

# Minimizing horticultural impacts on surface water quality to encourage re-use through enhanced pond management

February 17, 2022 Research Meeting  
COHA Cluster3 - Project #7



# Work Plan

## FY 2021-2022 – Year 4

- In-Pond & Pre-Pond technologies installed
- Full seasonal monitoring completed (water, sediment, biology)
- Annual data analysis and review
- Technical report draft
- TAC meeting
- KTT – video, etc.

# Mesocosms

- First up – don't think the mesocosms worked...
  - Too small?
  - Trials in Germany use much larger cells
  - Isolated lakes (e.g., kettle lakes) are useful but there's no control
  - Not representative of water/pond?
  - Or not enough time to see a result?
  - Maybe will see some differences once analyses are complete?

So much data! No clear answers?



# What factors drive poor pond conditions?

- Nutrient availability (N, P, Organic Matter)\*
- Light\*
- Temperature
- Oxidation-Reduction (REDOX) Potential

\* The focus of COHA7 project

# 2021 Sampling Season Focus

1. More replicates
2. More biology/flora diagnostics
3. Changed grab sampling to 'whole column' since the demo ponds don't stratify (YSI done at all levels first)
4. More treatments (e.g., bacterial applications)
5. New pre-pond swale installation

# 2021 TREATMENTS

In enclosures (mesocosms):

- Traditional aeration
- Submerged macrophytes
- Surface shading (cloth)
- Surface shading (duckweed)
- Bacteria
- P-Binding (Clariphos)
- (control)

In pond:

- PhytoLinks
- Nano-bubbler

Pre-Pond:

