Improving cold-weather ammonia removal in a northern lagoon with an in-situ, rope-type media system. Case study of a full-scale project.

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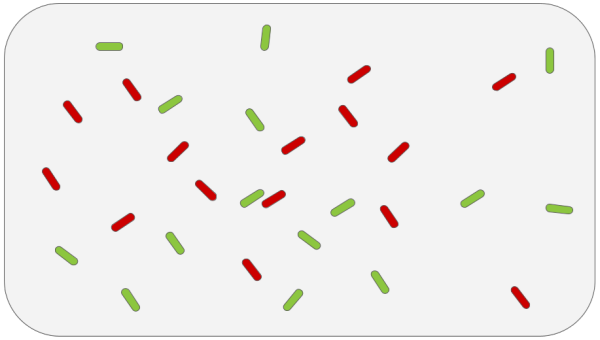
November 6, 2024

BISHOPWATER

Agenda

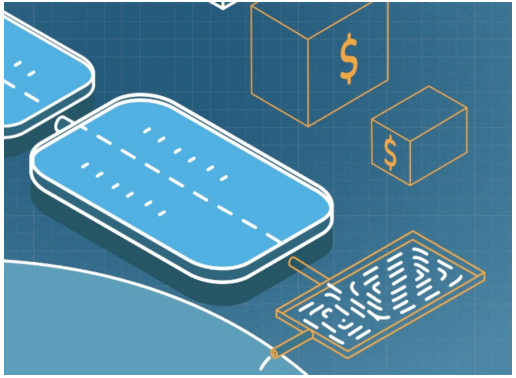
- Biological treatment and cold weather
- BioCord overview
- Full scale pilot project case studies
- Current implementation and commissioning

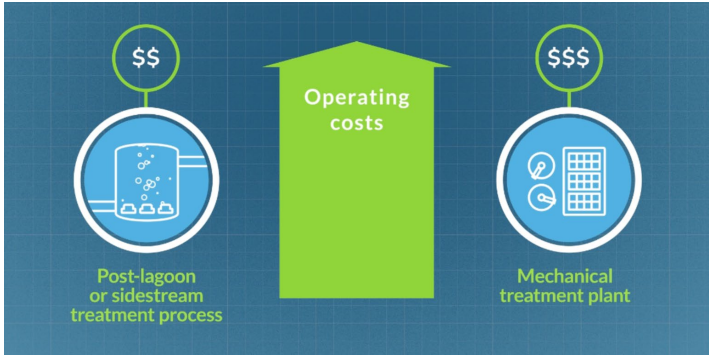
Ammonia and BOD removal declines in cold weather



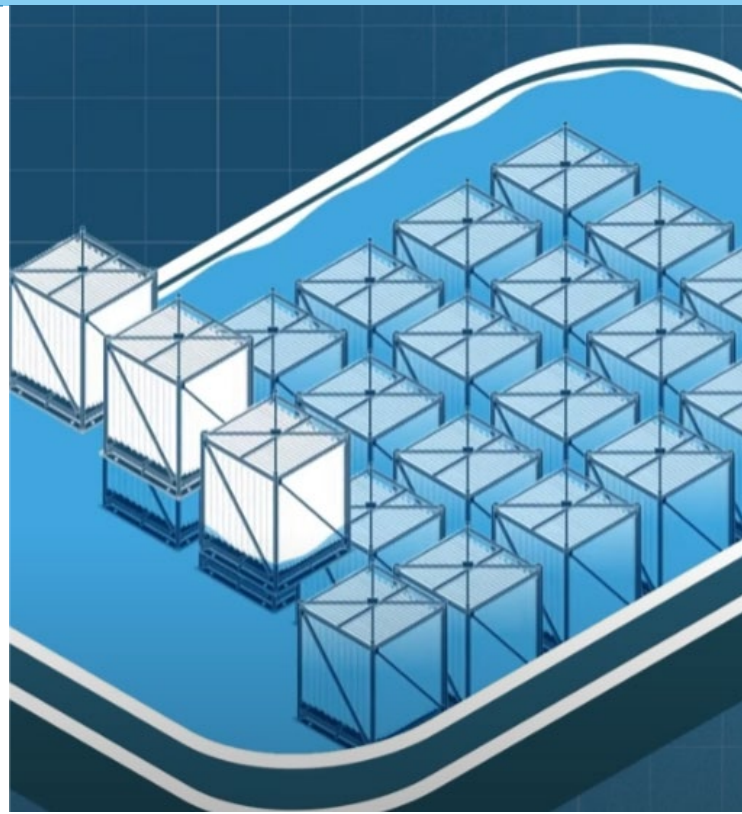
Biological removal of ammonia
and BOD declines
as temperature drops.

