



**2024 SME Minnesota
Conference**

Towards Zero Tailings – Can We Get There?

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Agenda

- Objectives
- Background
- Benefits of tailings reduction
- Tailings reduction challenges
- Tailings reduction methods
- Case histories
- Summary and path forward

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Objectives

- To introduce tailings reduction concept,
- summarize the state of the practice,
- identify areas for future innovation,
- and suggest whether we can get to zero tailings.

Background

- By product of mining process.
- Typically sand to silt size particles, plus water and air voids.
- Often disposed of as a slurry.
- Typically stored in impoundments.
- But can also be used as mine backfill.

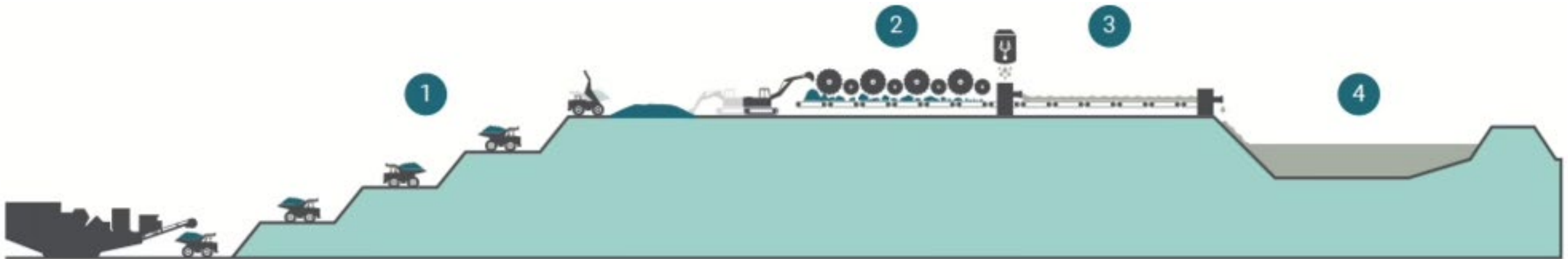


Image Source:
<https://www.icmm.com/en-gb/our-work/innovation-for-sustainability/tailings/about-tailings>

Background (cont.)

Tailings-Related Challenges

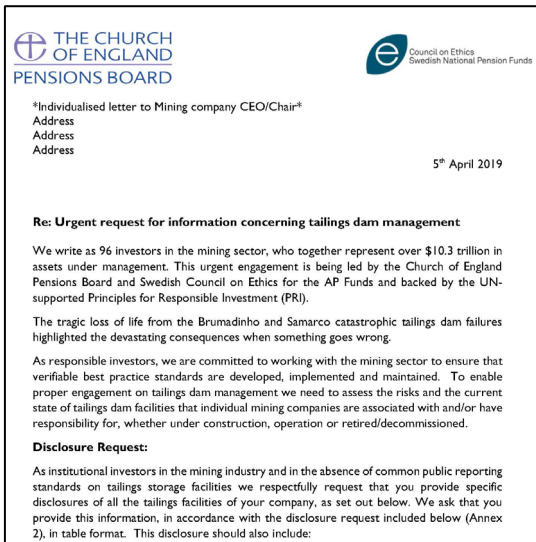
- End of flow sheet
- Cost center
- Physical risk
- Environmental risk
- Reputational risk
- Perpetuity

Background (cont.)

Safety Focus


Background (cont.)


Safety Focus



Background (cont.)

Safety Focus

 THE CHURCH OF ENGLAND PENSIONS BOARD

 Council on Ethics Swedish National Pension Funds

Individualised letter to Mining company CEO/Chair
Address
Address
Address

5th April 2019

Re: Urgent request for information concerning tailings dam management

We write as 96 investors in the mining sector, who together represent over \$10.3 trillion in assets under management. This urgent engagement is being led by the Church of England Pensions Board and Swedish Council on Ethics for the AP Funds and backed by the UN-supported Principles for Responsible Investment (PRI).

The tragic loss of life from the Brumadinho and Samarco catastrophic tailings dam failures highlighted the devastating consequences when something goes wrong.

As responsible investors, we are committed to working with the mining sector to ensure that verifiable best practice standards are developed, implemented and maintained. To enable proper engagement on tailings dam management we need to assess the risks and the current state of tailings dam facilities that individual mining companies are associated with and/or have responsibility for, whether under construction, operation or retired/decommissioned.