- Shallow swale





# Site B









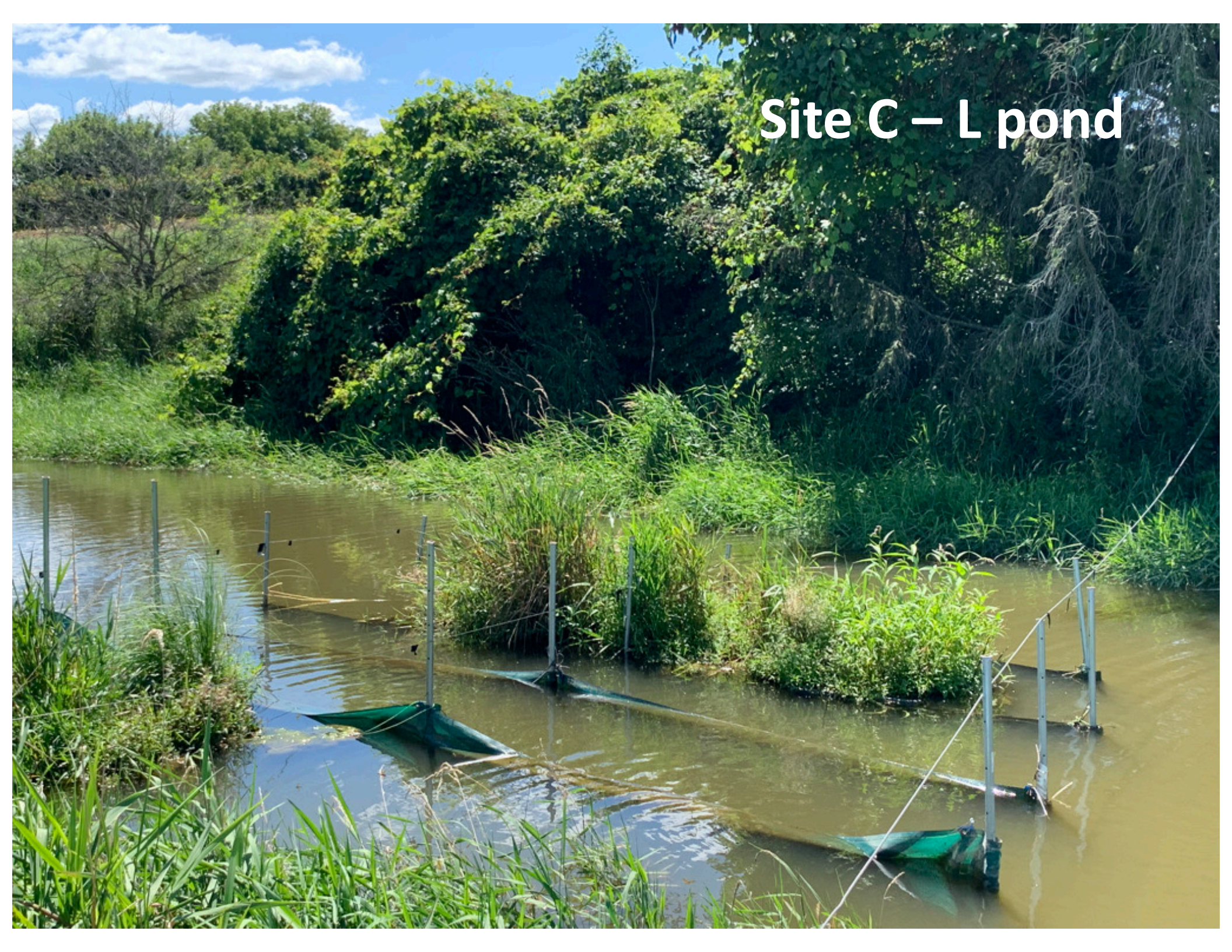


# Site C – H pond





# Site C – L pond







**Site D - West pond**



# Site D – HTS Swale Pre-Pond





# Site E – East pond



# Pond Water Quality – Column Grab & YSI

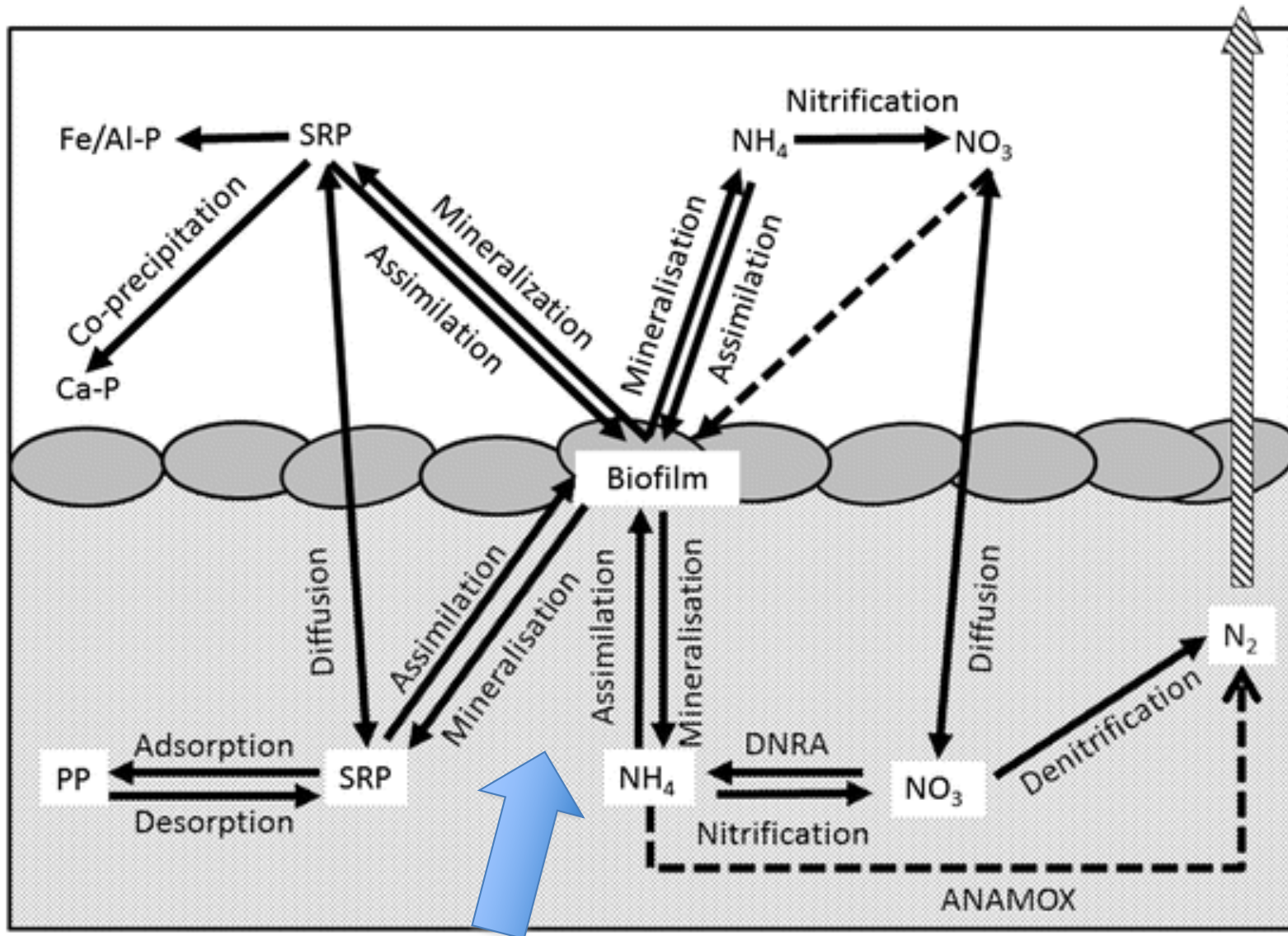
Parameter	B	C-H	C-L	D	E
Total P (mg/L)	0.11 (BDL-0.21)	0.12 (BDL-0.29)	0.19 (BDL-0.28)	0.9 (BDL-3.45)	0.2 (BDL-1.91)
Soluble Reactive P (mg/L)	BDL (BDL)	0.16 (BDL-0.29)	BDL	1.1 (0.14-2.48)	1.66 (-)
Nitrate (mg/L)	2.7 (1.7-3.1)	1.1 (BDL-1.2)	7.2 (3-17)	7.3 (1.8-13)	BDL
Ammonia (mg/L)	0.37 (BDL-1.34)	1.8 (BDL-16)	0.3 (BDL-3)	0.4 (BDL-1)	0.6 (BDL-5)



Average (range)



# Pond Nutrient Cycling



**Nutrients (N, P, etc.) and microbes (including algae & cyanobacteria)**

# Pond Water Quality – Column Grab & YSI

Parameter	B	C-H	C-L	D	E
Total P (mg/L)	0.11 (BDL-0.21)	0.12 (BDL-0.29)	0.19 (BDL-0.28)	0.9 (BDL-3.45)	0.2 (BDL-1.91)
Soluble Reactive P (mg/L)	BDL (BDL)	0.16 (BDL-0.29)	BDL	1.1 (0.14-2.48)	1.66 (-)
Nitrate (mg/L)	2.7 (1.7-3.1)	1.1 (BDL-1.2)	7.2 (3-17)	7.3 (1.8-13)	BDL
Ammonia (mg/L)	0.37 (BDL-1.34)	1.8 (BDL-16)	0.3 (BDL-3)	0.4 (BDL-1)	0.6 (BDL-5)
Chl <i>a</i> + Phycocyanin (ug/L)	47 (11-277)	20 (1-82)	24 (1-148)	24 (3-55)	21 (1-65)
Turbidity (FNU)	207 (5-358)	7 (3-17)	18 (2-227)	21 (16-30)	20 (7-53)
Secchi Depth (m)	0.3 (0.2-0.4)	1.2 (0.8-1.4)	0.4 (0.3-0.5)		0.5 (?)
ODO (mg/L)	7.7 (4-19)	5 (2-8)	8 (0.4-20)	6.7 (6-8)	6.7 (4-9)