Conventional upgrades
add costly, complex processes

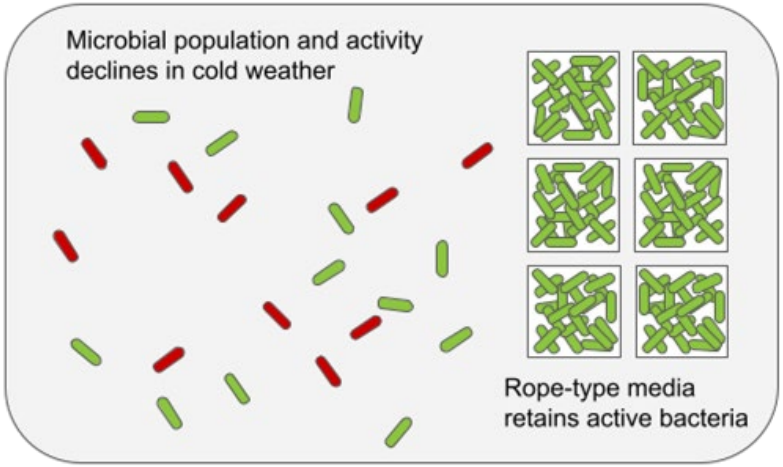




A condominium for bacteria



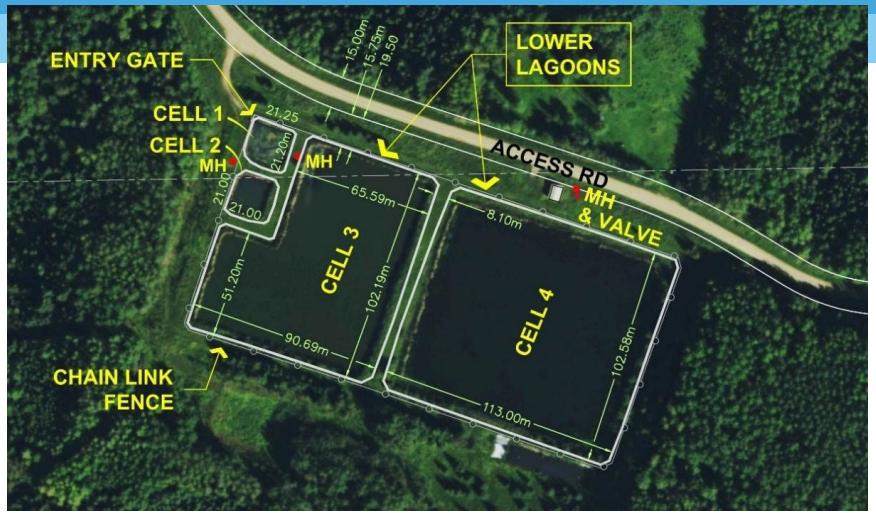
In situ process intensification with rope-type media



Assessing lagoons of Gift Lake Metis Settlement, N. Alberta

- Effluent exceeded WSER limits of < 1 mg/L un-ionized ammonia and < 25 mg/L BOD.
- Lagoon upgrades needed to achieve compliance and handle 2% annual pop'n growth
- Heavy sludge accumulation in Cells 1 and 2 reduced treatment capacity and caused sludge carry-over into Cell 3

