<u>Oxidation Ponds</u>

Understanding the risks to reduce the chance of failure

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Introduction

- Oxidation Ponds are a low maintenance and effective way of treating human waste. However as does any ecosystem, they rely on a balance of all parts of the system to function effectively. By understanding the makeup of the ponds we can start to understand and mitigate the risks of failures.
- This presentation looks at the typical algal makeup of our ponds and their limitations along with three different causes of pond failures that we have experienced with our ponds here in the Timaru District.

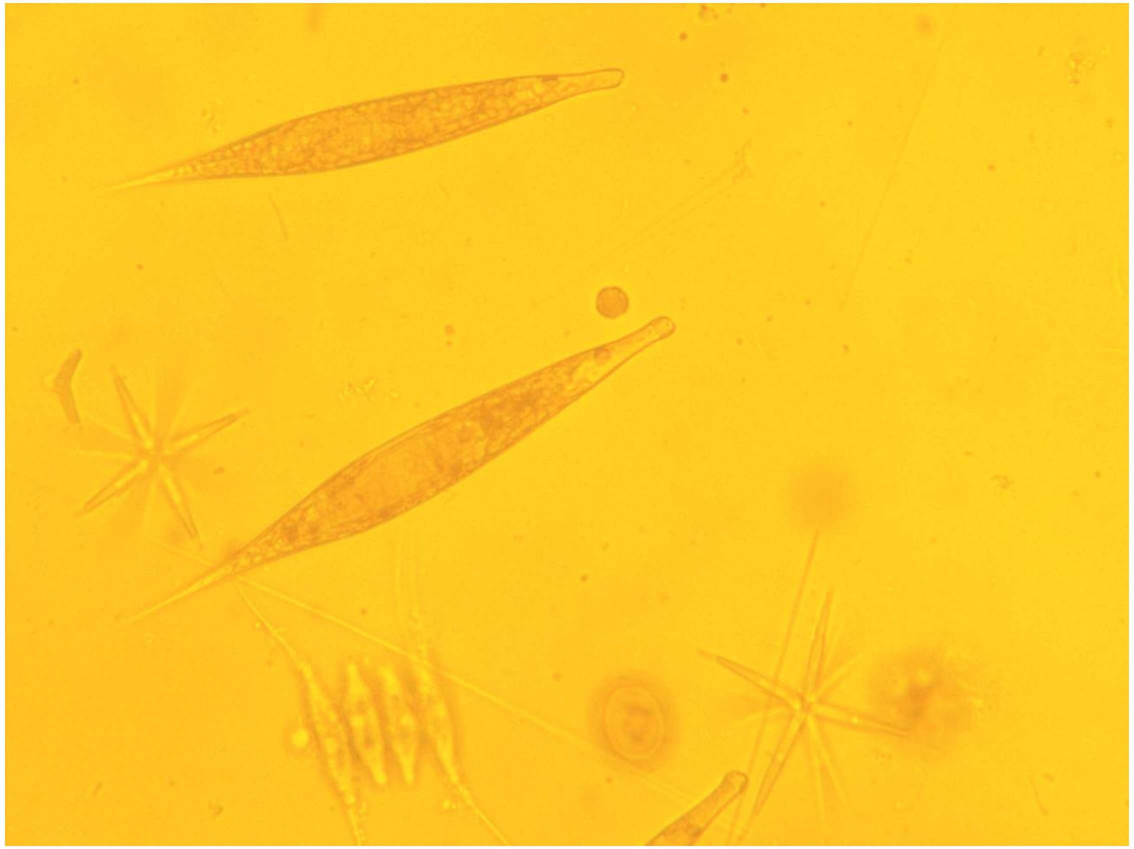
Algal Diversity

- As with many South Island oxidation ponds the predominant algal species in our systems are the various types of Euglena species and Phacus. These are large, high DO producing species which increase the treatment capacity of our ponds but are very easily damaged or destroyed.
- We also have abundant chlorella which are a very small, low DO producing, algae often referred to as a pioneer species. They are often the first algae to reappear when ponds are stripped of their populations and are usually more resilient to adverse conditions including low DO.
- Having diversity in ponds is essential to reduce the effects of natural predation from rotifers and fungal parasitism. Whilst we do have a multitude of different species throughout the year these are the predominant ones that are present most of the time.

