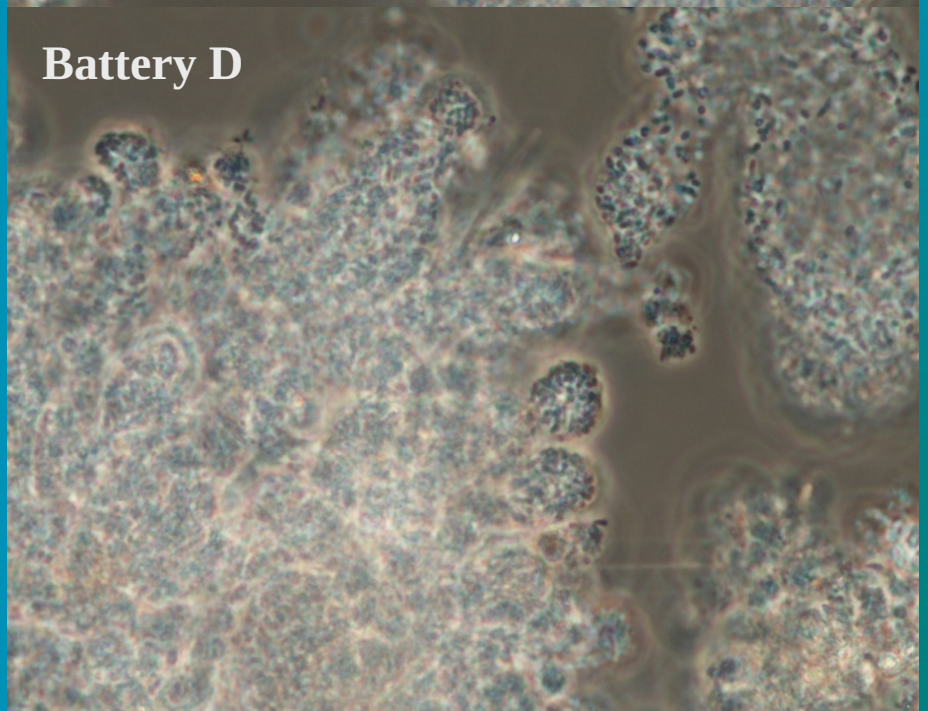


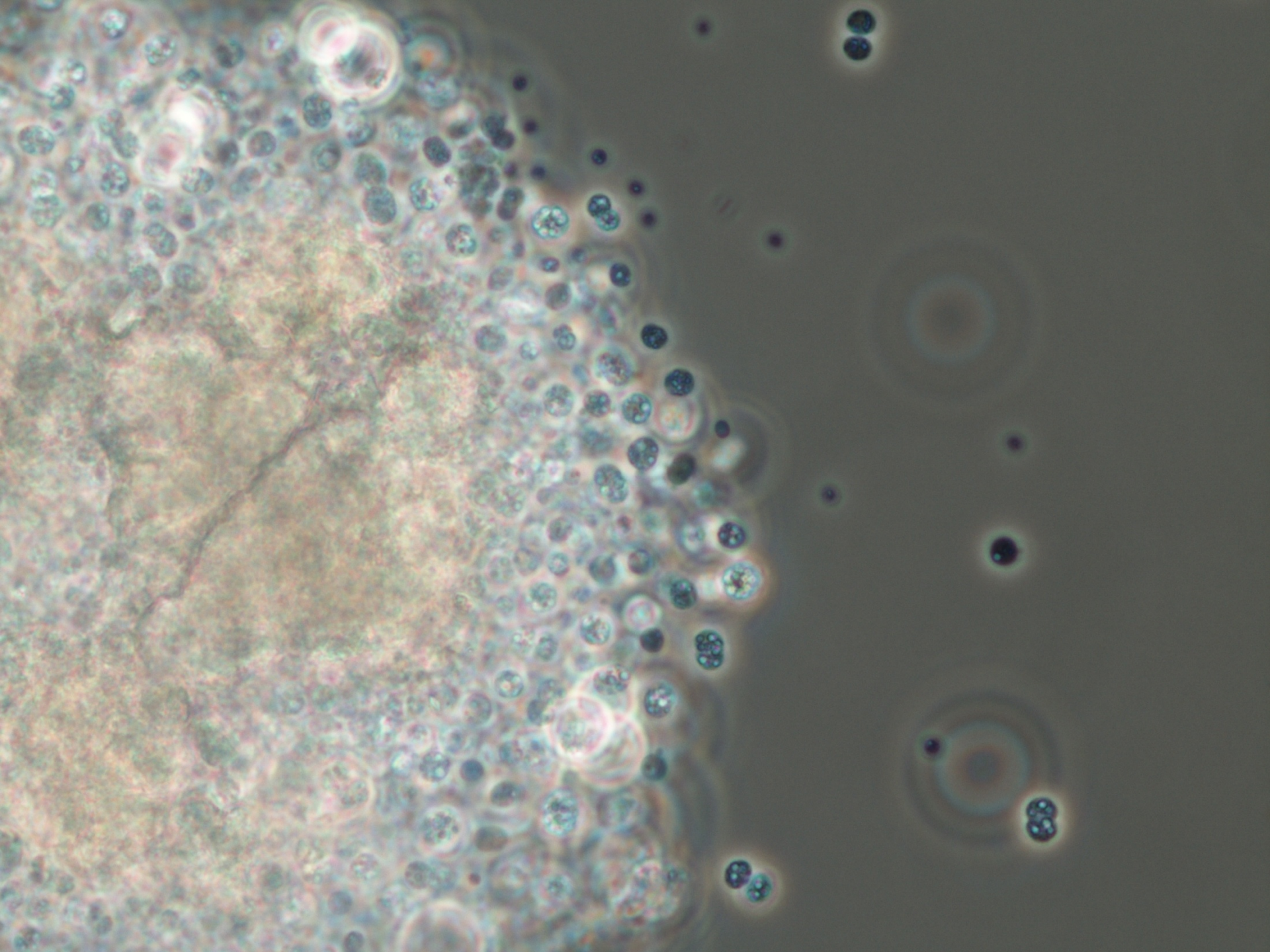
10/26 Stickney Battery C (40X magnification)