TECKERA
civil engineering consultants

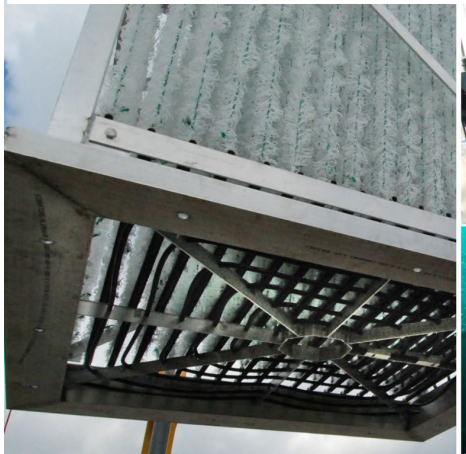


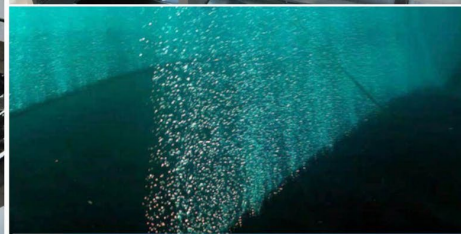
	Flow rate	Cell	Description	Depth (m)	Volume (m^3)	HRT (days)
Lower Lagoon	190 m^3/day	1	Settling/holding (Anaerobic)	2.70	450	2.5
		2	Settling/holding (Anaerobic)	2.70	450	2.5
		3	R-1 Holding	1.50	10,250	55
		4	F-1 Facultative (Retention)	3.40	34,000	180

Depth and volume of Gift Lake lagoons

Rope-type media selected for full-scale demonstration

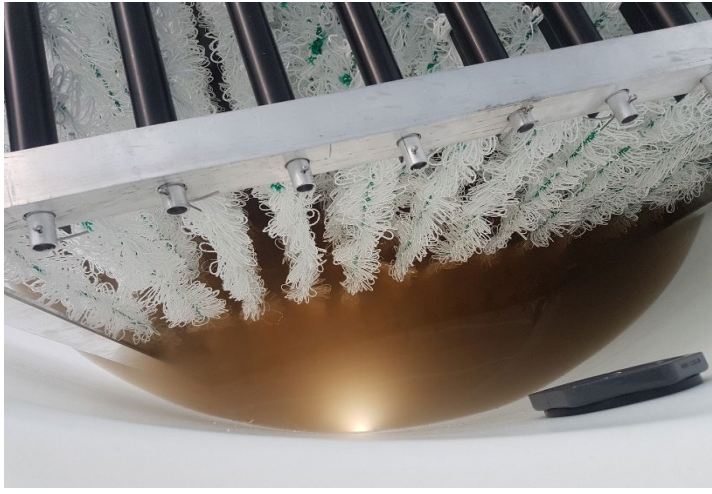
- In situ design lowers capital costs
- Self-regulating, self-cleaning system aligns with lagoon operating procedures
- Low-energy compressors reduce maintenance and operating costs.
- Modular components enable fast, simple expansion
- Reliable removal of ammonia and BOD in cold conditions



