# MEND Update - 2018

Patrick Chevalier and Charlene Hogan
MEND Secretariat
INAP Meeting
27 November, 2018

## Mine Environment Neutral Drainage Program

- Established in 1989 (nearly 30 years old)
- National multi-stakeholder network
- ~$21 million
- Annual research budget:
- $60 to 100K/year
- CanmetMINING provides Secretariat

## MEND Study – In Progress

***In-situ Application of In-pit Treatment for Water Management at Closed Mine Sites: Literature Review and Field Trial***

- Contractor: EcoMetrix
- Research Partners: Goldcorp, McEwen Mining and Envirobay
- In-pit treatment of metals has been used at several mines in Canada
  - Highland Valley Copper, BC
  - Selbaie, Quebec
- Removal of arsenic with ferric sulphate has not yet been applied in situ
- Batch treatment of arsenic and other constituents in an open pit may represent a low-cost alternative to conventional treatment.

## In-Pit Treatment

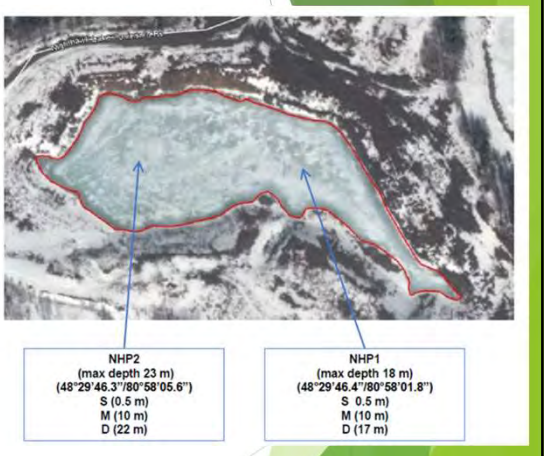
- Study underway at the Nighthawk Pit, ON
  - Volume: 100,000 $m^3$
  - 0.6 mg/L As
- Bench-Scale studies are completed
  - Provided treatment efficiencies, reagent dosage
  - 20:1 molar ratio (Fe:As) to reduce As to 0.05 mg/L

## In-Pit Treatment
## *Field Trial*

- Field study completed mid-November
- Two water cannons used to apply dosage of ferric sulphate
- 10% of the pit volume was recirculated while applying a 20:1 dosage of ferric sulphate in the recirculated water.
- This approach required less time and smaller process equipment that will translate overall to less capital and operating costs when scaled to larger pits.

## In-Pit Treatment
## *Next Steps*

- Waiting on laboratory results post-treatment
- Ongoing monitoring campaign
  - Goldcorp to sample profiles within the pit quarterly (2 Locations)
  - Will help to ascertain performance and batch frequency required based on the ongoing loadings to the pit.
- Sludge stability test work suggested as part of this follow-up as the treatment solids settle.



# MEND - Completed Project

*How to Assess Potential Biological Effects of Subaqueous Disposal of Mine Tailings: Literature Review and Recommended Tools and Methodologies* (MEND 2.19.1)

Authors: Dr. Peter Campbell, Institut national de la recherche scientifique
Dr. W.A. Price, CanmetMINING, NRCan

Report provides update on previous literature reviews on biological aspects of SAD

- MEND 2.12.1a (1993) and MEND 2.11.2b (2009)

Information provided on:

- potential diagenetic changes in submerged tailings
- biogeochemical interactions between submerged tailings and overlying aquatic communities
- guidance regarding recommended tools and methodologies that could be used to predict and/or monitor the biological effects of submerged tailings.
- Now Available on the MEND website

# MEND Report 2.19.1: Potential Biological Effects of SAD

Background:

- Most studies have focused on the initial physical and geochemical performance of SAD facilities and the resulting chemistry of the surface water.
- Longer-term aspects are not well known
  - i.e. progressive addition of natural organic matter on top of tailings
- Major gaps
  - biological colonization of these facilities,
  - health of the established biological communities
  - influence of those communities on water and sediment geochemistry.

8

## Elements considered in review

- Cationic trace elements
  - Cd, Cu, Pb, Ni, Zn
  - Data-rich
  - Covered in previous reports
- Trace elements that form oxyanions and neutral polyhydroxy species:
  - As, Mo, Sb, Se
  - Not considered in previous reports

9

## Approach

Studies on natural water bodies with elevated metal concentrations examined to understand behaviour of SAD facilities.

- Consider how **waterborne** and **diet-borne** metals interact with living organisms.
- Propose how to assess metal bioavailability in sediments and in submerged tailings.

