Mirarco
MINING INNOVATION

THE CENTRE FOR MINE WASTE BIOTECHNOLOGY

March 2023

STILETTO

INTRODUCING

THE CENTRE FOR MINE WASTE BIOTECHNOLOGY

The Mining Innovation, Rehabilitation, and Applied Research Corporation (MIRARCO) is spearheading the development of a new Centre for Mine Waste Biotechnology ("the Centre").

Located in proximity to active mines and legacy waste sites in Sudbury, Ontario, the Centre will provide a development and testing site where large samples of waste materials can be brought for pre-processing and treatment.

With the Centre's state-of-the-art facility and niche technical and business expertise, emerging mine waste biotechnologies will be optimized and ready to implement ***in-situ*** at mine sites. Access to this scale of research is crucial in bridging the bench-to-market gap.

The Centre will respond to the urgent need for innovative solutions that transform mine waste from an environmental hazard and costly liability, to an economic opportunity through sustainable mine waste strategies.

As critical minerals become more scarce and methods to extract them become more costly, it is vital to bring new mining technologies to market to improve economic and environmental outcomes.

The Centre for Mine Waste Biotechnology will be a pilot-scale facility equipped with tools and expertise to accelerate the commercialization of bioleaching and bioremediation technologies to extract critical minerals from waste while rendering it environmentally benign.

THE OPPORTUNITY

Canada needs critical minerals to support its transition to a low-carbon economy. It also faces significant environmental and financial liabilities associated with traditional mining practices.

Our mining industry would benefit from the commercial advantage of technologies for value recovery and stabilization/repurposing of waste. Mining biotechnologies (including bioleaching and bioremediation offer innovative solutions to these challenges.

ENVIRONMENTAL IMPACTS

200 ACTIVE MINES[1] | and approximately **10,000 abandoned mines**[2] in Canada present the single largest source of waste produced by any natural resources industry

OVER **650.0 MILLION TONNES**
of mine waste are deposited by the Canadian mining industry yearly[3,4]

FOR MOST BASE METALS
20.0-200.0 TONNES OF SOLID WASTE ARE GENERATED
for every tonne of metal extracted[5]

70.0%
OF CANADIAN MINES
report a substantial environmental risk[6]

FINANCIAL LIABILITIES

APPROXIMATELY
$10.0 BILLION
in liability costs are associated with ongoing treatment of mine wastes[7]

MORE THAN
$5.7 BILLION
in unsecured government liability costs are associated with contaminated mine sites in Canada[8]

OVER
$1.8 BILLION
in government liability costs are associated with Ontario's contaminated mine sites[9]

FINANCIAL OPPORTUNITIES

$8.0-10.0 BILLION
worth of nickel is contained in waste from nickel mining in Sudbury region[10]

$10.0 BILLION
in estimated value is stored in Canada's gold mine waste[11]

$2.4 TRILLION
worth of copper is contained in mine waste globally[12]

OVER **$2.0 BILLION**
in mineral value is held in Alberta oil sands tailings[13]

DEMAND FOR
BATTERIES | **is expected to triple** the available supply by 2030[14]

CORE ACTIVITIES

The Centre will accelerate the development, commercialization, and regulatory uptake of alternative green technologies in mine waste treatment by providing crucial infrastructure and expertise in three critical areas:

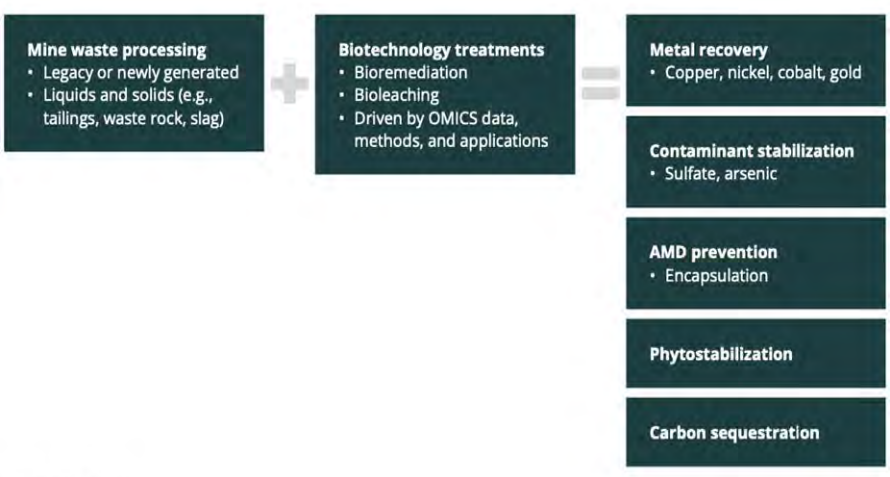
- Process and scale-up from bench to pilot
- Commercialization, de-risking, adoption, and implementation
- Highly-qualified personnel (HQP) training