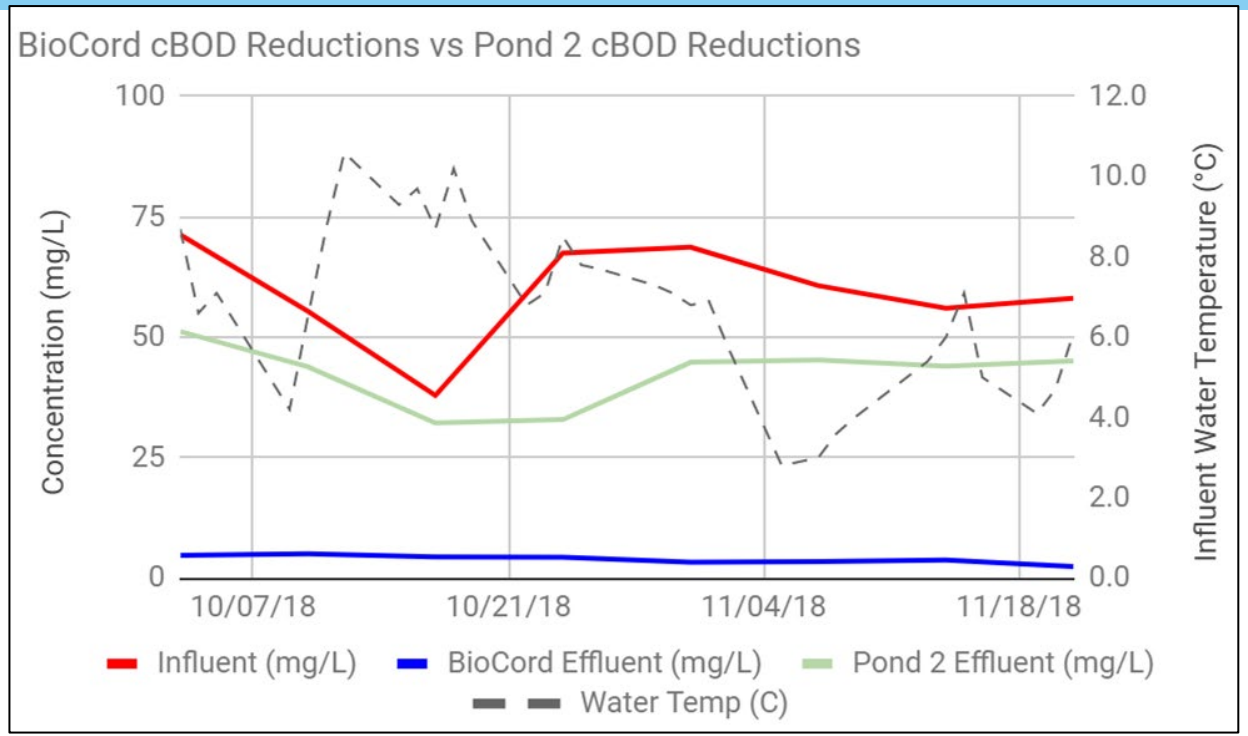


1) Cold-weather pilot study - Petrochemical manufacturing site

- Three-cell lagoon system
- Compare cold-weather performance of BioCord vs. lagoon system
- 14-week study (Aug. - Nov.)
- Second reactor added after five weeks of operation



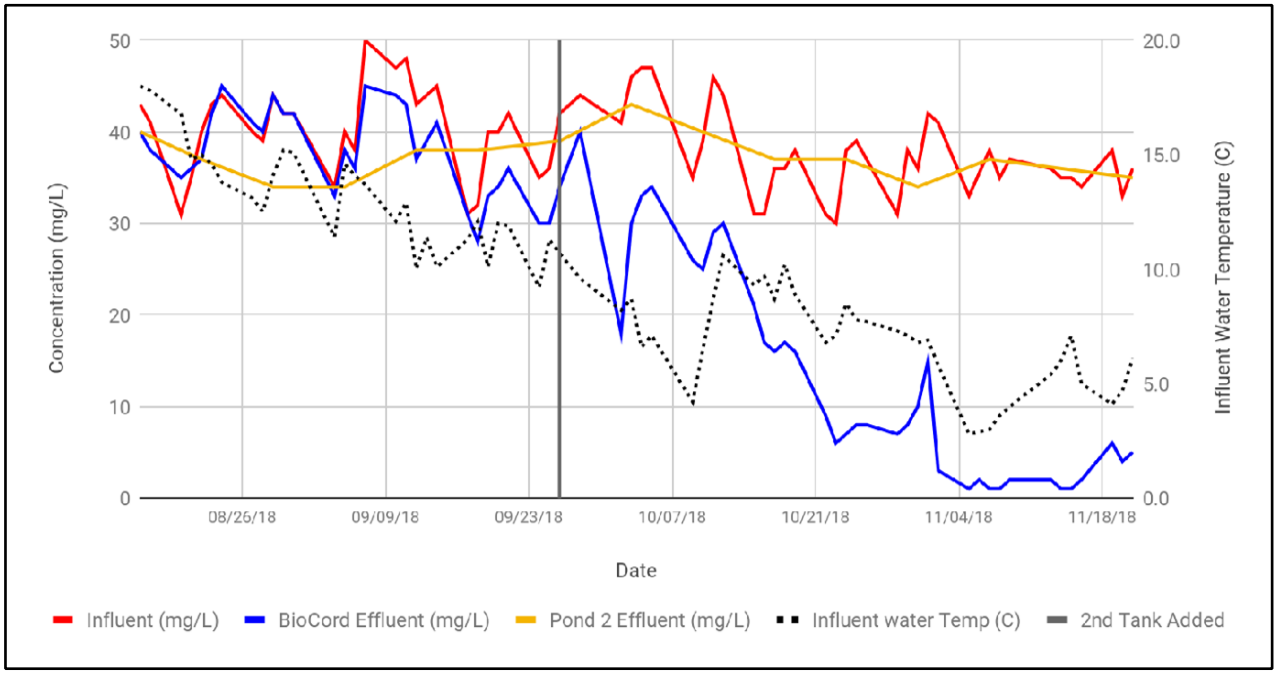
BOD removal - BioCord outperforms lagoon