Disclosure Request:

As institutional investors in the mining industry and in the absence of common public reporting standards on tailings storage facilities we respectfully request that you provide specific disclosures of all the tailings facilities of your company, as set out below. We ask that you provide this information, in accordance with the disclosure request included below (Annex 2), in table format. This disclosure should also include:

 Global Tailings Review.org


 ICMM
International Council on Mining & Metals


 UN environment programme

 PRI | Principles for Responsible Investment

Background (cont.)

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GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT

AUGUST 2020


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GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT

AUGUST 2020

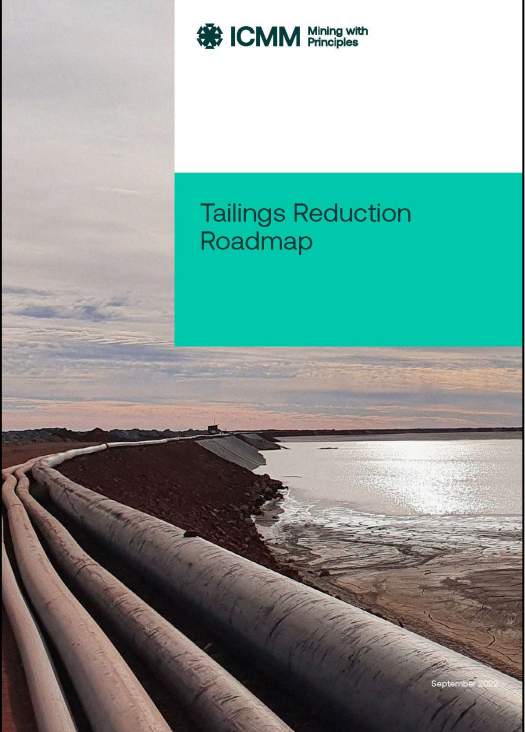
 ICMM International Council on Mining & Metals

 UN environment programme

 PRI Principles for Responsible Investment

 ICMM Mining with Principles

Tailings Reduction Roadmap



September 2020

Background (cont.)

Economic Engine

- Increased mineral demand
- Lower grade ore
- Increased tailings production
- Larger tailings storage facilities
- Opportunity for innovation

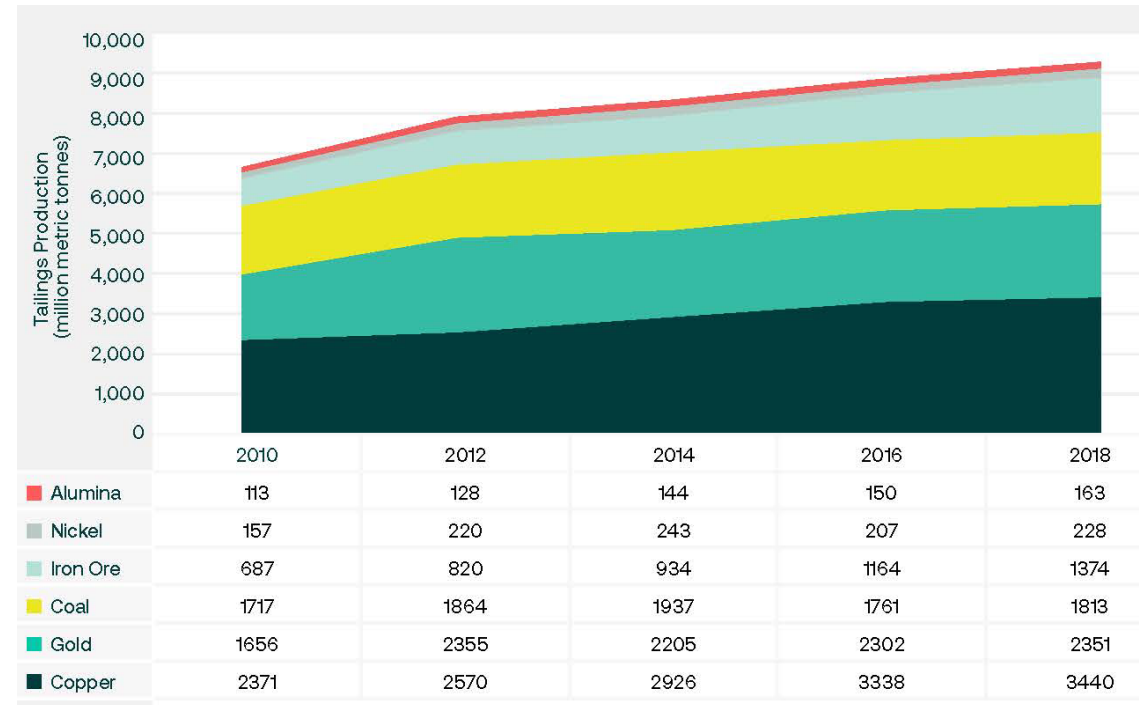


Figure Source:
https://www.icmm.com/website/publications/pdfs/innovation/2022/roadmap_tailings-reduction.pdf?cb=20771