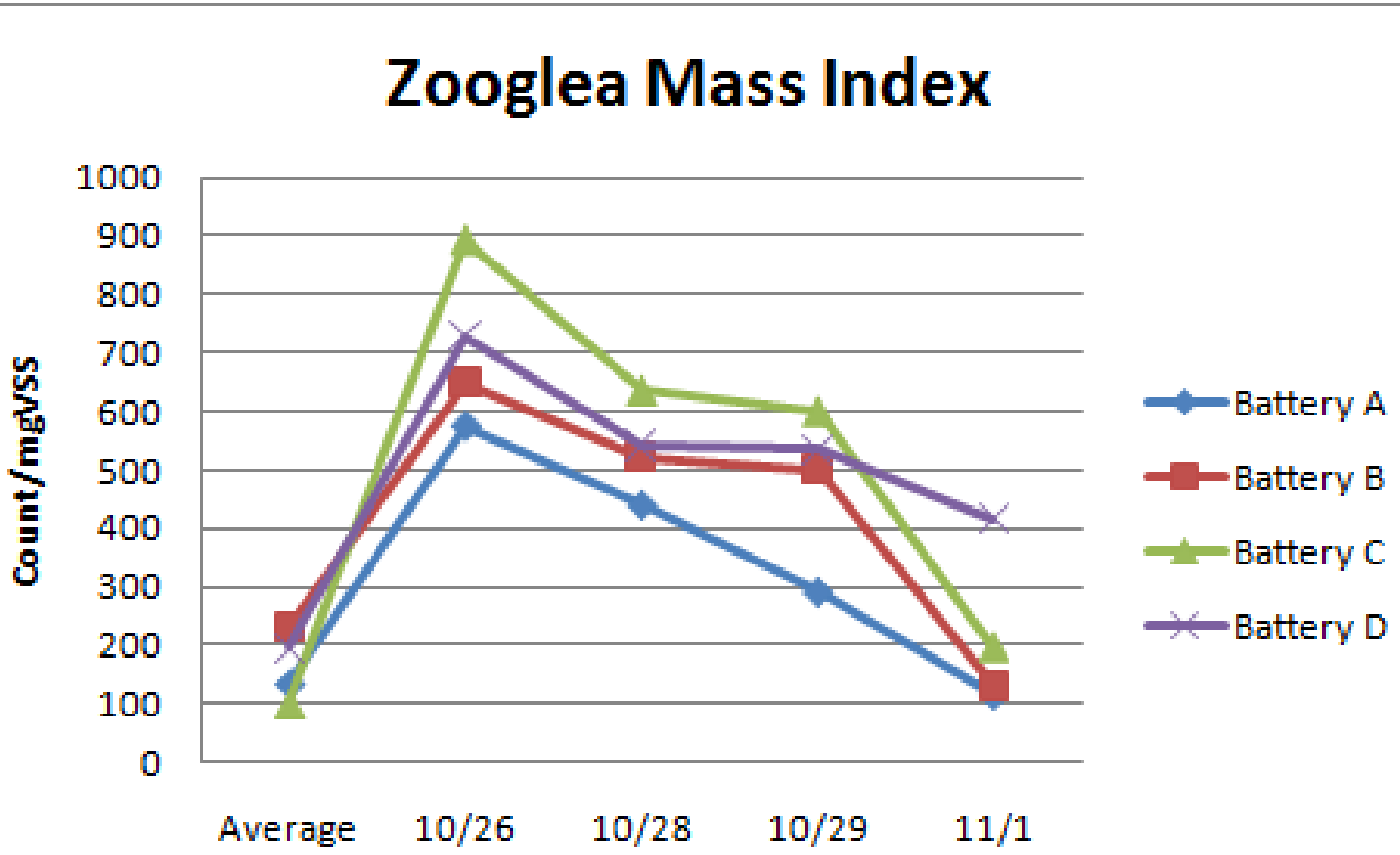

Battery A


Battery B


Battery C


Battery D

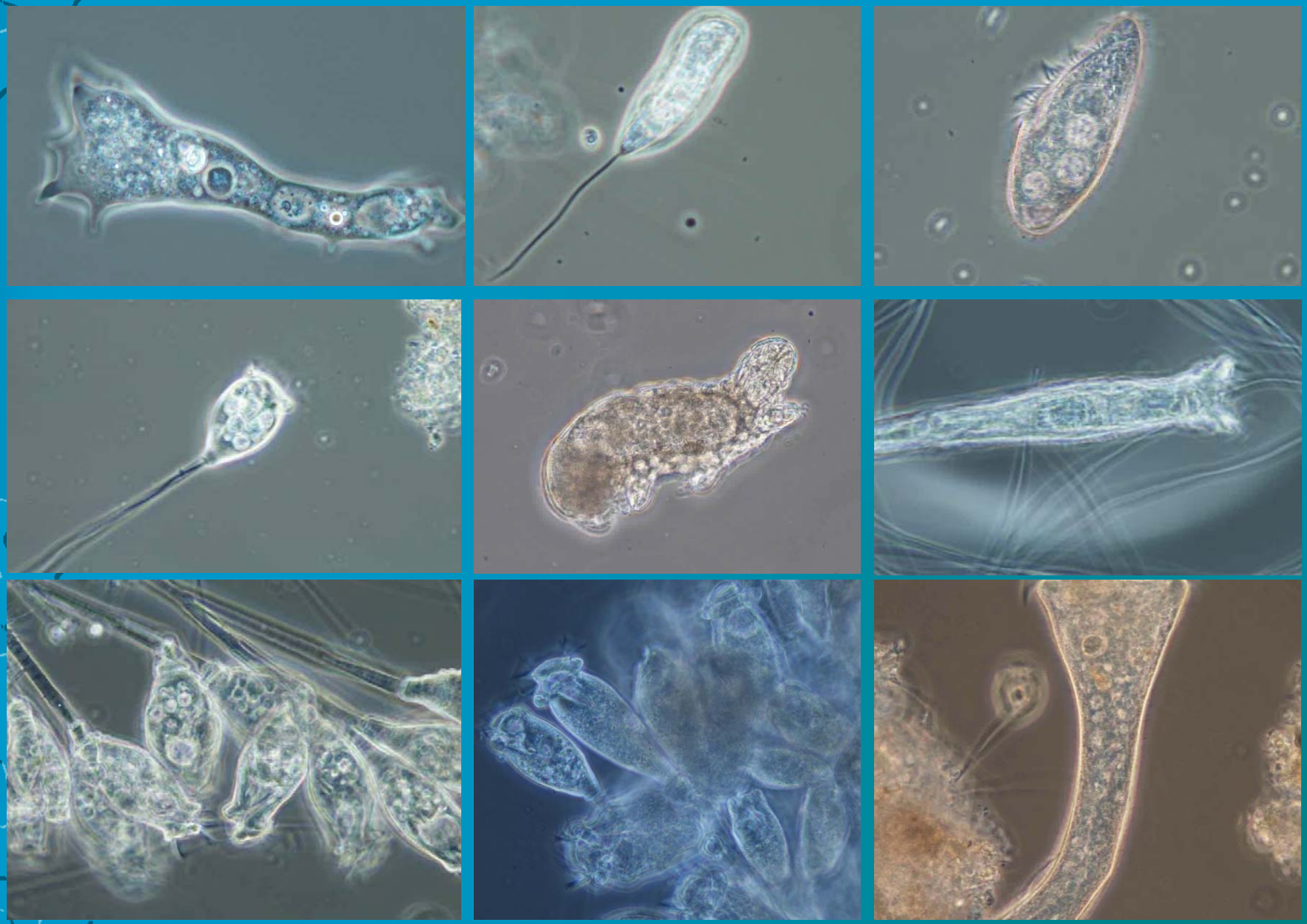



Zooglea Mass Index
Count/mgVSS
1000
900
800
700
600
500
400
300
200
100
0
Average
10/26
10/28
10/29
11/1
Battery A
Battery B
Battery C
Battery D

