Innovative, low-energy treatment to remove contaminants from process wastewater and ML/ARD

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Bishop Water

BC MEND ML/ARD
Annual Workshop 2022

BISHOPWATER

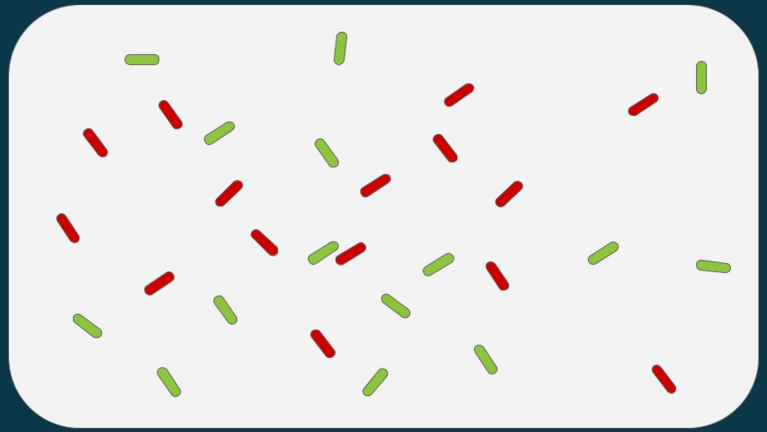
Simple, low-energy solutions for:

Ammonia removal from process wastewater

Treatment via capture and containment of ML/ARD contaminants

Temperature and ammonia treatment

- Cold conditions impair biological activity
- Nitrifying bacteria slow or die
- Ammonia removal declines significantly



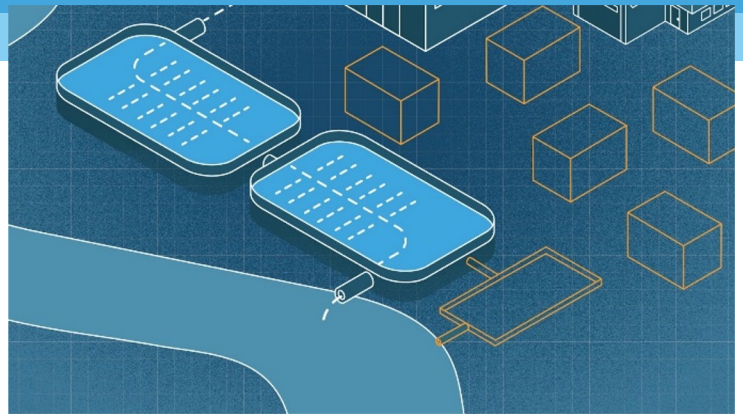
Fixed-film processes offer a solution

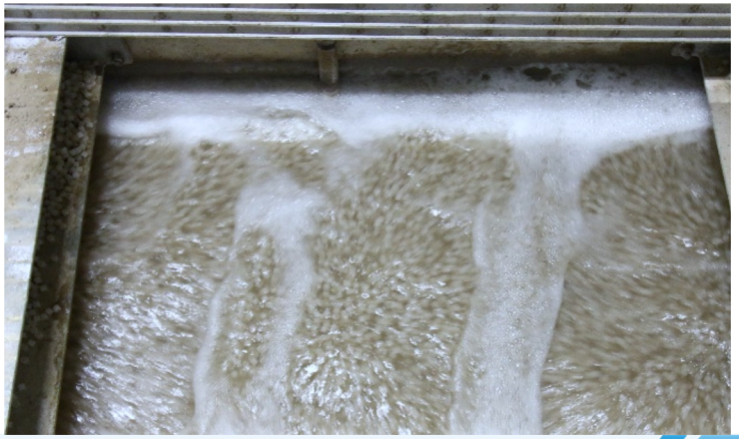
Advantages over conventional activated sludge systems

- Easy to use, handle shock loading, process stability

Disadvantages

- Clogging, excessive biofilm growth, high energy use, poor mixing
- Post-lagoon or sidestream process