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Benefits of tailings reduction

- Risk reduction
- Reduced footprint and environmental impact
- ESG benefits
- Valorization opportunities

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Tailings Reduction Challenges

Environmental & Social

- Higher energy and water demands
- Re-use requires tailings to be benign

Geological

- Geologic variability
- Increased waste rock

Technological

- Scalability
- Operator risk aversion

Regulatory/Political

- Existing permits
- Organizational barriers

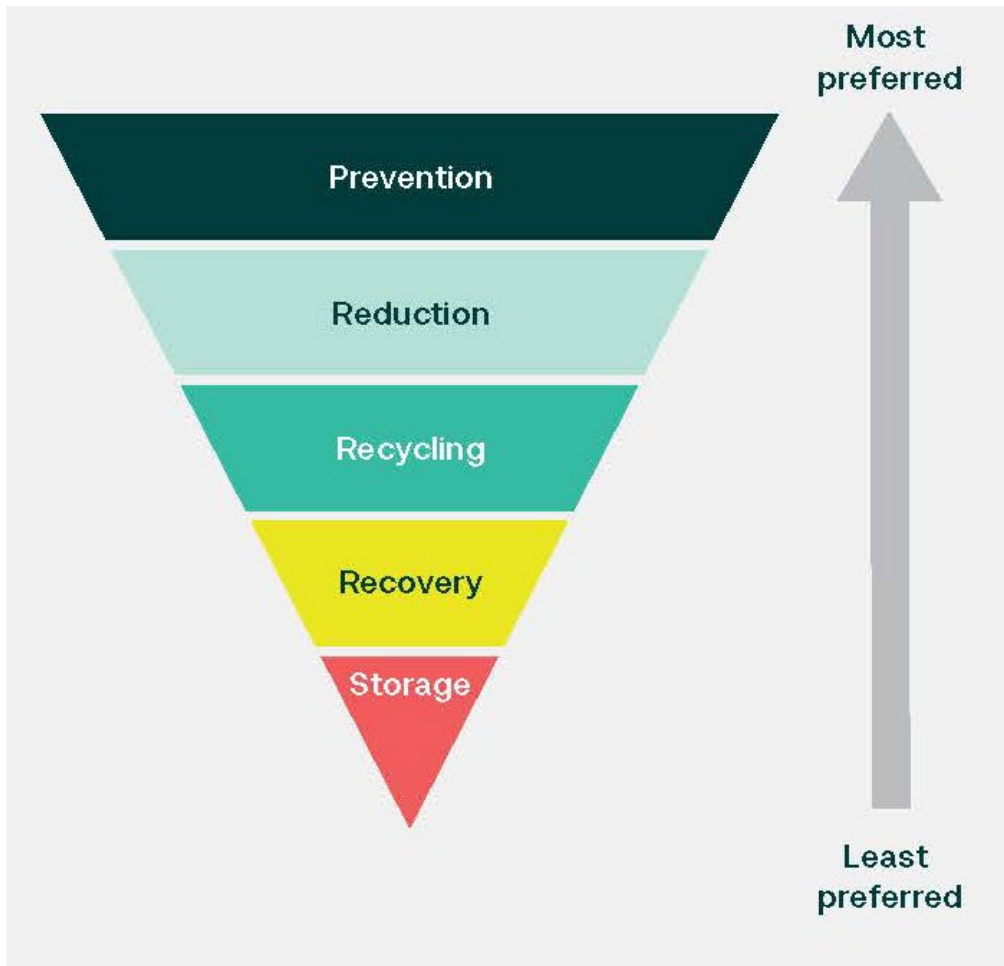
Cost

- Up-front cost

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Tailings Reduction Methods



Related Methods

- Volume reduction
 - Thickening
 - Filtering
- Diversion
- Reprocessing
- Etc.