CENTRE GOALS AND ACTIVITIES

MISSION
With pilot-scale facilities and world-class expertise, the Centre develops biotechnologies for use in real-world sites to improve the environmental and economic sustainability of mining and related sectors.

VISION
The Centre is a catalyst for transforming bench mine waste biotechnologies into commerical applications.

TARGET PROCESSES AND OUTPUTS



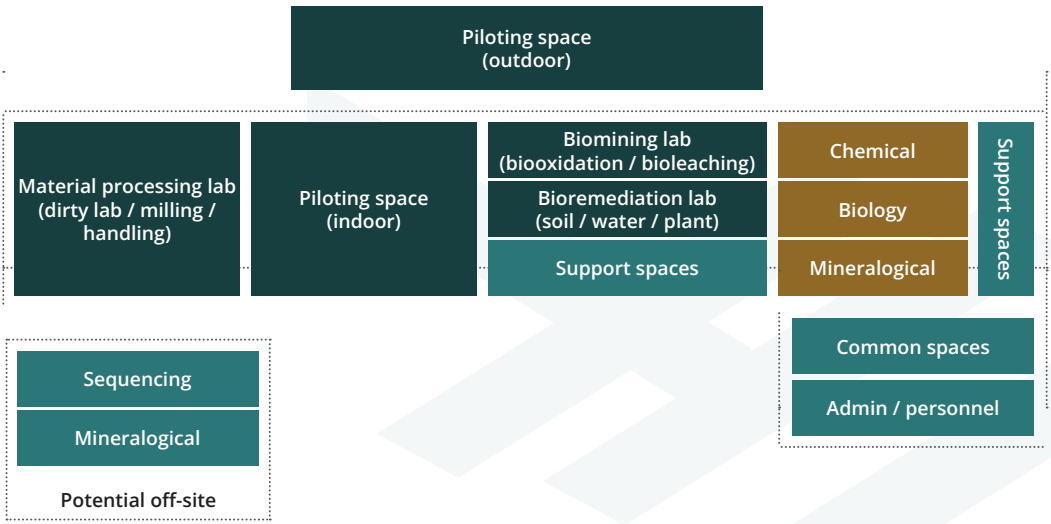
TYPES OF FACILITIES

Core pilot / demonstration facilities
including tools, technology, and space for testing, optimizing, and demonstrating mine waste biotechnologies

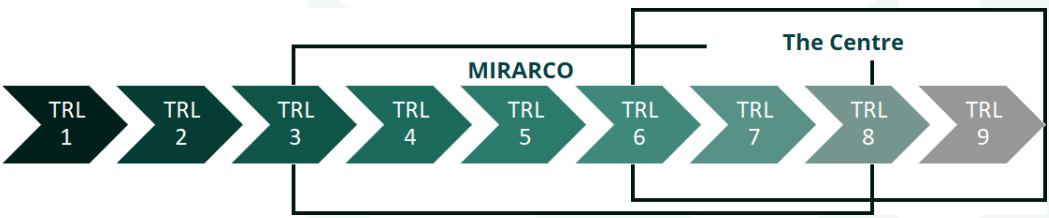
Support labs
Including a suite of analytical equipment for mineralogy, microbiology, geochemistry, and molecular analyses

Support spaces
for staff, administration, students, and project/ industry partners

ARRANGEMENT OF SPACE



TECHNOLOGY READINESS LEVELS OF RESEARCH



WHY THE CENTRE IS FEASIBLE

An in-depth study (March 2022) of proposed facilities, services, and revenues concluded that the Centre for Mine Waste Biotechnology is a feasible opportunity because:

Financial positioning is strong

Two building size options (30,000 sq. ft. and 45,000 sq. ft.) were assessed in the feasibility study. Both options and funding scenarios have the potential to be feasible over time. Based on stakeholder input, MIRARCO plans to pursue a 45,000 square foot building with the funding scenario to be confirmed based on available financing.