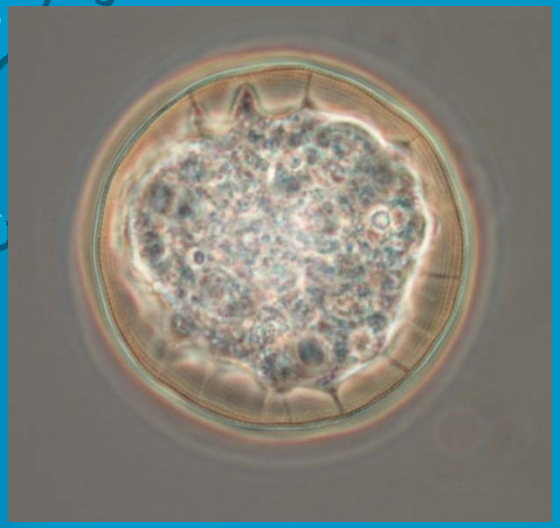
Zoogleal Mass Index

	Average	10/26	Maximum prior to 10/26
Battery A	136	575	195
Battery B	230	650	354
Battery C	102	892	134
Battery D	196	729	328

Protozoa and Metazoa

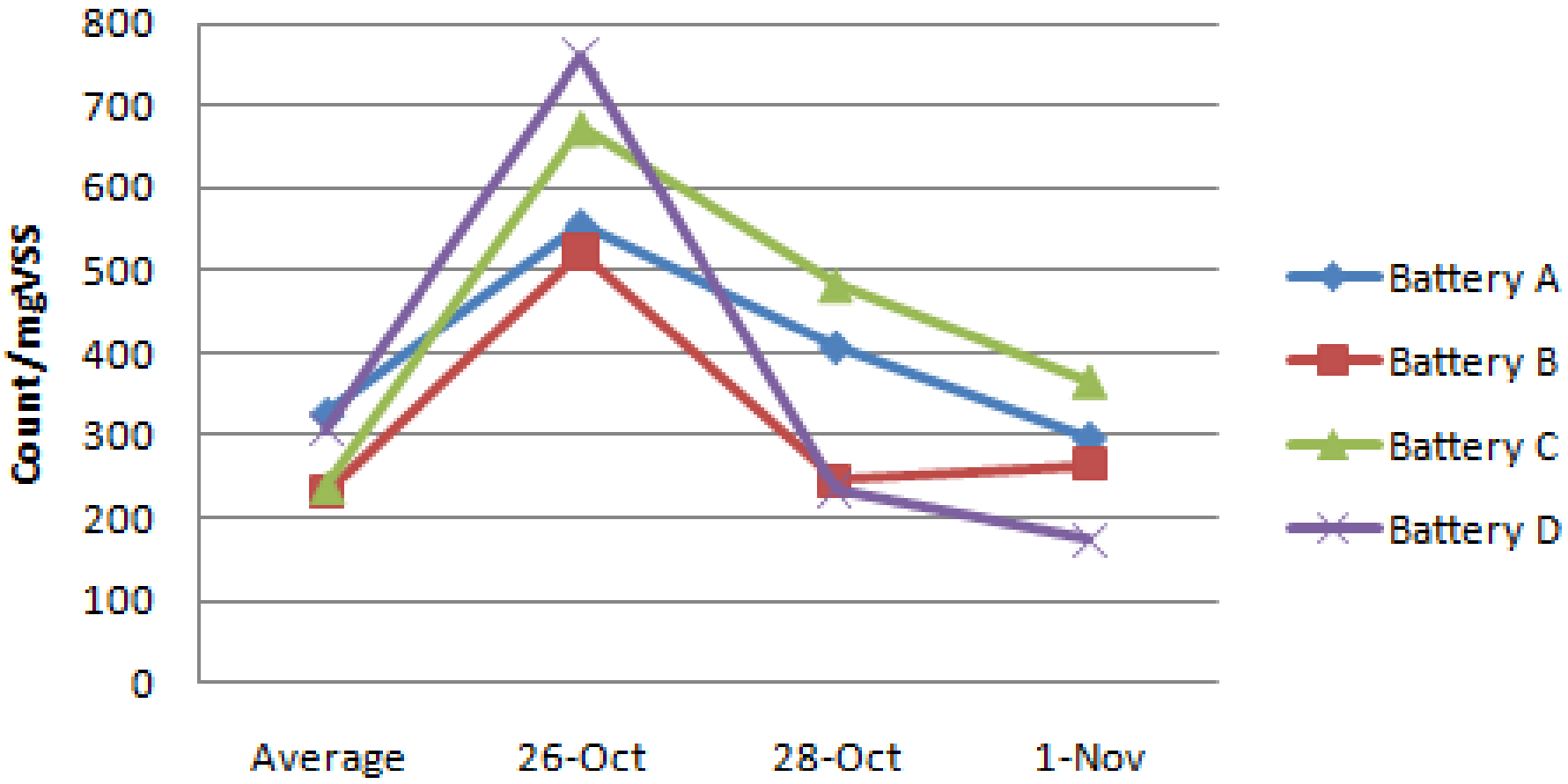


Shelled Protozoa & Metazoa

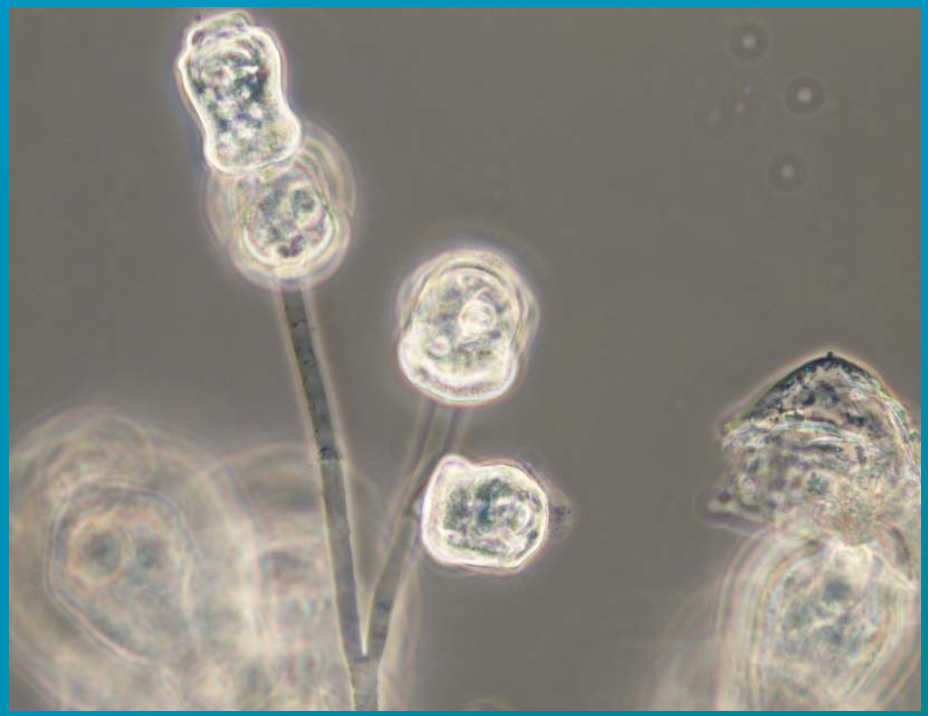





Shelled Species

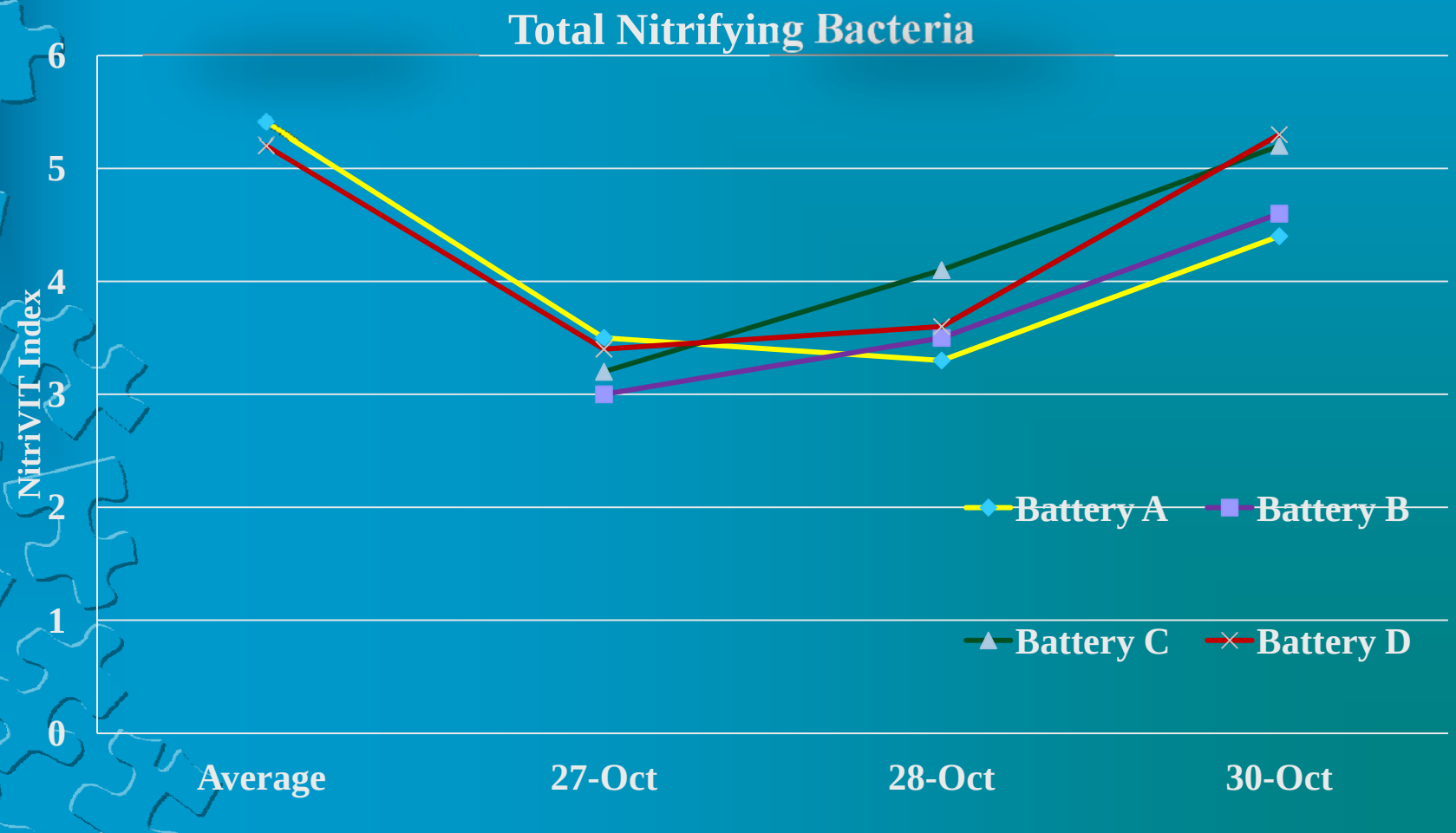


Additional Observations



Additional Observations

VIT Gene Probe Technique



Toxic Effects*

Cadmium is the most highly toxic metal for the microbial communities present in the activated sludge process, followed by copper, and lastly zinc.

MaD. COELLO OVIEDO et al., Toxic Effects of Metals on Microbial Activity …, *Chem. Biochem. Eng. Q. 16 (3) 139–144 (2002)

Conclusions

- Microscopic evidence of acute stress to the microorganisms.
- Impact large enough to affect all major microbiological populations.

Wastewater Treatment & Process Research Observations

Stickney Water Reclamation Plant

October 26-31, 2013

M&R WTPR section Actions

- Biological health in the aeration tank
  - Eight (8) field OUR tests of aeration tank ML
- Nitrification activity