Average (range)

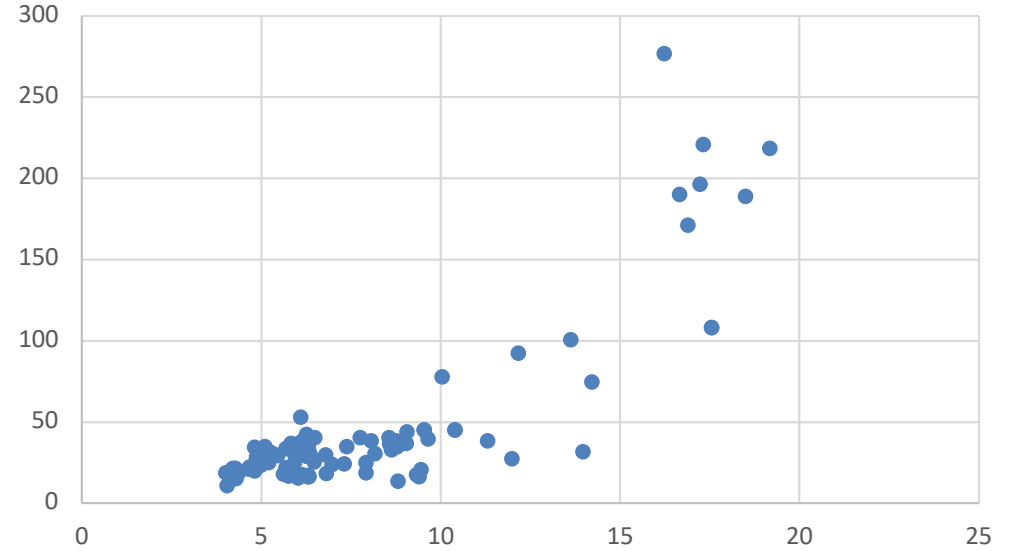
# Pond Sediment Quality – Grab Samples

Parameter	B	C-H	C-L	D	E
Total P (mg/L)	27 (18-35)	32 (16-58)	50 (37-62)	7 (1-13)	34 (17-46)
Nitrate (mg/L)	1 (0-4)	1 (0-3)	2 (1-5)	0.5 (0-1)	1 (-)
Ammonia (mg/L)	0	0	0	0	0
Organic Matter (mg/L)	6 (5.2-6.7)	4.5 (3.6-5.2)	5.1 (2.3-6.7)	1.9 (1.1-2.7)	2.2 (1.3-3.7)
pH	7.5 (7.3-7.9)	7.4 (7.2-7.7)	7.3 (7-7.6)	7.6 (7.3-7.9)	7.3 (7.1-7.5)
<i>n</i> =	27	18	8	2	9