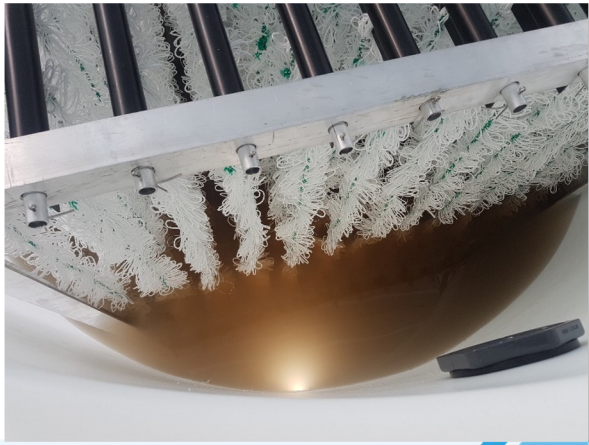




Proving the benefits of rope-type media

Assess ammonia removal at Canadian gold mine

- Treat WW from mill and tailings
- Achieve cold-weather nitrification
- Determine average ammonia removal rates

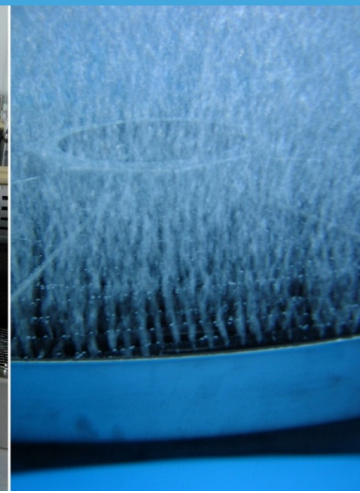


Bishop BioCord™ Reactors

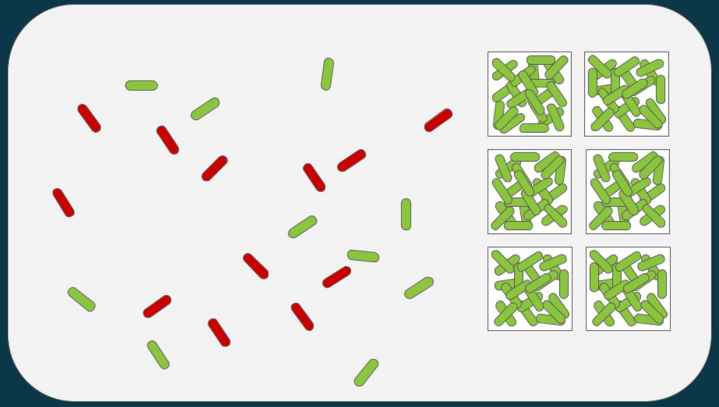
- **Simple, low-energy nutrient removal**
- Installed into treatment pond, no tanks and equipment
- Improves removal of ammonia and organics
- Woven polypropylene loops – high surface area enables robust biofilm

Efficient aeration

- Fine-bubble aeration provides high oxygen transfer
- Low-energy compressors achieve same or better DO as blowers, but with less air and energy