  - Sixty six (66) lab OUR tests of aeration tank ML and thickened WAS from Calumet and Egan WRP w/ and w/o NH_4 spike
- Heterotrophic activity
  - Ten (10) lab OUR tests of aeration tank ML w/ and w/o sugar spike to check if heterotrophs were affected
- Nitrification rates
  - Twenty four (24) respirometer nitrification tests of ML and WAS samples
- Toxicity of upset sludge
  - Eight (8) lab OUR tests of seeded WAS and Battery A ML mixed with slow responding aeration tank ML w/ and w/o NH_4 spike
- Monitored on line ammonia probe in Battery D
- Used operational change information from control room to guide lab tests
- Provided action suggestions to M&O based on lab test results

M&R Suggestions

- North Side WAS: positive nitrifier activity therefore suggested to seed Battery A
- Calumet thickened WAS: no nitrifier activity therefore not suggested to use as seed sludge
- Egan thickened WAS: positive nitrifier activity therefore suggested to seed Battery D
- Cross seed slow responding batteries (C&D) with recovered battery sludge (A&B)
- Don’t feed a few digesters w/ the affected sludge

Field OUR tests (mg O_2/L-hr)- 10/26/13

Field OUR (mg O2/L-h)							
Battery A		Battery B		Battery C		Battery D	
P1 (middle of pass 1)	P4E (end of pass 4)	P1 (middle of pass 1)	P4E (end of pass 4)	P1 (middle of pass 1)	P4E (end of pass 4)	P1 (middle of pass 1)	P4E (end of pass 4)
23.3	11.2	28.1	14.5	20.3	8.7	34.2	11.1

- Normal field OUR in the middle of Pass 1 (P1): ~ 50 mg O_2/L-h; by the end of pass 4 (P4E): ~10 mg O_2/L-h.
- OUR at P1 much lower than normal values.
- The difference between P1 and P4E indicates some biological activity remained with elevated ammonia episode.

Lab OUR tests (mg O_2/L-hr)

Date	Battery A			Battery B			Battery C			Battery D		
	control	NH4 Spike	Carbon spike	Control	NH4 Spike	Carbon Spike	Control	NH4 Spike	Carbon Spike	Control	NH4 Spike	Carbon Spike
10/26	11	11.2	nd	nd	nd	nd	5	8.2	11.5	13.8	13.7	15.2
10/27	12.7	13.5	15.3	11.5	12.9	15.6	13.6	13.4	18.6	21.3	19.8	25.2
10/28 AM	15.4	17.9	21.6	14.2	22.1	18.6	11	10.9	14.8	22	16	26.2
10/28 PM	17.4	19	nd	12.7	17.8	nd	8.9	10.4	nd	17.4	15.2	nd
10/29	14	23.7	nd	18.5	22.2	nd	14.8	14.4	nd	19.7	18.2	nd
10/30	11.7	27.6	nd	25	29.5	nd	11.1	15.4	nd	15.5	16.3	nd
10/31	13.7	28.8	nd	11.5	19.2	nd	11.8	19.2	nd	21.9	37.2	nd
11/1	14.6	26.7	nd	17.8	25.7	nd	11.9	19	nd	11.6	22.1	nd