# Site B – Cyanobacterial Blooms

Filter	Control	Plant matter	Control	Control	Barotonia C.1	Barotonia C.2	Barotonia Pond 1	Barotonia Pond 2	Barotonia Pond 3	Barotonia Pond 4	Barotonia Pond 5	Barotonia Pond 6	Barotonia Pond 7	Barotonia Pond 8	Barotonia Pond 9	Barotonia Pond 10	Barotonia Pond 11	Barotonia Pond 12	Barotonia Pond 13	Barotonia Pond 14	Barotonia Pond 15	Barotonia Pond 16	Barotonia Pond 17	Barotonia Pond 18	Barotonia Pond 19	Barotonia Pond 20	Barotonia Pond 21	Barotonia Pond 22	Barotonia Pond 23	Barotonia Pond 24	Barotonia Pond 25	Barotonia Pond 26	Barotonia Pond 27	Barotonia Pond 28	Barotonia Pond 29	Barotonia Pond 30	Barotonia Pond 31	Barotonia Pond 32	Barotonia Pond 33	Barotonia Pond 34	Barotonia Pond 35	Barotonia Pond 36	Barotonia Pond 37	Barotonia Pond 38	Barotonia Pond 39	Barotonia Pond 40	Barotonia Pond 41	Barotonia Pond 42	Barotonia Pond 43	Barotonia Pond 44	Barotonia Pond 45	Barotonia Pond 46	Barotonia Pond 47	Barotonia Pond 48	Barotonia Pond 49	Barotonia Pond 50	Barotonia Pond 51	Barotonia Pond 52	Barotonia Pond 53	Barotonia Pond 54	Barotonia Pond 55	Barotonia Pond 56	Barotonia Pond 57	Barotonia Pond 58	Barotonia Pond 59	Barotonia Pond 60	Barotonia Pond 61	Barotonia Pond 62	Barotonia Pond 63	Barotonia Pond 64	Barotonia Pond 65	Barotonia Pond 66	Barotonia Pond 67	Barotonia Pond 68	Barotonia Pond 69	Barotonia Pond 70	Barotonia Pond 71	Barotonia Pond 72	Barotonia Pond 73	Barotonia Pond 74	Barotonia Pond 75	Barotonia Pond 76	Barotonia Pond 77	Barotonia Pond 78	Barotonia Pond 79	Barotonia Pond 80	Barotonia Pond 81	Barotonia Pond 82	Barotonia Pond 83	Barotonia Pond 84	Barotonia Pond 85	Barotonia Pond 86	Barotonia Pond 87	Barotonia Pond 88	Barotonia Pond 89	Barotonia Pond 90	Barotonia Pond 91	Barotonia Pond 92	Barotonia Pond 93	Barotonia Pond 94	Barotonia Pond 95	Barotonia Pond 96	Barotonia Pond 97	Barotonia Pond 98	Barotonia Pond 99	Barotonia Pond 100
Barotonia C.1	Barotonia C.2	Barotonia C.3	Barotonia C.4	Barotonia C.5	Barotonia C.6	Barotonia C.7	Barotonia C.8	Barotonia C.9	Barotonia C.10	Barotonia C.11	Barotonia C.12	Barotonia C.13	Barotonia C.14	Barotonia C.15	Barotonia C.16	Barotonia C.17	Barotonia C.18	Barotonia C.19	Barotonia C.20	Barotonia C.21	Barotonia C.22	Barotonia C.23	Barotonia C.24	Barotonia C.25	Barotonia C.26	Barotonia C.27	Barotonia C.28	Barotonia C.29	Barotonia C.30	Barotonia C.31	Barotonia C.32	Barotonia C.33	Barotonia C.34	Barotonia C.35	Barotonia C.36	Barotonia C.37	Barotonia C.38	Barotonia C.39	Barotonia C.40	Barotonia C.41	Barotonia C.42	Barotonia C.43	Barotonia C.44	Barotonia C.45	Barotonia C.46	Barotonia C.47	Barotonia C.48	Barotonia C.49	Barotonia C.50	Barotonia C.51	Barotonia C.52	Barotonia C.53	Barotonia C.54	Barotonia C.55	Barotonia C.56	Barotonia C.57	Barotonia C.58	Barotonia C.59	Barotonia C.60	Barotonia C.61	Barotonia C.62	Barotonia C.63	Barotonia C.64	Barotonia C.65	Barotonia C.66	Barotonia C.67	Barotonia C.68	Barotonia C.69	Barotonia C.70	Barotonia C.71	Barotonia C.72	Barotonia C.73	Barotonia C.74	Barotonia C.75	Barotonia C.76	Barotonia C.77	Barotonia C.78	Barotonia C.79	Barotonia C.80	Barotonia C.81	Barotonia C.82	Barotonia C.83	Barotonia C.84	Barotonia C.85	Barotonia C.86	Barotonia C.87	Barotonia C.88	Barotonia C.89	Barotonia C.90	Barotonia C.91	Barotonia C.92	Barotonia C.93	Barotonia C.94	Barotonia C.95	Barotonia C.96	Barotonia C.97	Barotonia C.98	Barotonia C.99	Barotonia C.100							

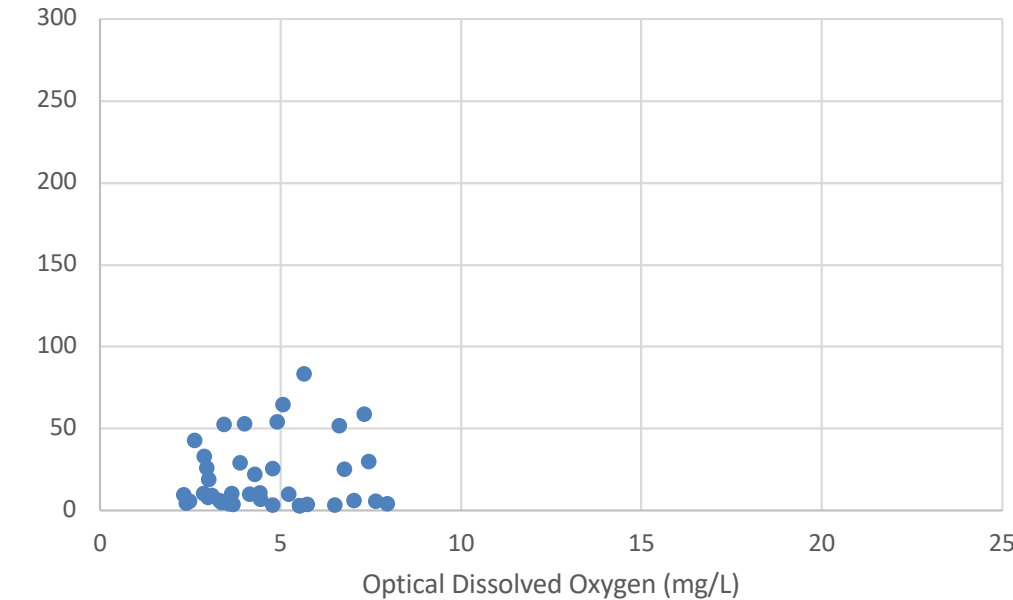
## Chl a + Phycocyanin (ug/L) vs ODO (mg/L)