The Centre offers a powerful return on investment

Economic modelling forecasts that this investment will be more than paid back in the federal and provincial taxes generated by construction and by the Centre operations within 10 years.

The initiative responds to an identified gap in the mining innovation ecosystem

The Centre will provide the facility, instruments, access to waste material, and expertise needed to build a clear path for innovators to reach the market. The Centre will focus specifically on biotechnology as a mine waste strategy, offer pilot-scale mining biotechnology facilities, provide bench- to-market innovation support, and coordinate industry, government, and academic research in biotechnology.

The Centre has a unique value proposition/key differentiator

With pilot-scale facilities and world-class expertise, the Centre will be a hub for biotechnology collaboration, commercialization, and training. Its facilities and resources will accelerate the process of bringing emerging technologies from bench to mine.

The Centre aligns with government and industry priorities

As the world embraces a clean energy transition, Canada's reserves of critical minerals will make it an important global supplier. Canada has the opportunity to extract these minerals from waste in a greener way.

EXPENSES AND REVENUES

The estimated total project costs for the 45,000 square foot facility is detailed below. The financial model demonstrates that the Centre has the potential to achieve long-term sustainability regardless of which building size option is selected.

Project Construction Costs

	45,000 sq. ft. Building
Square feet	
Building (sq. ft.)	45,000
Office space %	50.0%
Office space (sq. ft.)	22,500
Lab space (sq. ft.)	22,500
Hard costs	($)
Site development and roadways	3,375,000
RFP fees	67,500
Base building costs	5,625,000
Lab costs	6,750,000
Construction Insurance	112,500
Landscaping	225,000
Subtotal hard costs	16,155,000
Soft costs	
Legal fees	80,775
Financing fees	121,163
Architect and engineering fees	242,325
Development fees	323,100
Subtotal soft costs	767,363
Other costs	
Tenant inducements (office only)	1,125,000
Leasing fees (office only)	90,000
Contingency	1,615,500
Subtotal other costs	2,830,500
Total building project costs	19,752,863
Equipment	1,000,000
TOTAL CAPITAL COSTS	20,752,863

FEASIBILITY AND FINANCIAL MODEL

The Centre will offer a variety of services and programs, each generating valuable revenue:

Revenue Streams

Type of Revenue	Details
Memberships	A three-tiered approach to membership will be offered at rates of $150,000, $50,000, and $5,000. The services and membership benefits will vary based on the membership type and on the individual agreement established by the parties involved. Financial modelling does not include service or rental discounts that may be arranged as part of membership agreements.
Research and Technical Consulting services	Revenue will be derived from services based on time and materials. For purposes of this financial model, only the time has been incorporated into the revenue estimates and would include research associates, technicians, and a managing director billing out at an hourly rate of $100, $100, and $175 respectively. It is assumed the billable capacity for each of the staff will start slowly at 35.0 per cent, 35.0 per cent, and 25.0 per cent, respectively, increasing to 75.0 per cent, 75.0 per cent, and 50.0 per cent, respectively.
Research project support	Support for research projects will be offered at a rate of $250,000 per project with the offsetting cost to complete each research project of approximately $209,000. This amount would include the salaries and benefits of a full-time researcher, a full-time research assistance, and material costs of $25,000.
Workshops / training	Revenue will be generated by hosting workshops / training sessions or small conferences. It is estimated that the MIRARCO would charge an average fee per participant of $2,000 and would hold two events in Year 1 increasing to six events by Year 3 with at least 20 participants at each event.
Equipment and site rentals	Equipment and access to mining test sites would be rented out at rates of $3,000 per day for equipment rental and $5,000 per day for access to test site. It is estimated for purposes of this financial model that income would be generated from these two revenue streams for 182 days a year each (or 50.0 per cent of their capacity).

Source: Stiletto Analysis

MEMBERSHIPS

SUPERUSER MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A SUPERUSER MEMBERSHIP IS IDEAL FOR:

- Organizations that want to commercialize, adopt, and / or implement biotechnologies
- Entities working on large or multiple projects
- Projects that require a pilot/demonstration site and/or access to specialized equipment and expertise

Term: Three Years

Annual Cost: $150,000

Equipment and Site Rentals (-10% reduced fee)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $2,700-$3,000/day for equipment
From $4,700-$5,000/day for site access

Research and Technical Consulting Services (up to 20 hours)

Access to world-class, cross-sector expertise: research associates, technicians, and a hands-on managing director