Recovered w/ higher nitrification rate (>1 mg NH4-N/L-h)

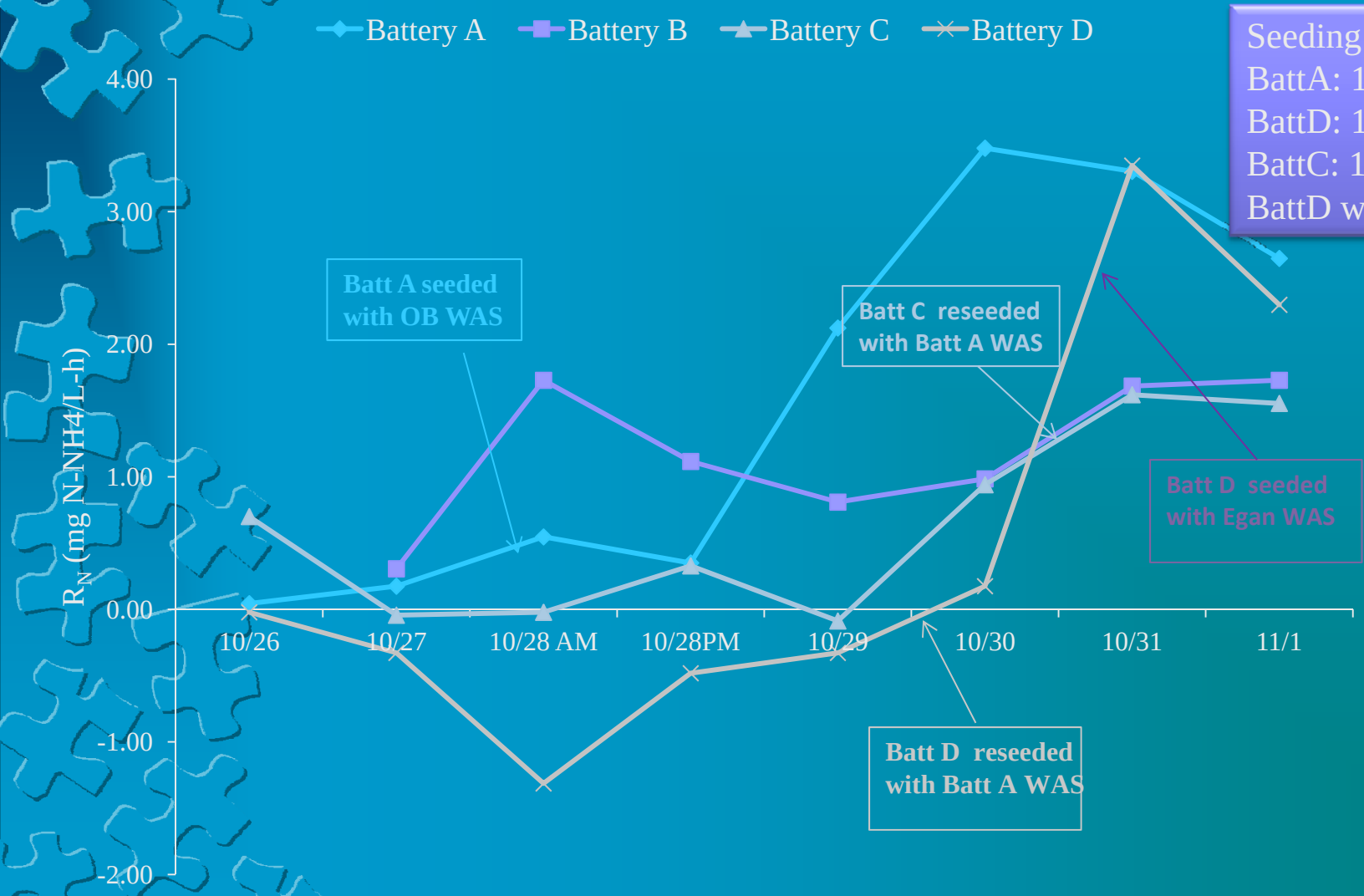
Highlighted area indicates recovery of nitrifier activity in the aeration tank.

Lab OUR tests (mg O_2/L-hr) continued

10/29/2013				10/30/2013			
BatC ML+OB WAS		BatD ML+OB WAS		BatC ML+BatA ML		BatD ML+BatA ML	
control	NH4 Spike	Control	NH4 Spike	control	NH4 Spike	Control	NH4 Spike
40.1	43.6	42.4	46.0	17.8	21.1	19.4	20.9

Batteries C&D activated sludge didn't show toxicity with reseed sludge because of increased OUR response.