# Site C-H – No Blooms

Pond	Control	Macrophytes	Duckweed	Shade	Aeration
Diatom	Diatom	Brown root-like hyphae - ?chara reproductive unit?	tiny flagellate	organic matter associated diatom	Euglena
ciliate					sediment associated organ
Trachelomonas	Trachelomonas*	Large rotifer	Merismopedia	Rotifer	Trachelomonas**
Euglena	Euglena**	Chlamydomonas**	Trachelomonas	Chlamydomonas	Cryptomonas spp **
Chlamydomonas?	diatom**	Trachelomonas	Chlamydomonas	Euglena	Euglena spp
diatom	Chlamydomonas	Cryptomonas	Euglena	Cryptomonas spp**	Merismopedia
Cryptomonas	diatom	diatom	cluster of small greens	Hanes brown filament	protozoa
Hanes brown filament	Merismopedia	Euglena	Volvox??		Hanes brown filament
	Hanes brown filament	detritus	Hanes brown filament		diatom
	detritus				
Chlamydomonas***	Chlamydomonas***	Chlamydomonas	Chlamydomonas***	Chlamydomonas***	Chlamydomonas***
Euglena	diatoms	Ceratium	Merismopedia	diatom	Merismopedia
Hanes brown filament	rotifer	Merismopedia	diatom	Merismopedia	
	Ankistrodesmus	diatom	vorticella-like rotifers	Monaraphidium	several protozoa types
	Merismopedia	Phacus	unicellular flagellates	small unicellular greens	
	Hanes brown filament		Hanes brown filament	Hanes brown filament	
			oocyst		
unicellular flagellate	unicellular flagellates	diatom	diatom	Euglena sp	
	unidentified cyanob.??	Chlamydomonas	unicellular flagellates (m	unicellular flagellates (man	unicellular flagellate
	green cluster??			unidentified filament	Chlamydomonas
					large ciliated ?rotifer?

## Chl a + Phycocyanin (ug/L) vs ODO (mg/L)

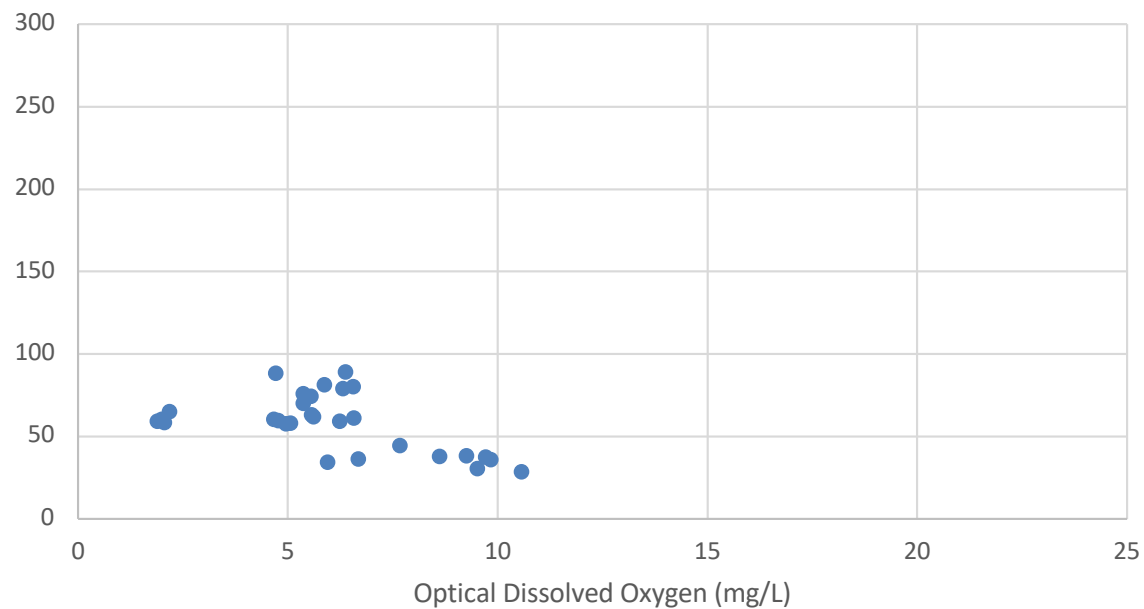




# Site C-L – 2021

Pond	Phytolinks	Middle	Shore
unkn. unicellular, eyespot, clearish	Trachelamonas	v.f. Oscillatoria	unkn. Unicell
unicell green cluster	unkn. Unicell	Trachelamonas	protozoa-like, flagella
euglena (small)	unicell green cluster	tiny flagellates	protozoa, spiny
	protozoa like cells	small clear granular flagellates	
		Euglena	
		Dictyosphaerium	
<b>Cryptomonas **</b>	<b>Euglena***</b>	<b>Euglena**</b>	<b>Euglena*</b>
Dictosphaerium		Trachelamonas	Trachelamonas*
Trachelamonas		Aktinastrum	unicellular greens (clur
<b>Euglena</b>		<b>very fine Oscillatoria</b>	single long green cells v
		Sphaerocystis?	
		single long green cells with swimming motion?	
unicellular flagellates (m	Trachelamonas*	unicellular flagellates (r	unicellular flagellates (r
<b>Euglena</b>	diatom	unidentified spiked cell	<b>Trachelamonas</b>
Chlorella*	Chlorella		<b>Euglena</b>
several unidentified unicells		rotifer?	Chlorella