Approximate value of $23,000

Sponsorship Benefits (Platinum Member - $10,000 value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research Project Support (up to 10 hours)

Support or collaboration on a grant application

Analytical Package (valued at $5,000)

Suite of sample analyses from Centre capabilities

Workshops / Training Sessions (5 annually)

Five customized workshops / training sessions on biomining / bioleaching advancements and other related topics

Dedicated Students (2 annually)

Dedicated students to support your research initiatives, fully supervised by the Centre's team

Access to Collaborative Space (20 days)

Opportunity to leverage the network of members at the Centre with 20 days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

mirarco MINING INNOVATION

KEY USER MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A KEY USER MEMBERSHIP IS IDEAL FOR:

- Organizations advancing research in biotechnology for mining
- Entities working on smaller projects
- Projects that require a pilot / demonstration site and / or access to specialized equipment and expertise

Term: Three Years

Annual Cost: $50,000

Equipment and Site Rentals (-5% reduced fee)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $2,850-$3,000/day for equipment
From $4,850-$5,000/day for site access

Research and Technical Consulting Services (up to 5 hours)

Access to world-class, cross-sector expertise: research associates, technicians, and a hands-on managing director

Approximate value of $5,700

Sponsorship Benefits (Gold Member - $5,000 value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research Project Support (optional add-on)

Support or collaboration on a grant application

Analytical Package (value of up to $1,500)

Suite of sample analyses from Centre capabilities completed to a total of $1,500

Workshops / Training Sessions (2 annually)

A total of two workshops and / or training sessions on biomining / bioleaching advancements and other related topics

Dedicated Students (optional add-on)

Dedicated student(s) to support your research initiatives, fully supervised by the Centre's team

Access to Collaborative Space (5 days)

Opportunity to leverage the network of members at the Centre with five days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

ECOSYSTEM MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A ECOSYSTEM MEMBERSHIP IS IDEAL FOR:

Organizations that want to be part of a unique, pilot-scale facility

Mining stakeholders who want package flexibility

Those who need to connect with other members and keep abreast of activities and advancements in this space

Term: Three Years

Annual Cost: $5,000

Workshops / Training Sessions (access to 1)

Access to 1 workshop / training session on biomining / bioleaching advancements and other related topics

Access to Collaborative Space (2 days)

Opportunity to leverage the network of members at the Centre with two days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

Sponsorship Benefits (Silver Member - $500 Value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research and Technical Consulting Services (optional add-on)

Access to world-class, cross-sector expertise: research associates, technicians and a hands-on managing director

Research Project Support (optional add-on)

Support or collaboration on a grant application

Analytical Package (optional add-on)

Suite of sample analyses from Centre capabilities

Dedicated Students (optional add-on)

Dedicated students to support your research initiatives, fully supervised by the Centre's team

Equipment and Site Rentals (optional add-on)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $3,000 / day for equipment
From $5,000 / day for site access

INVESTMENT: THE ASK

A total capital investment of $21 million commencing 2023 is required to launch construction of this important project in 2024.

MIRARCO is seeking support from municipal, provincial, federal, and private sector partners to help build and equip the Centre.

Once constructed, the facility will rapidly begin to generate revenues from its suite of memberships, services, and programs.

Investing in the Centre will:

1. Spark the creation of a biotechnology in mine waste cluster / ecosystem in Sudbury by:

   a. Fostering market confidence in new biotechnologies by demonstrating the ROI in terms of value creation and cost reduction;

   b. Attracting investment from technology companies, small-and medium-sized enterprises (SMEs), and multinational corporations;

   c. Supporting the growth of biotechnology firms with connections to local, provincial, and federal resources; and

   d. Increasing access to talent / HQP workforce in mine waste biotechnology;

2. Support the industry transition towards sustainable, zero-waste / zero-footprint mining operations by supporting the development and commercialization of green mining alternatives.

3. Improve the security and resiliency of critical mineral supply chains in Ontario and Canada by advancing the development and implementation of biotechnology techniques that recover metals from waste.

POTENTIAL IMPACT

The Centre's economic model has been thoroughly assessed to confirm its potential economic impact. The economic impact model is based on three sources of impact: 1) facility construction; 2) Centre operations; and 3) increased mining output generated by Centre technologies and innovations.