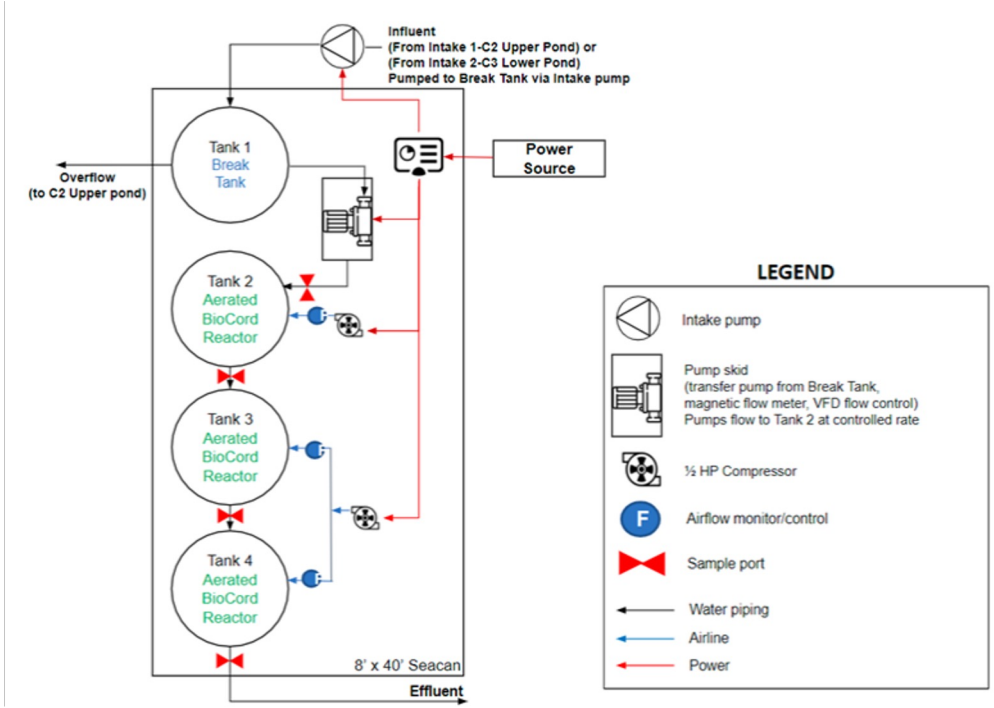


Enhanced cold-weather ammonia removal



Rope-type-media reactors retain a large population of active bacteria

Pilot setup and operation



Escalating treatment challenges

Influent 1 - C2UP (Aug. – Oct.)
Avg. ammonia conc.: 4.83 mg/L
Avg. temp.: 18^{o}C

Influent 2 – C3LP (Oct. – Dec.)
Avg. ammonia conc.: 22.32 mg/L
Avg. temp.: 7 ^{o}C

Wastewater characteristics

Total Ammonia (NH_3/NH_4^+)			Loading (g/day)			
Flow rate (L/min)	Rope-type Media Reactor Influent (mg/L)	Rope-type Media Reactor Effluent (mg/L)	Influent	Effluent	Ammonia Removal (g/day)	Influent Temp (°C)
Intake Point - C2 Upper Pond (Aug 30 - Oct 11, 2021)						
Max	9.10	4.30	128.16	53.28	119.52	21.70
Min	0.70	0.00	5.04	0.00	4.97	14.10
Average	4.83	1.13	49.44	11.67	37.77	17.79
STD	2.69	1.36	32.89	14.26	26.93	1.81
Intake Point - C3 Lower Pond (Oct 12 - Dec 13, 2021)						
Max	32.00	26.10	237.89	208.66	163.73	19.80
Min	9.67	1.15	69.62	8.28	5.18	0.50
Average	22.32	14.51	147.94	92.98	54.96	6.55
STD	5.21	7.36	35.92	45.13	40.48	5.39

Determining performance of rope-type media

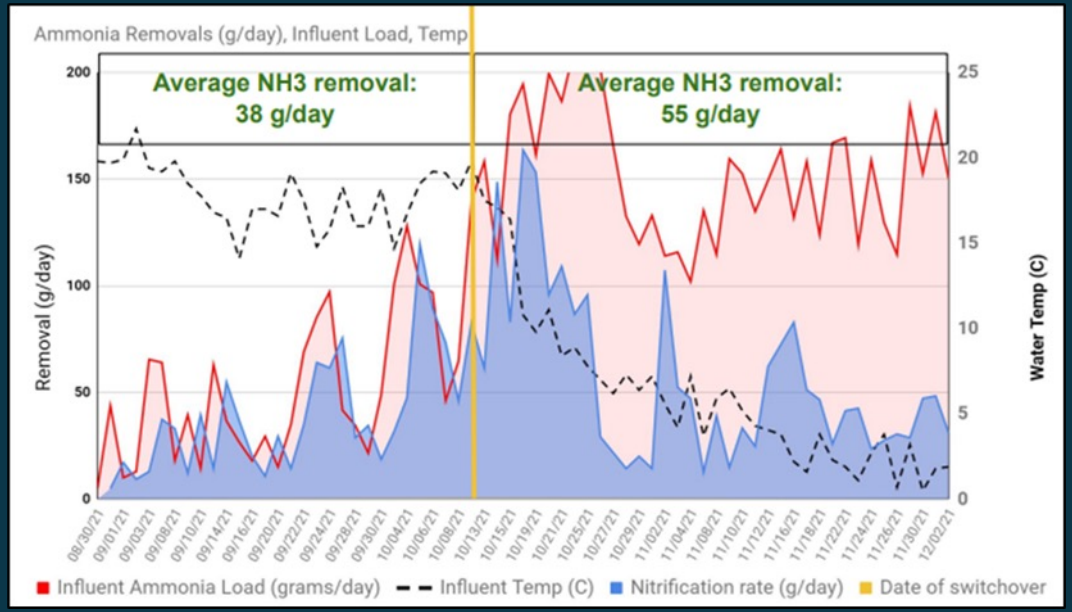
$$\frac{\text{Ammonia removal rate}}{\text{Surface area of rope-type media}} = \text{Surface area removal rate (SARR) } (g/m^2/day)$$