Chl a + Phycocyanin (ug/L) vs ODO



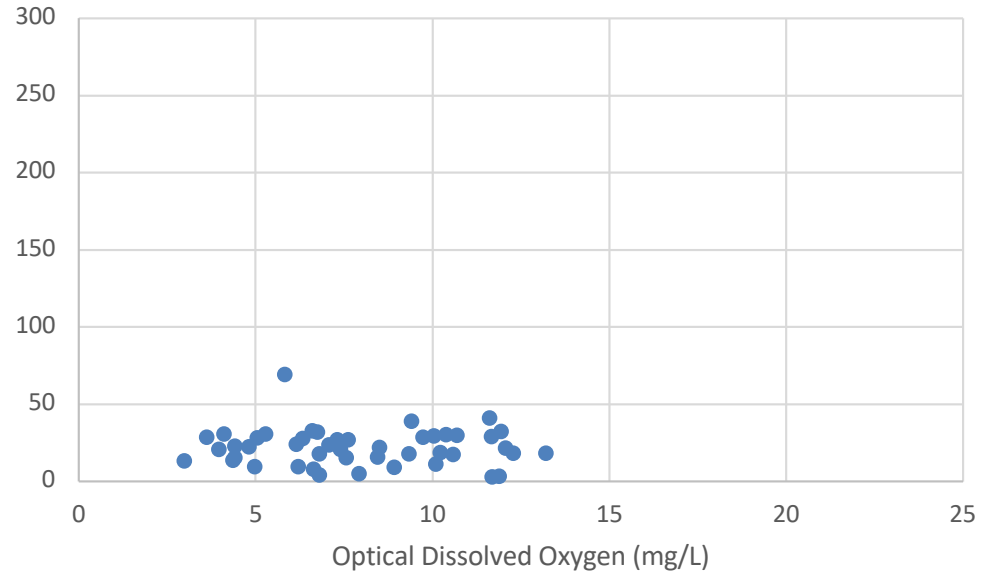
2020

East Pond (Nano)	Mesocosm 1 (near Nanobubbler)	Mesocosm 2	Mesocosm 3 (North end)
Microcystis bloom			
	Microcystis	Microcystis	Microcystis
	with unicell greens?	same	Diliosperum circinalis (aka Anabaena circinalis)
North end scum: Microcystis and D. circinalis			
scum formation: Microcystis, D. circinalis, Planktothrix			
Microcystis dominant	Microcystis (incl 'noodles')	Microcystis	Microcystis (incl 'noodles')
Planktothrix	unicellular flagellates	unicellular flagellates (Cryptomonas)	unicellular flagellates
D. circinalis	Planktothrix	D. circinalis	D. circinalis (with skinet)
Brown circular blobs: Euglena sanguina			Cylindrospermopsis?
Green flagellates		Phormidium	
Microcystis***			
green - unknown*	Microcystis*	Microcystis clumps**	Microcystis clumps**
green - unknown*	Cylindrospermopsis	collapsed Microcystis clumps	green (unknown)
green - unknown*	Trachelomonas	Anabaena cylindrica	Skenedemosus
Microcystis - small *	Ceratium	green (unknown)	Tribonema
Microcystis - large, gelatinous tv	green (unknown)		Trachelomonas
Trachelomonas*	green (unknown)		Trachelomonas
Staurastrum*	Staurastrum type		
Crucigenia (greens)	Trachelomonas	Crucigenia (greens)	brown flagellate
green unicells**	tiny flagellates	unicellular greens	Crucigenia
oval unicells	green flagellate	sickle shaped cells	small greens, clumped
small flagellates	pale brown flagellate	small microcystis clump	Crucigenia
small microcystis clump	broken cyst		Microcystis
Trachelomonas			Micractinium
diatoms			
decomposing D. circinalis			
Euglena			
clump of greens			
Fine flt BGB (Oscillatoria sp)* S&C	fine flt BGB (Oscillatoria sp)**	not done - flooded	fine flt BGB (Oscillatoria sp) S&C
Trachelomonas* S&C	Trachelomonas*** C, present S		Microcystis
Microcystis S	Microcystis colony S&C		
	Planktothrix *C		
	Chlamydomonas S		
Micractinium S	Unicellular greens C		
rotifer S	Skenedemosus **S		
Fine flt BGB (Oscillatoria sp) S & C*	Planktothrix* S&C	Planktothrix S&C	Microcystis **C
Trachelomonas S&C	Trachelomonas* S&C	Trachelomonas *S&C**	Diliosperum circinalis
Euglena S&C	Euglena spp *C		fine flt BGB (Oscillatoria sp)* S&C
Planktothrix C	Crucigenia C	Fine flt BGB (Oscillatoria sp)* S&C	Trachelomonas **S *C
Crucigenia C	small flagellates**C		Euglena spp C
Microcystis C	Staurastrum C		Skenedemosus C
unicellular greens C	Skenedemosus S		Coelastrum S
rotifer S			
	Microcystis*		
	Planktothrix		
	Diliosperum circinalis		
	of Oscillatoria		
	Skenedemosus		
	Trachelomonas		
	Tribonema		
	diatom		
	Aekistrodesmus?		
	Chlorococcum		
	Euglena		
	rotifer		
Planktothrix*** (S&C)	Planktothrix*** (S&C)	Planktothrix*** (S&C)	Planktothrix*** (S&C)
very fine Oscillatoria (S&C)	Ceratium *** (S&C)	Ceratium * (S&C)	Ceratium **S) *C)
unicellular green clump	very fine Oscillatoria (S&C)	Microcystis ** (S), present in Column	very fine Oscillatoria*ID), present Column
unicellular green*	unicellular flagellate	very fine Oscillatoria* (S)	Trachelomonas (S)
	D. circinalis	D. circinalis** (S)	D. circinalis (S&C)
	Chlamydomonas	diatom	Cryptomonas
	Trachelomonas	very small unicellular oval greens ***	Microcystis ID
	small rotifer		Ankistrodesmus
			rotifer (S)
Planktothrix *** (S&C)	Planktothrix *** (S&C)	Planktothrix *** (S&C)	Planktothrix ***
Fine Oscillatoria (S&C)	Fine Oscillatoria	Microcystis	fine Oscillatoria
Ceratium (S&C)	Ceratium C	diatom S&C	unicellular flagellate
Oocystis ? ID	diatom C	cluster of green unicells	group of 4 small unicell greens
Trachelomonas (S&C)	clear protozoa like, spikes C	Trachelomonas S&C	Oocystis ?
clear protozoa like, spikes ID	unicellular flagellate (S&C)	Fine Oscillatoria (S&C)	
	microcystis (small clump) S	Pediastrum duplex	
unicellular flagellates (S)	Pediastrum (S)	microcystis (small clump) S	
rotifer (S)	Nodularia hormogonia like		
unicellular greens cluster (S)	Trachelomonas S		
Planktothrix*** (S&C)	Planktothrix *** (S&C)	Planktothrix *** (S&C)	Planktothrix *** (S&C)
Ceratium* (S&C)	Ceratium*** (S&C)	Ceratium (S&C)	Ceratium**C ***S
Trachelomonas (S&C)	Trachelomonas (S)	Trachelomonas *** (S)	Trachelomonas (S)
Euglena (S&C)	Euglena (C)	Tribonema (C)	Euglena (S&C)
diatom (S&C)	diatom (S&C)	diatom (C)	diatom (S&C)
Tribonema (S)	Cryptomonas (C)	Eudorina (C)	Tribonema (S&C)
Cryptomonas (C)	unicellular flagellates	Ankistrodesmus C	Oscillatoria C
	protozoa	Microcystis C	Volvox-type C
		Dicthyosphaerum? (S)	
column ->			
Trachelomonas	Trachelomonas*	Trachelomonas	Trachelomonas
unicellular flagellates (many)	Staurastrum	Chlorella	Chlorella
	unicellular flagellates (many)	Staurastrum	Coelastrum
	Planktothrix	unicellular flagellates (many)	unicellular flagellates (many)
	Micractinium?		
	dinoflagellate		