10

## How to assess metal "bioavailability"

- Geochemical approach
  - measure or calculate the free metal ion concentration in overlying water and submerged tailings
  - apply Biotic Ligand Model
- Biomonitoring approach
  - passive biomonitoring (compare indigenous fauna and flora with reference specimens)
  - active biomonitoring (introduce 'naïve' plants and animals into SAD facility and monitor their performance)

## Biomonitors – Examples of Selection Criteria

| Criterion | Explanation |
|---|---|
| associated with sediments | (none needed!) |
| limited home range (sedentary) | bioaccumulated metal related to a specific location |
| widespread (cosmopolitan) | ease of comparison of the biomonitor species among different sites |
| abundant (not threatened species) | sample collection will not affect species abundance |
| metal-tolerant | biomonitor species must be present in metal-rich environments or survive when introduced there |

12

# Examples of biomonitors

| Type | Species | Metals |
|---|---|---|
| Benthic invertebrates | *Pyganodon grandis* | Cd, Cu, Ni, Pb, Zn |
| | *Physa gyrina* | Cu, Ni, Pb |
| | *Chaoborus sp.* | Cd, Ni, Se |
| | *Hexagenia limbata* | Cd, Hg |
| | *Hyalella sp.* | As, Cu, Ni, Sb, Se, … |
| Benthic feeding fish | *Perca flavescens* | Cd, Cu, Ni |
| | *Catostomus commersonni* | Cd, Cu, Hg, Se |
| Rooted aquatic plants | *Nuphar variegatum* | Cu, Zn |
| | *Vallinsneria americana* | Cd, Cu, Ni, Pb, Zn |
| Periphyton | - | Cd, Cu, Mn, Ni, Pb, Zn |

13

# Recommendations (1)

- Coordinated geochemical and biological measurements; phased approach
- Standardized methodologies (cf. AETE)
- Field trails for methods recommended for use in SAD facilities
- Focus on approaches that will yield estimates of free metal ion concentrations
- In the tailings, focus on upper strata (contact zone with benthic fauna and flora)
- Measure pore-water composition at different depths (fluxes across interface; biogeochemical processes governing contaminant mobility)

14

## Recommendations (2)

- Within tailings, measure solid phases exerting geochemical controls on pore-water metal/oxyanion concentrations, and pH.
- Biomonitoring focus on plants and animals (i) in direct contact with the bottom sediments/tailings and (ii) for which there are already some biomonitoring data (in Canada)
- When feasible (e.g., in multicellular biomonitor organisms), focus on specific organs or tissues (e.g., liver, gills, gonads; roots, stems, leaves) rather than on the whole biomonitor organism

15

## MEND – Future Work – Field Study

- Ecology of Subaqueous Tailings Storage Facility at Louvicourt
- Campbell & Price report to provide guidance on methodologies and tools to be used to assess biological effects of submerged tailings

## Ecology of Subaqueous Tailings Storage Facility at Louvicourt

Field Study: To increase understanding of natural colonization of TSF

- Assess diversity and productivity of established flora and fauna
- Examine relationship between these communities and the sediment/water chemistry

Two stages:

1. Reconnaissance study to establish existence of vegetative growth and its spatial extent
2. Field study


## Ecology of Subaqueous Tailings Storage Facility at Louvicourt

Reconnaissance Study (Spring 2019)

- Surface area TSF, 0.9 $km^2$
- Bathymetric study
- Extent of coverage by submerged and emergent aquatic vegetation
- Identification of aquatic plants
- Document other relevant flora and fauna

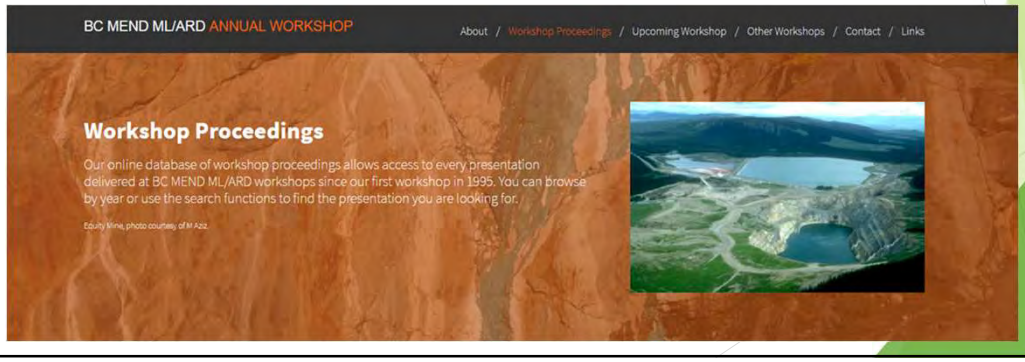
**Go or No-Go Decision (Spring 2019)**

Field Study (Summer-Fall-Winter 2019/2020)

# BC-MEND ML/ARD Workshop Proceedings

www.bc-mlard.ca

25th BC-MEND Workshop Proceeding to be posted in Spring 2019




# Canadian Green Mining Innovation Network

Developed to

- Improve organization and communication
- Optimize available resources
- Build a culture of innovation

https://ami-aim.ca

MEND now part of this digital network


# For more Information

- To download reports, newsletters, or workshop proceedings please visit:

  Mine Environment Neutral Drainage (MEND)
  www.mend-nedem.org

Contacts:

| MEND Secretariat | |
|---|---|
| Patrick Chevalier | Charlene Hogan |
| Patrick.Chevalier@canada.ca | Charlene.Hogan@canada.ca |
| 613-992-4105 | 613-996-7855 |