Nitrogen removal influenced by:

- NH_3-N, COD loading
- DO concentration
- Temperature
- pH
- Hydraulic retention time (HRT)

Results

The combined effect of loading and temperature change on ammonia removal by rope-type media.



Results

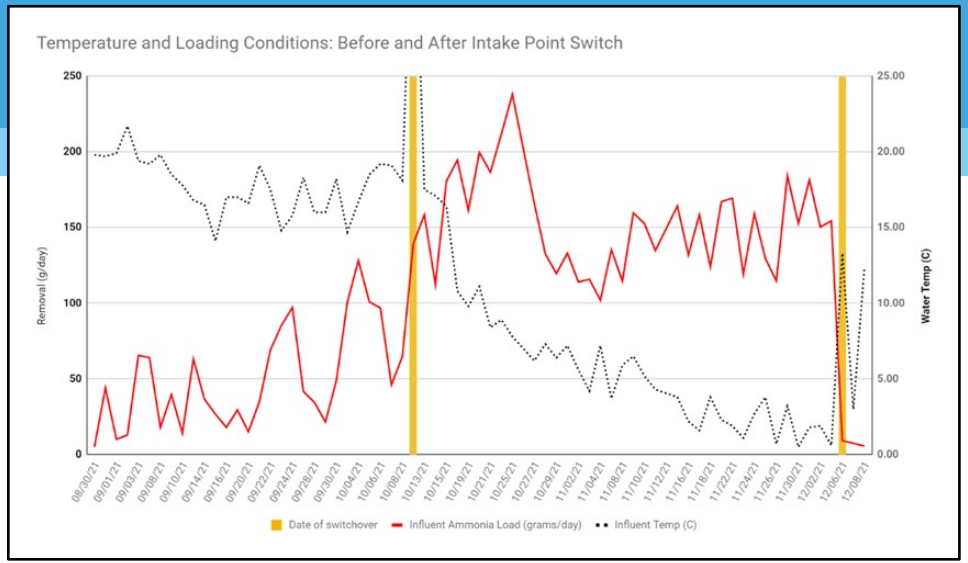
Influent 1

- Avg. removal – 37.77 g/day
- 100% removal (max)

Influent 2

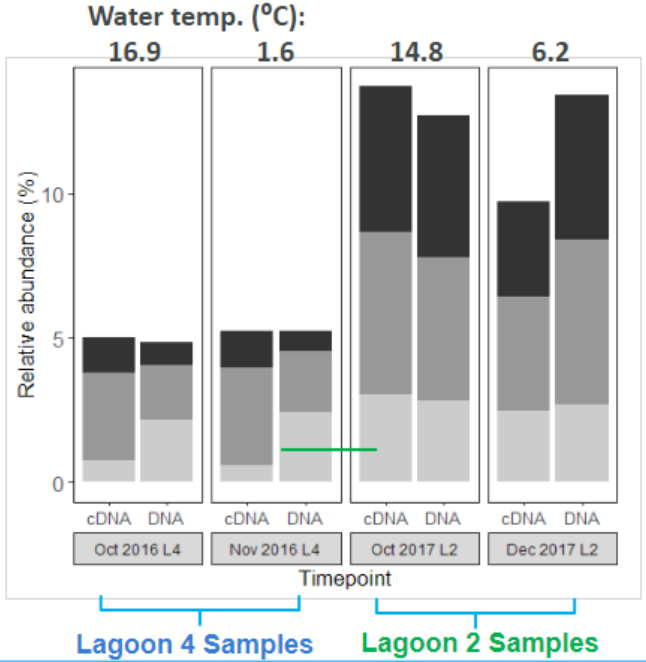
- Avg. removal = 54.96 g/day
- 74% removal (max)