Figure Source:
https://www.icmm.com/website/publications/pdfs/innovation/2022/roadmap_tailings-reduction.pdf?cb=20771

Tailings Reduction Methods (cont.)

ICMM Prioritized Technical Solutions

Level of Impact	ICMM Project	Objectives
Incremental (<30% Tailings Reduction)	Waste valorization	<ul style="list-style-type: none">• Practical commercial options
	Ore sorting (sensor and bulk)	<ul style="list-style-type: none">• Rapid testing• High volume particle sorting
	Coarse flotation	<ul style="list-style-type: none">• High volume sorting by physical properties, rather than sensors and analysis
	Tailings data platform	<ul style="list-style-type: none">• Democratize access to data and technologies• Knowledge sharing

After:
https://www.icmm.com/website/publications/pdfs/innovation/2022/roadmap_tailings-reduction.pdf?cb=20771



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Tailings Reduction Methods (cont.)

ICMM Prioritized Technical Solutions (cont.)

Level of Impact	ICMM Project	Objectives
Transformative (30% to 60% Tailings Reduction)	Non-chemical extraction	<ul style="list-style-type: none">Ore extraction without chemicals (electrolysis, synthetic, biology, or thermal treatments)Reduce environmental impact
	No waste mine architecture	<ul style="list-style-type: none">Novel mine design that eliminates waste due to open pit design, development, and or overcutting
	Mechanical cutting	<ul style="list-style-type: none">Continuous mechanical cutting to remove waste at the source

After:
https://www.icmm.com/website/publications/pdfs/innovation/2022/roadmap_tailings-reduction.pdf?cb=20771

Tailings Reduction Methods (cont.)

ICMM Prioritized Technical Solutions (cont.)

Level of Impact	ICMM Project	Objectives
Disruptive (>90% Tailings Reduction)	Smart comminution	<ul style="list-style-type: none">• Technology breakthrough• Preferentially breaking ore at grain boundaries• Replacing all tailings producing processes
	In-situ leaching	<ul style="list-style-type: none">• Identify future technologies• Addressing remaining technical challenges

After:
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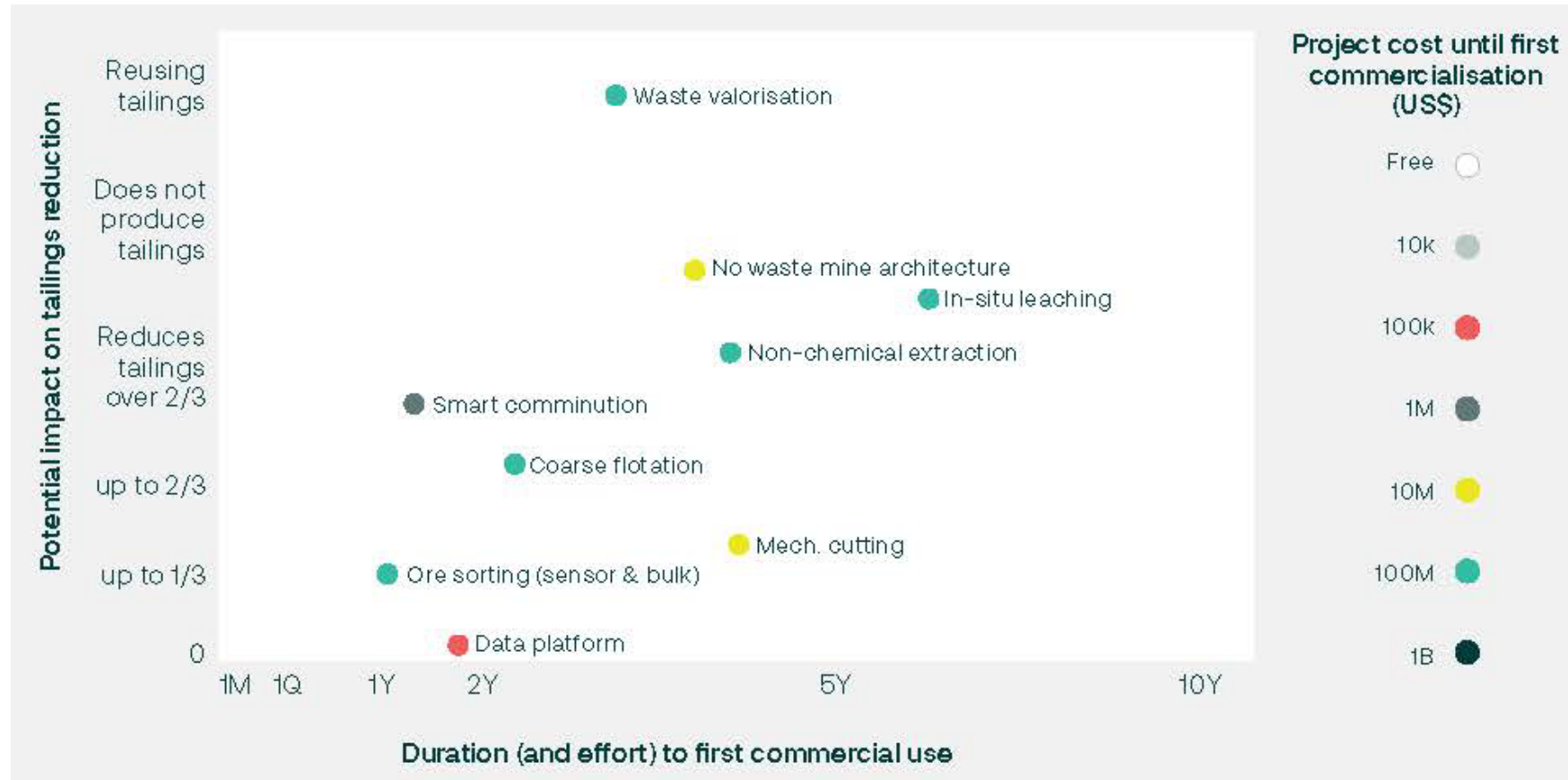