2021

### Site E

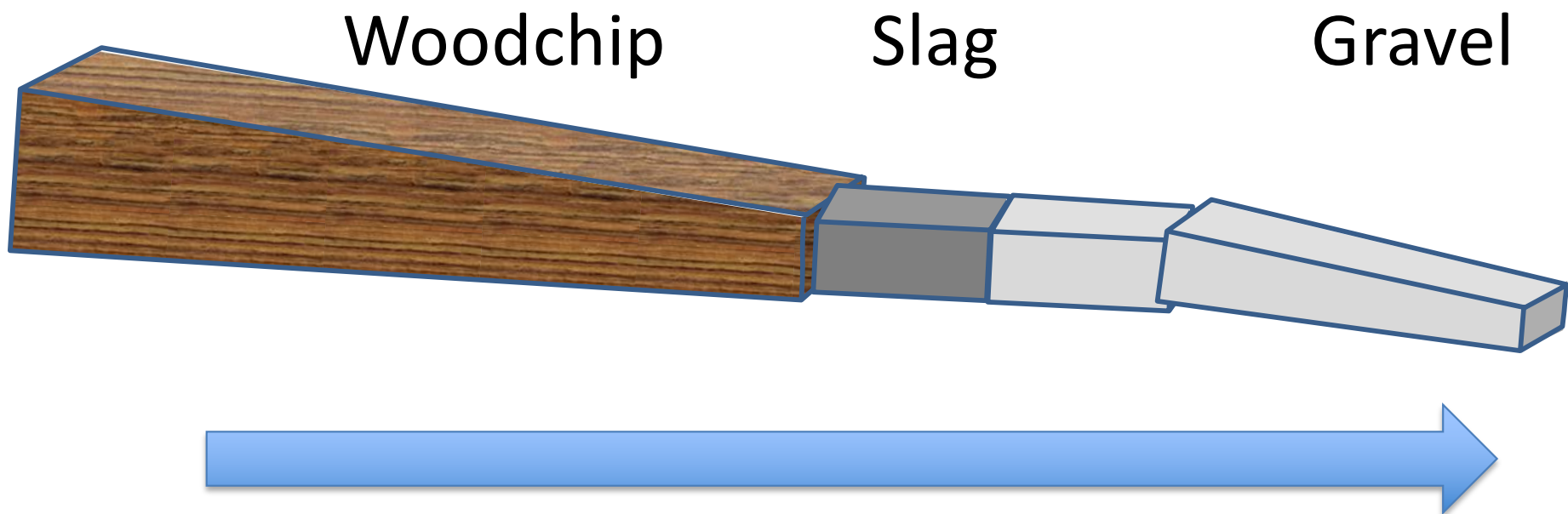
Chl a + Phycocyanin (ug/L) vs ODO





# Shallow Treatment Bed Concept

- 18-24" deep max
- 4 day retention for ~25,000L
- Weirs to direct and manage flow