- SARR = 0.21 g/m^2/day
- Loading rate increased
- Mass removed increased
- Longer acclimatization would improve rate of removal



Microbial abundance

FIELD TRIAL RESULTS – LAB TAXONOMY ROPE-TYPE MEDIA



- No significant decrease of nitrifying genera on rope-type media as temperatures decrease

Genus
- Candidatus Nitrotoga
- Nitrosomonas
- Nitrospira

Building Leaders & Making Impact 13

MDMER compliance

MDMER (2021)

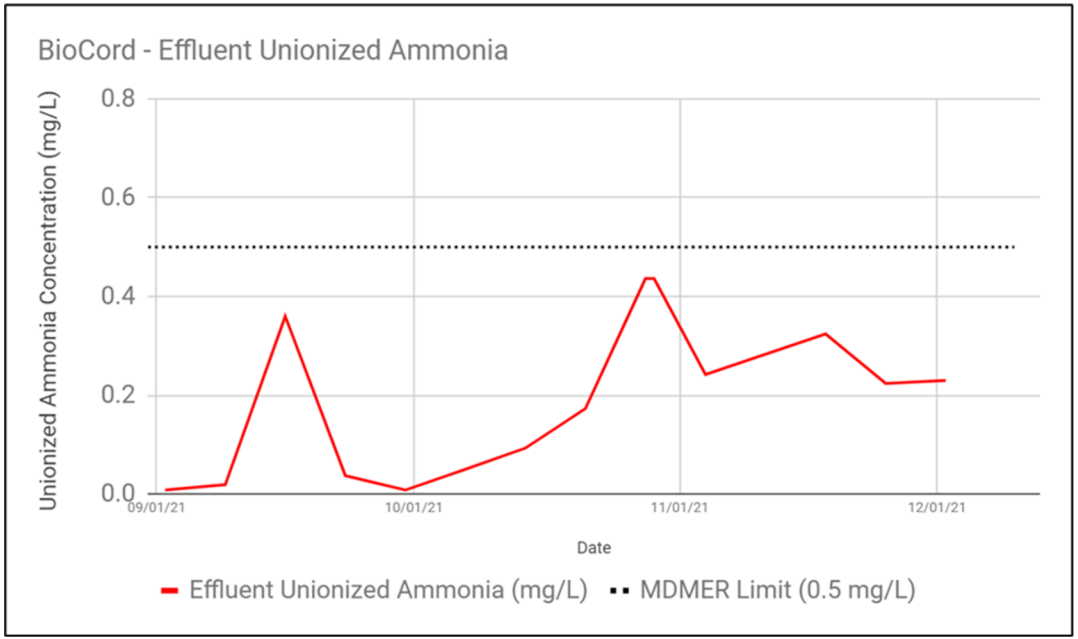
Limit for unionized ammonia: 0.5 mg/L

Influent 1 (C2UP)

