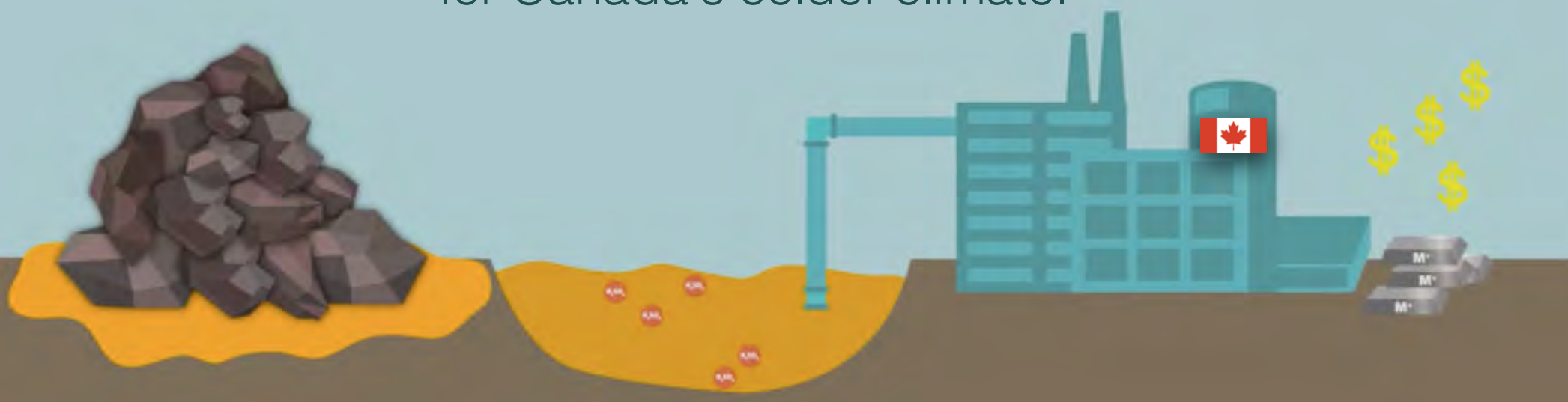


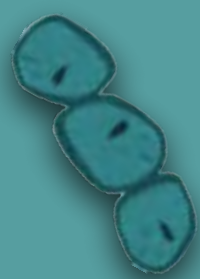
Passive mine waste treatment methods are important as low-cost solutions to extract metals and also remediate these materials and reduce impacts on the environment. We must work to adapt these for Canada's colder climate.



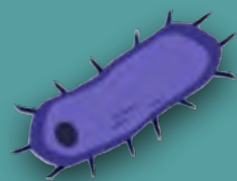
## OBJECTIVES



Identify cold-adapted microbial communities for cold temperature bioleaching processes.



Identify microbial communities for neutral pH bioleaching, and under anoxic conditions

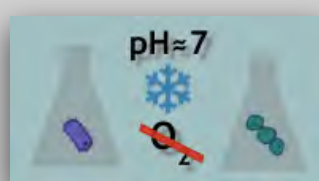


Scale up bench processes to field trials for cold Canadian climates

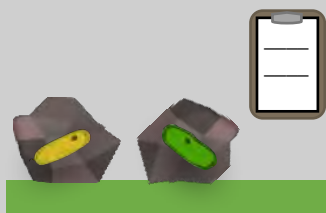


Understand stability of organic covers over tailings materials

## METHODS



Lab microcosm and column experiments to assess the bioleaching potential under cold and neutral pH conditions



Field bioleaching and passivation experiments for waste rock with Vale



Lab scale bioleaching under anoxic conditions to extract metals without sulfur mobilization



Field testing stability of organic covers on tailings following 5+ years of field applications

## DELIVERABLES FOR INDUSTRY

The following deliverables and SOPs will feed into the development of passive technologies in cold climates through Life Cycle Assessments

- ▶ Laboratory and field scale optimization for reductive/anaerobic, acidic or near-neutral, and cold temperature bioleaching processes (Process rates, microbial cultures, Standard Operating Procedures).
- ▶ Field-based optimization strategies for enhancing stability of stabilization or treatment with organic amendments for tailings or waste rock materials. (Process rates, microbial cultures, Standard Operating Procedures)

Year 1

Year 2

Year 3

Year 4/5



## Process 2 Passive Bioleaching

Weathered Zones with  
Metal Accumulation

Low Sulfur Waste  
Rock and Tailings

Evaluate reductive processes to extract valuable components from altered (oxidized) zones of mine-waste disposal areas at laboratory scale

Evaluate reductive processes to extract valuable components from altered (oxidized) zones of mine-waste disposal areas at mine-waste disposal sites

Deploy SOPs and guidance tools to facilitate implementation of technologies to stabilize mine-waste disposal sites

Analysis of the bioleaching potential of low concentration tailings and waste rock under low temperatures (natural to low pH) at laboratory scale

Analysis of the bioleaching potential of low concentration tailings and waste rock under low temperatures (natural to low pH) at field scale

Deploy standard operating procedures (SOP) and guidance tools to facilitate implementation of technologies to stabilize low sulfur waste rocks and tailings

Enabling Technologies

Enrich and adapt microbial cultures that can perform S (and Fe) oxidation at higher rates under cold (<10 oC) temperatures

Enrich dissimilatory iron-reducers for reductive dissolution of weathered (i.e. oxidized) materials and release of base metals

Database for all process, operational, analytical, and microbiome data

Novel bioprocess modelling and control approaches

Techno-economic impact evaluation and LCA of Process 1