- BioCord significantly outperformed the lagoon
- BioCord treatment removed **93%** of influent BOD
- Pond 2 treatment removed only **27%** of influent BOD

BOD removal for BioCord vs. Pond 2 (Western Canada)

Ammonia removal - second reactor balances microbial pop'n



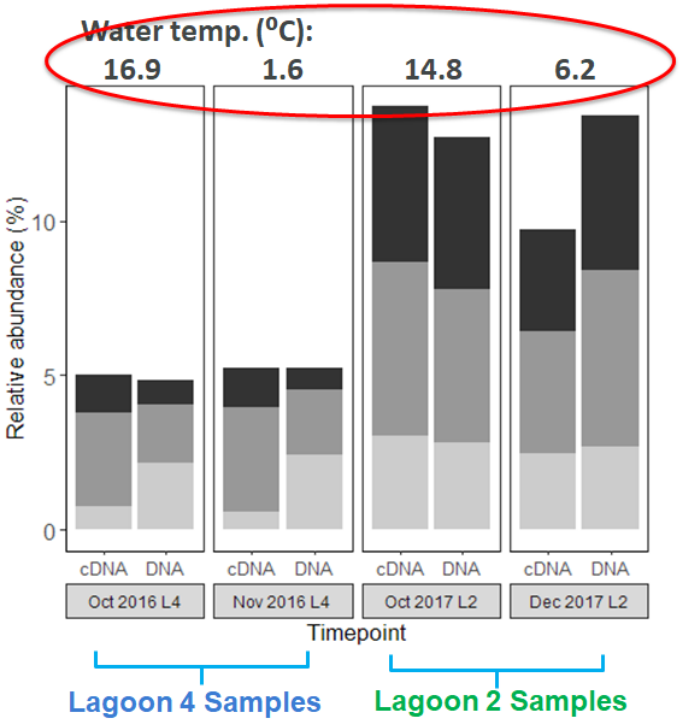
Ammonia removal for BioCord vs. Pond 2 (Western Canada)

- BioCord significantly outperformed the lagoon
- BioCord achieved **67%** ammonia reduction
- Pond 2 treatment achieved only **2%** ammonia reduction

2) Microbial community analysis- Dundalk, ON

- Purpose: identify the microbial community that forms on the BioCord media
- Two-phase study
- Ten reactors installed in Lagoon 4 then cleaned and reinstalled in Lagoon 2
- Wastewater and biofilm samples were collected under warm and cold conditions
- Lab-extracted RNA and DNA identified key community members