The Risks to Euglena

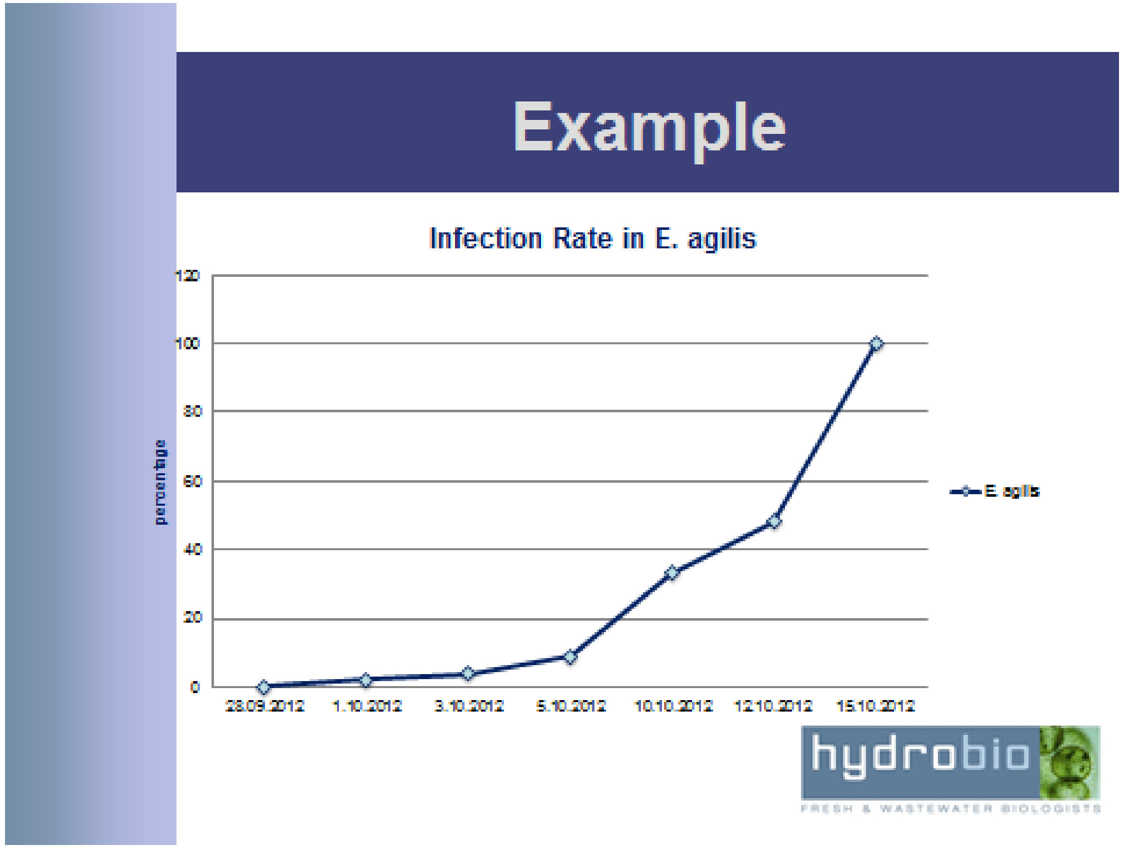
- H2S which is completely toxic to Euglena at 1ppm and can be introduced from industrial sources, first flush of sewer pipes during rain events after periods of hot dry weather or even from the sludge layer during periods of increased sludge activity (usually during very high pond temps over summer).
- Low DO, especially when population sizes reach maximum capacity.
- Temperature, below 10 degC the generation time can be longer than the pond residence time and below 5 degC they can die off completely.
- Fungal Infections, especially during spring and autumn.
- Overloading from industrial providers or toxic shock from industrial tankered loads.

Fungal Infection



Infected *E.acus* cell (lower) with healthy *E.acus* (upper). This is at x400 magnification.

Fungal Infection rates



The graph shows how quickly fungal infection rates can destroy an algal population. From first detection to completely destroyed within a 2 week period. This is why diversity is so important to ensure that the ponds can recover quickly from these events. Whilst we did have a bout of this throughout all of our pond systems this year there was enough diversity to carry them through with the effects lasting less than a week before the other populations had grown to fill the void left by the infected populations.

Date	11/03/19				18/03/19			
PHYTOPLANKTON	P1a	P1b	P2		P1a	P1b	P2	
Chlorella	118,000	3,000			46,000	26,000	42,000	
Ankistrodesmus falcatus	18,000	1,000	20,000		5,000	5,000	18,000	
Scenedesmus spp.					1,000		7,000	
Chlamydomonas					2,000			
Coelastrum			67,000		2,000		57,000	
Dictyosphaerium	2,000						3,000	
Oocystis			1,000					
Actinastrum	15,000		2,000			3,000	9,000	
CYANOPHYCEAE								
Arthrospira / Oscillatoria.	1,000					2,000	3,000	
EUGLENOPHYCEAE								
Euglena texta	1,000	84,000	36,000					
Phacus tortus	6,000	33,000	11,000		29,000	33,000	25,000	
Euglena gracilis							2,000	
Euglena acus	7,000	1,000	6,000		44,000*		3,000	
Euglena polymorpha	2,000	50,000	10,000		1,000	25,000*	8,000	
AHS	7	9	7		7	7	7	
Fungal parasitism %					13%	9%		
Total Cells/ml	170,000	172,000	153,000		130,000	94,000	177,000	

Chart showing the diversity in the Timaru Ponds and the beginnings of fungal infection in a couple of the species present.