Nitrification Rates Calculated from OUR



Seeding Timeline:
BattA: 10/27 5:00 pm
BattD: 10/29 12:50 pm
BattC: 10/30 9:25 am
BattD w/ EWAS: 10/31

Seeding with other plant's WAS or thickened WAS is an efficient way to recover knocked out nitrifiers

Lessons Learned

- Plant Specific Emergency Reseeding
- Real Time Monitoring of NH_3
- Interceptor Discrete Sampling
- Change Early Warning Probe to End of 1st Pass

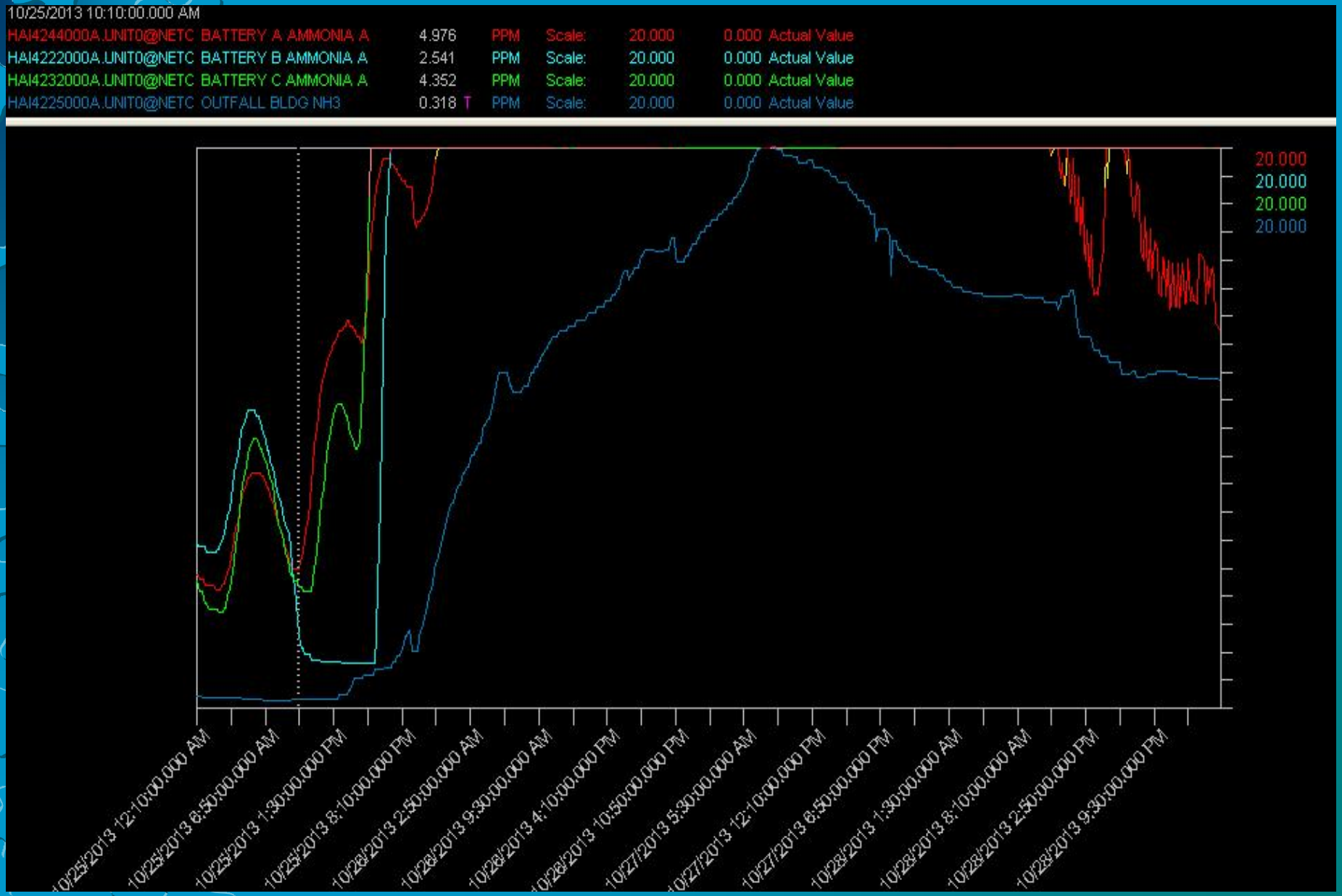
Sections BBC NEWS AA

SCOTLAND

Sewer was blocked by large Pooh

Last updated 17 Feb 2014 00:03 GMT

Battery A, B, & C (end of pass 2) and Plant Outfall NH_3



Battery A End of Pass 2 DO probes