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Case Histories



Vale now
Press

11/29/21 • Innovation

Vale innovates by producing sustainable sand for the market, reducing the volume of tailings disposed in dams

Source:
<https://vale.com/w/vale-innovates-by-producing-sustainable-sand-for-the-market-reducing-the-volume-of-tailings-disposed-in-dams>



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Case Histories

Vale Sustainable Sand

- 250,000 tons of sand re-used... ramping up to 2 Mtons/yr
- Helps meet significant global demand
- Previously stored in piles and dams
- Alternative to other sands that are often illegally extracted
- Certified non-toxic

Source:

<https://vale.com/w/vale-innovates-by-producing-sustainable-sand-for-the-market-reducing-the-volume-of-tailings-disposed-in-dams>



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Case Histories (cont.)

Nutrien Road Salt in New Brunswick

- Salt from decommissioned mine used for roadways
- Cost-neutral for province, which had been importing salt from Nova Scotia and Quebec
- Added 16 jobs that were previously lost when mine operations were suspended

Case Histories (cont.)

Tailings Reprocessing as a Closure Strategy

- Barrick Golden Sunlight Mine (Montana)
- Mining completed in 2019
- Perpetual pit water treatment required by permit



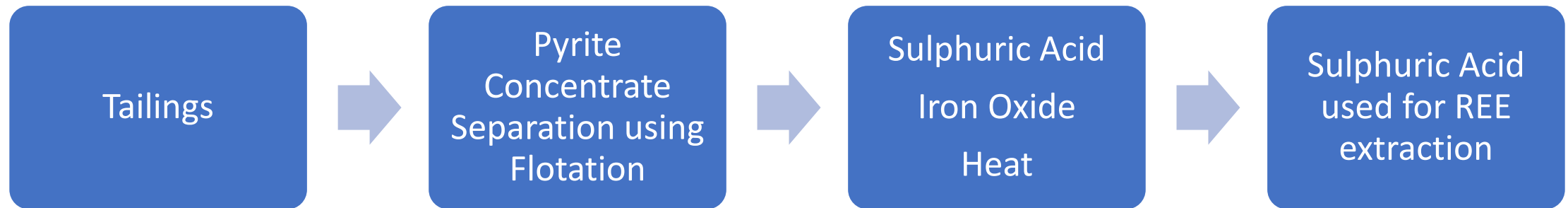
Benefits

- Elemental S for NGM, residual Au and Ag concentrate
- Unlined TSF seepage eliminated
- Reduced need to treat pit water

Case Histories (cont.)