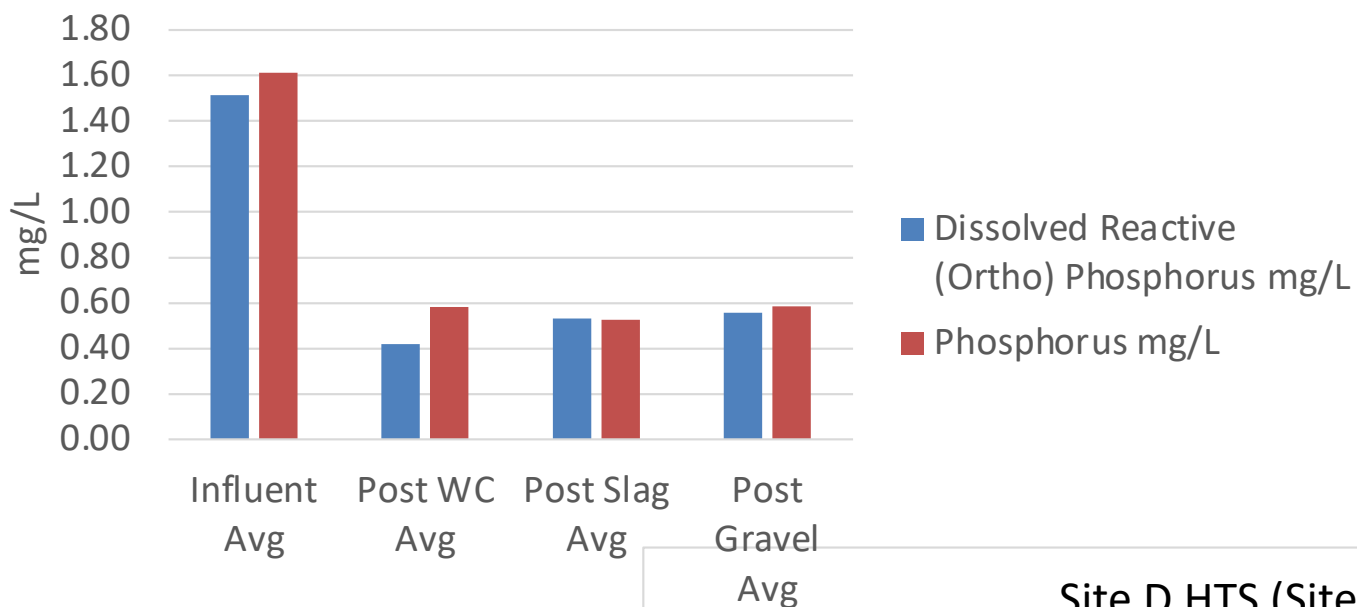




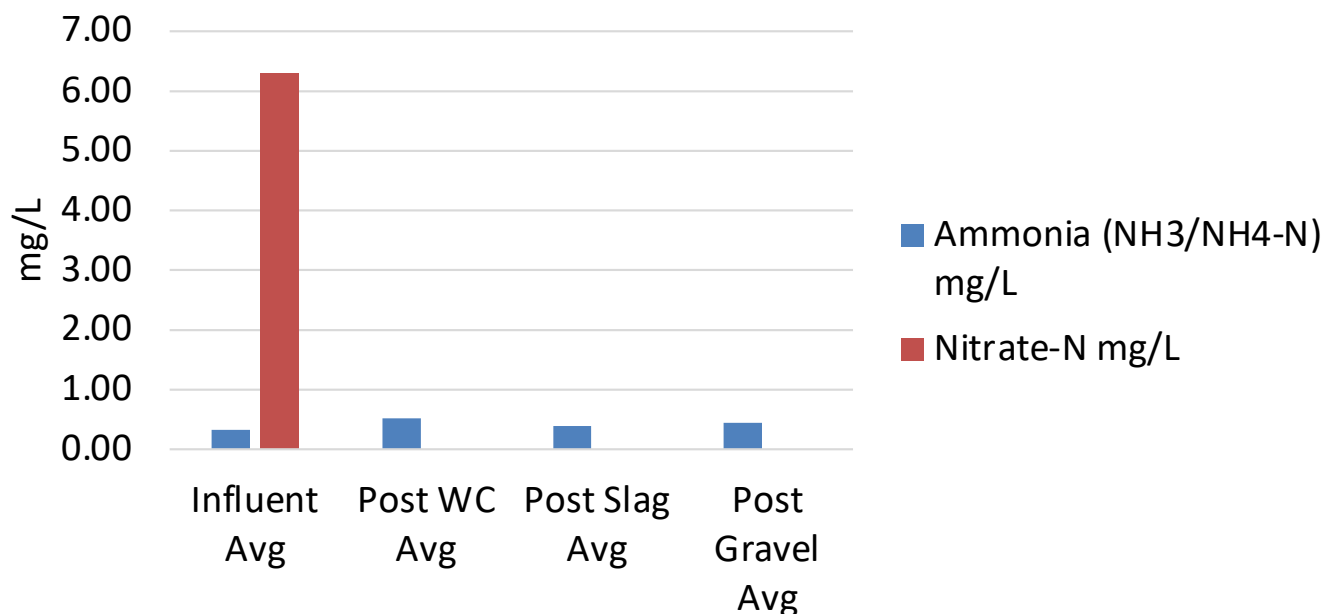


# Site D Pre-Pond Swale Results 2021

Site D HTS (Site D; July-Sept)



Site D HTS (Site D; July-Sept)



# Where does this leave us?

- Factors that cause blooms and poor water quality:

**Light**

**Nutrients**

**Temperature**

- So...how to deal address water quality issues?
  - Limit amount of light – cover (physical or plants)
  - Limit amount of nutrient supply – pre-pond removal, dredging, BMPs for fertilizer use
  - TIME...don't expect instant results!
  - Measure the parameters that tell us the story – Chl *a*, phycocyanin levels, BG/algal populations, phosphatase?

So maybe we do have some answers!





# Work Plan for 2022

- Huge amount of data from 2021/2020/2019 to still work through!
- R or Tableau software analysis
- TAC meetings
- Technical report
- On-farm demo possible?
- Look for a site with 2 matching ponds for more research?!

# Thanks to:

Collaborating Farms

Soil Resource Group

OMAFRA

Landscape Ontario

AAFC

[jwest@phytoserv.com](mailto:jwest@phytoserv.com)

[ahuber@srgresearch.ca](mailto:ahuber@srgresearch.ca)

This project is part of the Accelerating Green Plant Innovation for Environmental and Economic Benefit Cluster and is funded by the Canadian Ornamental Horticulture Alliance (COHA-ACHO) and by the Government of Canada under the Canadian Agricultural Partnership's AgriScience Program.