Tankered Waste – Toxic Shock

- One of the largest controllable risks to pond networks is toxic shock from industrial loads that have been introduced to the pond networks via Tankered Waste (Vacuum Trucks).
- We have quite a rigid acceptance criteria at our ponds where no waste other than Human domestic waste is accepted. However even the most rigid systems cannot prevent human error which is what we had in this particular pond turnover event.
- In November 2017 a 17000 L holding tank from a local vet was mistakenly discharged via vacuum truck into our domestic system. This holding tank was full of all the sanitised washings of the Vet’s gear and vehicles. At the time there was the bovine issues in South Canterbury and the rules of sanitising between farm visits was stringently adhered to. The primary sanitiser used for this was iodine.

- The discharge travelled down the first primary pond as a cloud and was seen by operators at the time. As it travelled it destroyed all the algae it came in contact with before finally dissipating.
- At the time of the discharge the algal cell count per ml was approximately 214,000, most of which were Euglena gracilis and the pond had an 8/10 algal health rating.
- The next samples were taken 4 days later and showed all of the gracilis population was dead and a small population of chlorella had started to repopulate the pond – Algal health status 1/10.

Timaru Treatment Ponds

Our primary pond system is actually made up of 2 primary ponds running in parallel before combining at the outlet to run through the secondary pond. The infeed to these primary ponds is usually set at a 50/50 split but at the time of this discharge 75% was being diverted to the first pond and only 25% to the second one. This was just pure luck for us as the second primary pond was only partially effected.

After the event

- Recovery time was 3 weeks and during that time the pond was producing objectionable odour.
- Because the second primary pond was only partially effected by the discharge we were able to reduce the influent into the first pond until it recovered.
- The time was recorded that it was seen travelling down the pond and we use WasteTRACK for all loads brought into the treatment plant so we were able to pinpoint the load responsible very quickly.
- As a result of this event we have included a component to the driver induction process to reiterate the importance of knowing what they are picking up and what goes where and why.

Industrial Overloading

- Industrial discharges to pond networks need to be closely monitored and issues detected and dealt with early. Failure to check early enough can result in major pond failures which can take months to recover from.
- We had exactly this happen on one of our smaller pond systems with effects that took almost 8 months to recover from.
- The industry had failed to remove a high strength by-product from its waste stream despite it being identified at the earliest stages of the consenting process.

Within 4 months of this industry commencing discharge into this pond it was completely devoid of any algae and had been taken over by purple anaerobic bacteria which are sulphate bacteria that thrive in anaerobic conditions. These bacteria turned the whole pond pink and in the aerial photo (left) you can see it just as the pond is turning.

Purple Anaerobic Bacteria

Managing the aftermath

- After the Initial turnover all high strength by-product was removed from the waste stream.
- Sodium Nitrate was dosed on a regular basis to help reduce dissolved sulphides and inhibit further sulphide production from the purple bacteria.
- Influent was diverted away from the pond.
- Reseeding was commenced from a healthy pond system once H2S levels reduced.
- We had vacuum trucks on site every week removing any floating sludge to help reduce odour.
- Approximately 8 months later the pond started to recover.

Further issues – secondary loading

- Late last year we had further issues with the pond and it would not recover.
- It was apparent that influent levels had increased again (from increased production)
- Further immediate measures were taken to reduce loadings to the pond with higher strength flushing’s being diverted to our industrial outfall.

Stage	CBOD average	Population equivalents per day
Initial discharge including high strength byproduct	7000g/m3	14,700
Secondary discharge – no byproduct	2144g/m3	4,500
Current Discharge	935g/m3	1,190
Consented limit	600g/m3	430
Current population served		Approx. 4000
Pond capacity		Approx. 5000

The table shows the estimations of loadings based on Population equivalents and test results at each of the stages in this process.

Within a week of implementing the changes that dropped the discharge to 935g/m3 of CBOD the ponds recovered.

Whilst we still haven't quite managed to get to the consent limit yet there are still other changes in the process of being implemented to drop these levels further.

What have we learnt?

- Early detection of loading issues with Industry dischargers is absolutely critical and steps need to be introduced immediately to prevent major failure. Remember industries wont always tell you when they have increased production.
- Education of tankered waste operators and industry suppliers of the ramifications of getting it wrong should be a high focus.
- The effects of natural algal decline from fungal infections can be minimized with good species diversity which can be promoted by not allowing overnight DO levels to drop too far so that the larger species can establish.
- Whilst ponds are generally low maintenance and effective, managing and monitoring influent for changes is paramount especially when there are non-domestic sources involved.

Questions