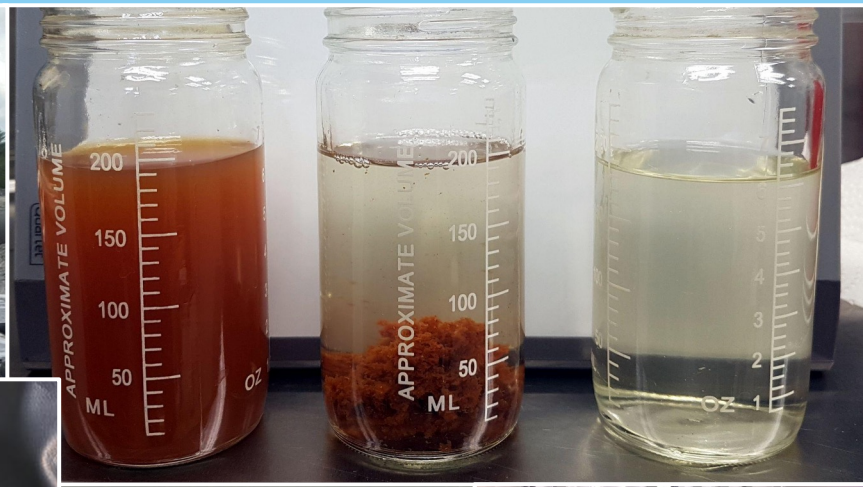
- 0.08 mg/L avg.

Influent 2 (C3LP)

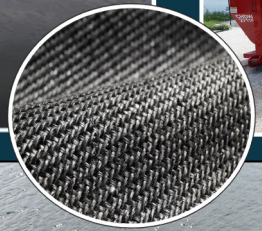
- 0.27 mg/L avg.

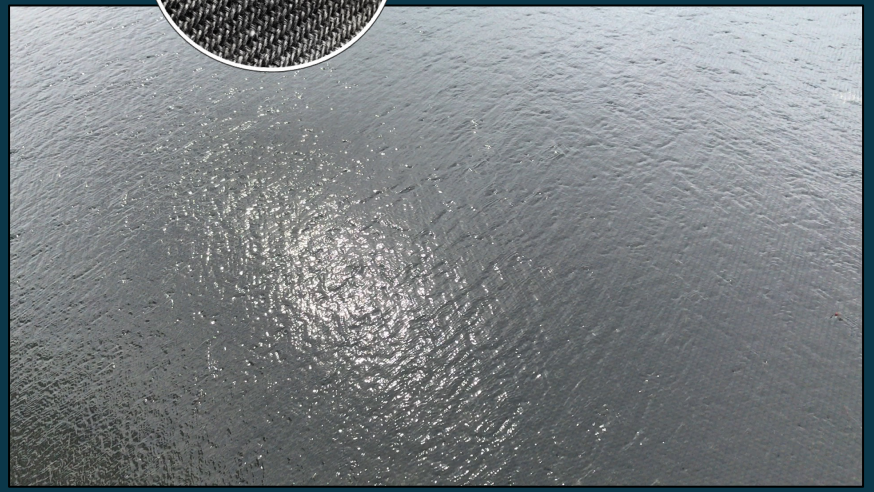


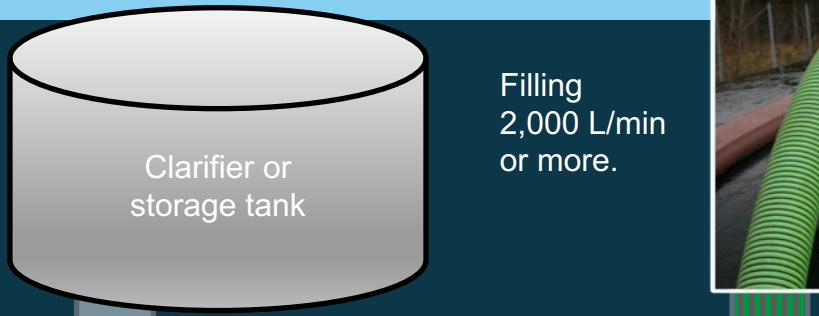
Geotextiles and polymers for ML/ARD sludge mgmt.



Bishop Solids Management Solution





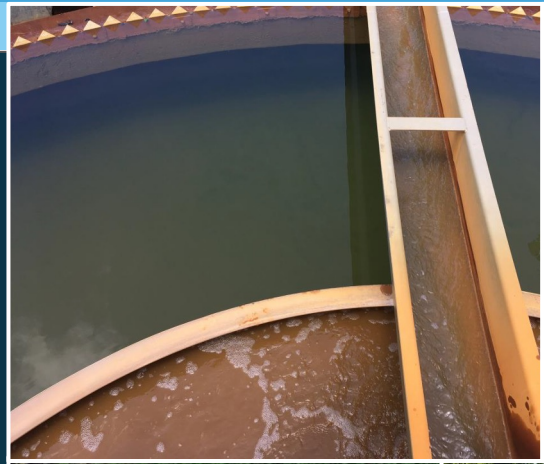


Filling
2,000 L/min
or more.