DNA and RNA analysis reveals cold-tolerant, nitrifying bacteria



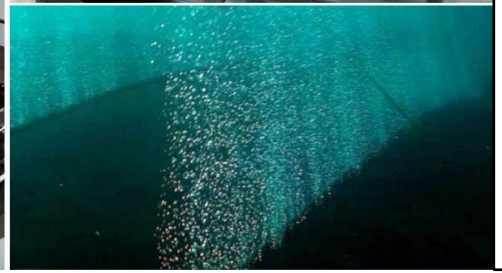
- No significant decrease of nitrifying genera as temperatures decrease

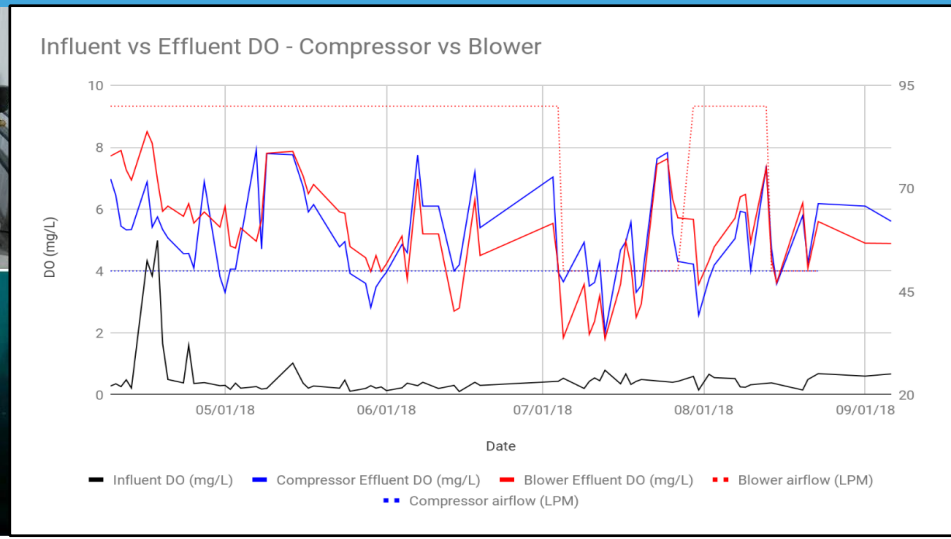
Dominant nitrifier identified in field studies

Genus
- Candidatus Nitrotoga
- Nitrosomonas
- Nitrospira

- Nitrifier abundance rose in Lagoon 2, but not affected by temperature changes in either lagoon
- Candidatus nitrotoga was the dominant species, indicating favorable conditions for biofilm development

BioCord design: Simple, low-energy aeration





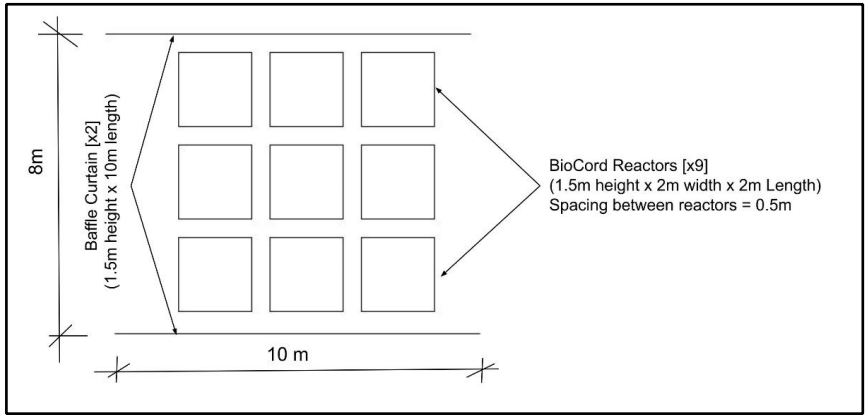
- Fine bubble aeration tubing integrated into the base of reactors (left)
- Air is supplied by ¾ horsepower compressors - one for each reactor
- Efficient oxygen transfer, low-energy usage compared to blower-powered aeration (see graph)
- Low maintenance and oversight