LKAB and Boliden ReeMAP

- Sweden's two biggest mining companies teaming
- Reduces use of fossil fuels to generate sulphuric acid for REE extraction



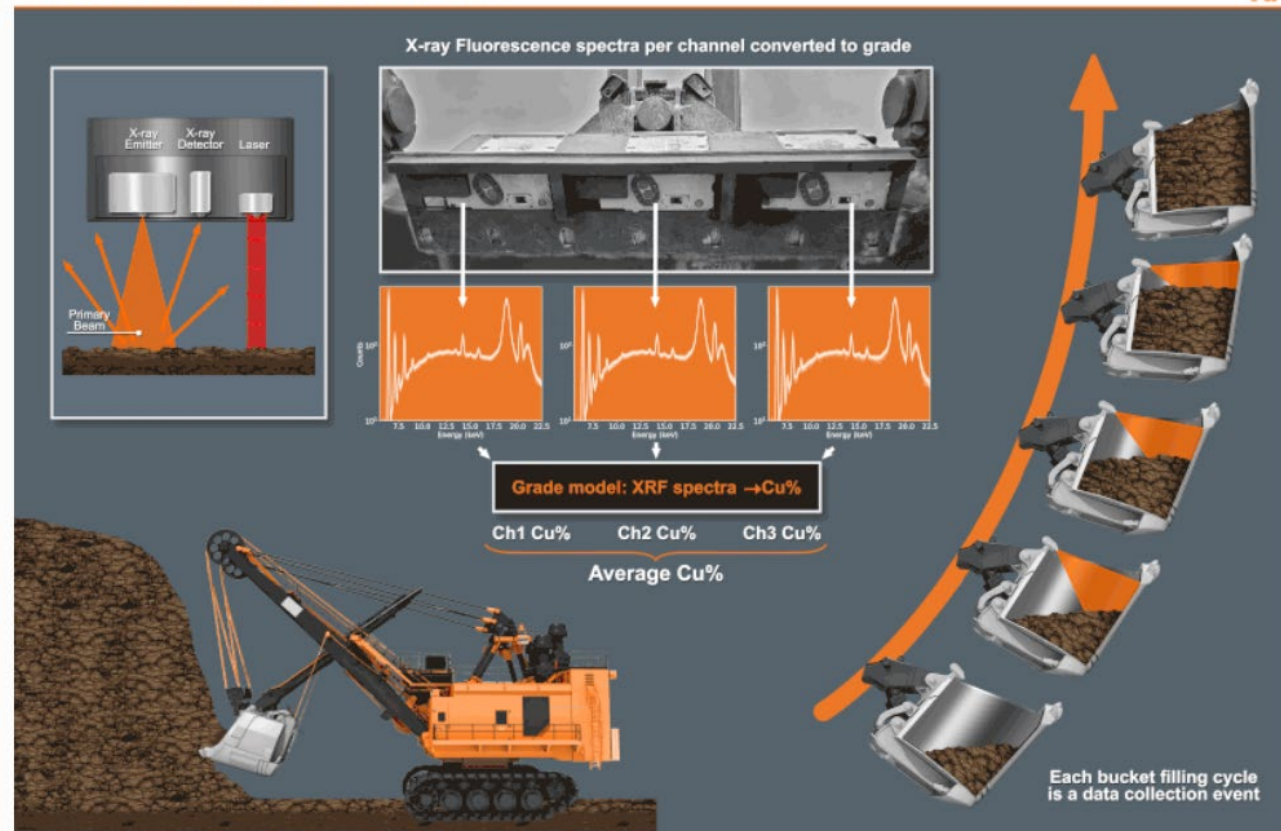
Source:
<https://www.e-mj.com/features/turning-the-tide-on-tailings-creating-opportunities-rather-than-risks/>

Case Histories (cont.)

Confidential Site in US

- Completing pilot program using minesense equipment
- System uses sensors to provide near-real time data at shovel to help identify higher grade ore and reduce dilution

How ShovelSense Works



Source:
Personal conversation with confidential client and
<https://minesense.com/>

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Technologies Currently In Use

- Mine backfill : 50-60% reuse of tailings
- Selective mining methods : 10-50% reduction in tailings
- Ore sorting : ~30% diversion of tailings to waste
- Reprocessing of tailings : *no new tailings produced
- Valorization of tailings : Unique opportunities

Path Forward

- Continued focus on safe tailings management.
- Innovation driven by mineral needs and ESG commitments.
- Continued collaboration between mining companies and vendors.
- Policy and financial support for circular economy.
- Need for recognizing mine waste as a coproduct and debottlenecking permitting process.
- Zero tailings? Maybe not, but lots of opportunity along the way.

Thank you



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