Polymer activation
and injection

Omega Mine - Morgantown, WV

- ARD sludge continuously pumped to containers
- Cell designed to hold multiple layers
- 20-year capacity
- Geotube units provide containment and filtration



Consistent compliance

- Achieves 45% solids within 7 days; 65% within 30 days
- Operates year round
- No violations, consistently achieves discharge requirements

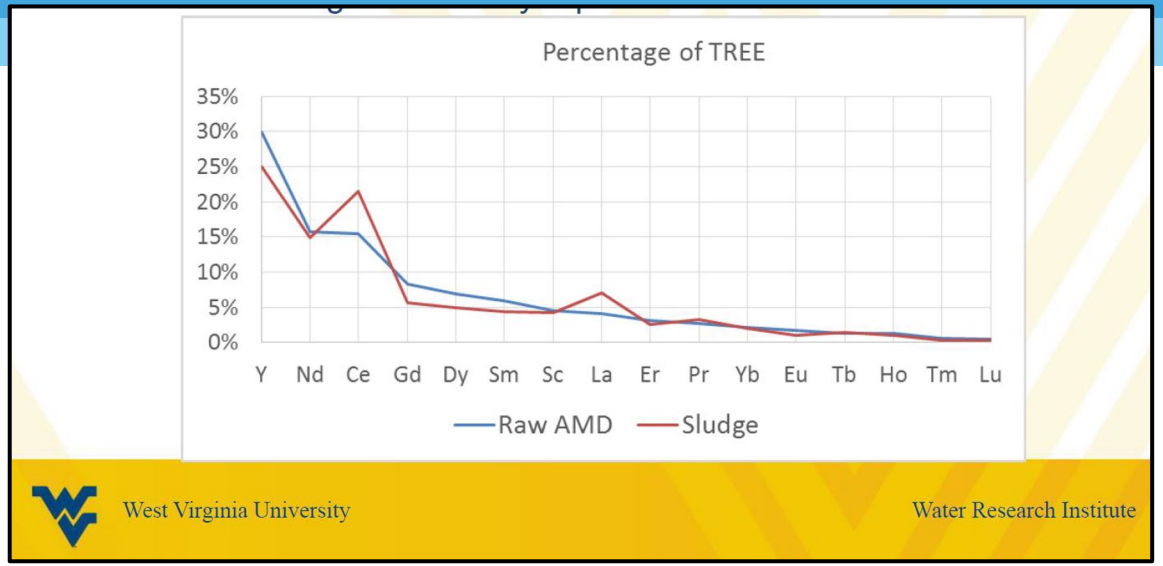
Environmental benefits

Incoming flow rate	46 m^3/hr (200 gpm)
pH range	2.3 – 3.4
Lime adjustment pH	6.0 – 7.5
Heavy metals and sulphate (ppm)	1,985
Allowable discharge limit (ppm)	3.73
General operating discharge (ppm)	< 1.0

Source: West Virginia Department of Environmental Protection

Economic benefits

- Researchers identified high concentration of rare earth elements in AMD sludge
- 397 g/tonne
- 58 kg per container
- 2017 value estimated at $800,000



Arsenic sludge treatment

- Infiltration up to 1,000 L/min, 500 ppb arsenic
- 1,900 L of sludge produced every 45 minutes from MF backwash
- Media filtration could not keep up

Mobile dewatering system

- Bishop Solids Management Solution
- Geotube containers, polymer injection and gravity
- Compact system operates inside mill building
- Geotubes and roll-off bins simplify relocation and storage

Simple, reliable operation

- Dewatering containers, polymer injection and gravity
- Compact system operates inside mill building
- Smaller containers and roll-off bins simplify relocation and storage

Thank you

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