Gift Lake full-scale demonstration and on site system

- Commissioned September 2024
- Sludge removal
- BioCord

	Influent – peak (mg/L)	BioCord effluent target (mg/L)	Removal rate (kg/day)
BOD	35	< 5	5.7
Ammonia	10	≤ 1*	3.857

* Enables unionized ammonia concentration of < 0.1 mg/L to comply with WSER



Gift Lake Full-Scale Project - Funding

- Significant funding provided by the *Federation of Canadian Municipalities Green Municipal Fund, Pilot Projects: Wastewater Systems*
- Provides up to $500,000 to cover up to 50% of eligible project costs.
- Awarded based on evaluation and scoring system

Evaluation and scoring system

Applications for feasibility studies and pilot projects are assessed by an independent peer review committee against these evaluation criteria.

Evaluation Criteria	Points
Expected environmental benefits	25
Links to existing plans and policies	10
Systems approach	10
Community Benefits	5
Innovative practices and technologies — beyond business as usual	10
Replication potential and lessons learned	10
Project management	10
Work plan	10
Budget	10
TOTAL	**100**

GREEN MUNICIPAL FUND / FONDS MUNICIPAL VERT

a program of/ Un programme de la FCM

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Gift Lake full-scale demonstration project - Startup

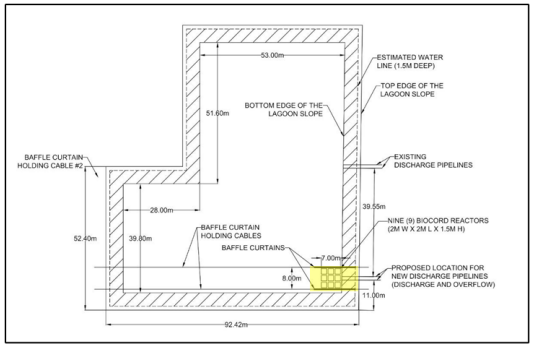
- Start the aeration system
- Collect samples
- Monitor compressor operation and system performance

Gift Lake full-scale demonstration project - Startup

- Steady-state system within 6 - 8 weeks
- Acclimatization should occur prior to cold season
- Biofilm is self-regulating, self-cleaning, responds to changes in loading rates

Compact size, easily expandable

- The treatment cell occupies a footprint of 80 m^2 (total lagoon area is nearly 6,000 m^2)
- Allows for easy expansion for future treatment needs (pre-arranged intervals, or as needed)
- The treatment cell aligns with anticipated population growth and fiscal capacity



Gift Lake Full-Scale Project - Summary

- BioCord Reactors will enhance Gift Lake lagoon system performance
- Evaluated for cold-weather performance
- Benefits include low costs, semi-passive process, proven cold-weather performance, and modular design
- Nine reactors have been installed in Cell 3 to meet WSER discharge limits in cold weather

Full-scale upgrade increases design capacity by more than 2x

- Ontario Municipal Sewage Treatment Lagoon
- Two trains, each with 30 BioCord Reactors
- Design capacity increased from 1,500 m3/day (intermittent discharge) to 3,500 m3/day (continuous discharge)
- CAPEX 50% lower than alternatives