For the ten-year period between 2024-2034 **the Centre is forecasted to generate:**

Construction

$20.7M boost in provincial GDP

$9.6M household spending

$5.7M tax revenue in Canada (**$3.4M** in Ontario)

$12.9M employment income

184 FTE Jobs

Operations

Cumulative over 10 years

$28.5M boost in provincial GDP

$14.6M household spending

$4.5M tax revenue in Ontario

$19.7M employment income

26.1 average annual employment

Impact Scenarios

1% national mining output

$446.8M mining output

$446.1M GDP

$209.1M labour income

$109.9M taxes (all government)

2,515 FTE employment

Dr. Nadia Mykytczuk

Dr. Nadia Mykytczuk is currently serving as the CEO and President of MIRARCO and also serves in the role of Interim Executive Director of the Goodman School of Mines at Laurentian University.

Until May 2021 she was an Associate Professor and Industrial Research Chair in Biomining, Bioremediation, and Science Communication at Laurentian University.

She brings 18 years of experience in biomining and bioremediation along with HQP training to MIRARCO, to expand these research efforts and help commercialize biotechnology applications in mining.

Endnotes

[1] "Mining in Canada," The Canadian Minerals and Metals Plan, 2020, https://www.minescanada.ca/en/content/mining-canada-0
[2] "Abandoned Mines – Overview," *MiningWatch Canada*, June 4, 2009, https://miningwatch.ca/blog/2009/6/4/abandoned-mines-overview
[3] "Tailings and Waste Rock Disposal in the Canadian Mining Industry 2006-14," *Mining Sector Performance Report 2006-2015*, August 2016, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/MSP_report_access_en.pdf
[4] "Waste Materials Diverted, by Type and by Source," Statistics Canada, Table 38-10-0138-01, March 8, 2021, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810013801
[5] "Mine Waste in Canada: A Growing Liability," *MiningWatch Canada*, October 5, 2020, https://miningwatch.ca/blog/2020/10/5/mine-waste-canada-growing-liability
[6] "Third National Assessment of Environmental Effects Monitoring Information from Metal Mines Subject to the Metal Mining Effluent Regulations," Environment Canada, June 30, 2017, https://www.canada.ca/en/environment-climate-change/services/managing-pollution/publications/third-national-assessment-monitoring-data/chapter-3.html
[7] "Mine Waste in Canada: A Growing Liability," *MiningWatch Canada*, October 5, 2020, https://miningwatch.ca/blog/2020/10/5/mine-waste-canada-growing-liability
[8] "Table 1 – Environmental Liability for Contaminated Mine Sites in Canada (August 2017)," *MiningWatch Canada*, August 2017, https://miningwatch.ca/sites/default/files/2017-08-emmc-table1.pdf
[9] "3.10 Management of Contaminated Sites," Auditor General of Ontario, 2015, https://www.auditor.on.ca/en/content/annualreports/arreports/en15/3.10en15.pdf
[10] "3rd Mining Value from Waste Workshop," Natural Resources Canada, April 29, 2020
[11] "Mining Value from Waste: A Potential Game Changer," Government of Canada, May 23, 2019, https://www.nrcan.gc.ca/simply-science/mining-value-from-waste-potential-game-changer/21944
[12] "Mining Copper Tailings Could Answer Supply Deficits Later This Decade", Mining.com, May 19, 2021, https://www.mining.com/mining-copper-tailings-could-answer-supply-deficits-later-this-decade/
[13] "Mining Value from Waste Workshop Report," Natural Resources Canada, December 19, 2017
[14] Ian Ross, "Temiskaming Battery Metals Park Should Fill Missing Link in Supply Chain," *Timmins Today*, January 1, 2022, https://www.timminstoday.com/local-news/temiskaming-battery-metals-park-should-fill-missing-link-in-supply-chain-4903713

To maintain its competitive edge, Canadian mining must look beyond traditional practices and invest in innovative technologies and expertise. By expanding the capacity for biotechnology research and commercialization, the Centre for Mine Waste Biotechnology will provide crucial support to the mining industry as Canada positions itself as a global competitor.

The Centre's forward-looking approaches will support the mining sector in achieving its environmental, social, and governance (ESG) goals and help cement the mining industry's ongoing social license to operate. Making a unique contribution to the mining innovation ecosystem, the Centre will generate long-term environmental, social, and economic impacts for Sudbury, Ontario, and Canada.

For more information, contact:

Dr. Nadia Mykytczuk
President / CEO, MIRARCO Mining Innovation
nmykytczuk@mirarco.org
info@mirarco.org
+1 (705) 675-1151 Ext. 5075