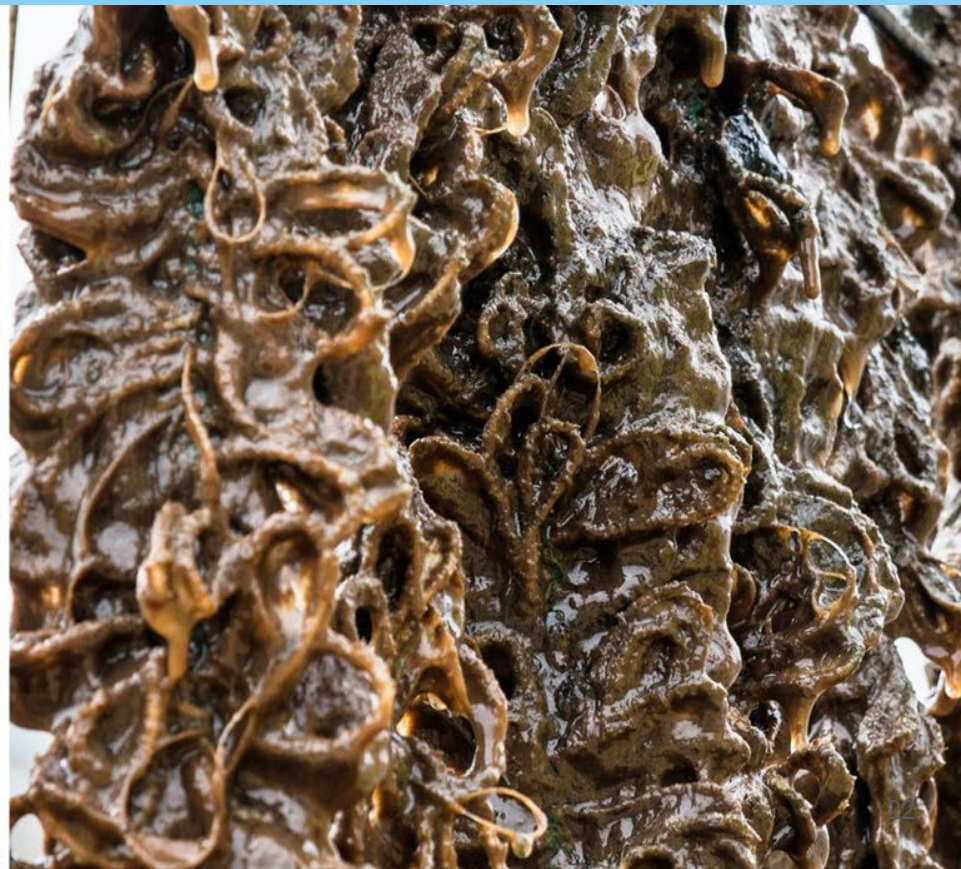
Significant reductions in BOD and ammonia

Date	Effluent flow avg (m^3)	Influent water temp (°C)	Ambient air temp (°C)	$CBOD_5$ (kg/day)	TSS (kg/day)	Total phosphorus (kg/day)	Total ammonia nitrogen (kg/day)	
Limits				17.3 kg/day	17.3 kg/day	1.0 kg/day	3.5 kg/day (May 1 - Oct.31) 17.3 kg/day (Nov. 1 - April 30)	Previous year comparison
June 2023	1,033	14.00	11.25	4.6	12.9	0.3	8.7	1.5
July 2023	1,248	15.95	16.25	3.4	12.2	0.2	8.1	6.5
Aug. 2023	1,352	17.36	12.75	1.1	2.7	0.6	5.3	6.6
Sept. 2023	980	18.04	10.8	0.0	1.2	0.1	7.1	5.8
Oct. 2023	928	17.28	4.4	0.0	3.3	0.1	0.4	2.0
Nov. 2023	1,045	15.13	-5.5	4.4	0.8	0.1	0.4	1.0
Dec. 2023	1,391	12.48	-5	0.0	2.1	0.2	1.2	7.2
Jan. 2024	1,350	8.52	-8.6	0.8	8.6	0.3	1.7	17.8
Feb. 2024	1,209	9.10	-11	3.2	9.3	0.2	0.9	21.9
March 2024	1,625	9.15	-1.5	7.1	19.0	0.3	0.8	31.3
April 2024	1,742	10.28	0.25	0.0	6.3	0.2	0.7	30.8
May 2024	1,534	11.90	9	0.0	1.5	0.1	0.4	8.8
June 2024	1,435	14.80	16.75	1.1	1.1	0.1	1.4	8.7

BioCord commissioning period

BioCord biofilm steady-state

Questions?



Thank you!

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