Tailings: *Fundamentals, Failures, and the New Standard of Care*

TAILINGS.WATER.WASTE.

Presented by: Kim Morrison

Date: 12 May 2026

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TAILINGS: *FUNDAMENTALS, FAILURES, AND THE NEW STANDARD OF CARE*

- About Me
- What are tailings and how are they managed?
- Past failures → the shift from trust to control
- The GISTM and “other actions” that lifted the bar
- How I got into tailings
- When work becomes purpose
- Key lessons for the next generation

Musselwhite Tailings Storage Facility, Ontario (SME Tailings Management Handbook)

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ABOUT ME: KIM MORRISON, PE, RG

- **CTO at ATC Williams**, leading technical governance, capability development, and independent review and advisory services.
- **Former Sr. Director of Global Tailings Management at Newmont**, leading company-wide implementation of the GISTM.
- **Editor of SME's *Tailings Management Handbook: A Life-Cycle Approach*** and ***Tailings Case Studies: Real-World Lessons in Tailings Management***, seminal handbooks for practitioners, operators, and regulators. A new ***Tailings Closure Handbook*** will be published later this year.
- **Over 28 years' experience** spanning consulting, owner's-team leadership, and academia:
  - Served in roles including **Engineer of Record**, Delegate to the **Accountable Executive**, and member of **Independent Tailings Review Board (ITRB)**.
  - Also, served as Interim Director of the **Tailings Center** and **Adjunct Faculty** at **Colorado School of Mines**.

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WHAT ARE TAILINGS, AND HOW ARE THEY MANAGED?

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TAILINGS ARE… … a waste product of the mining process

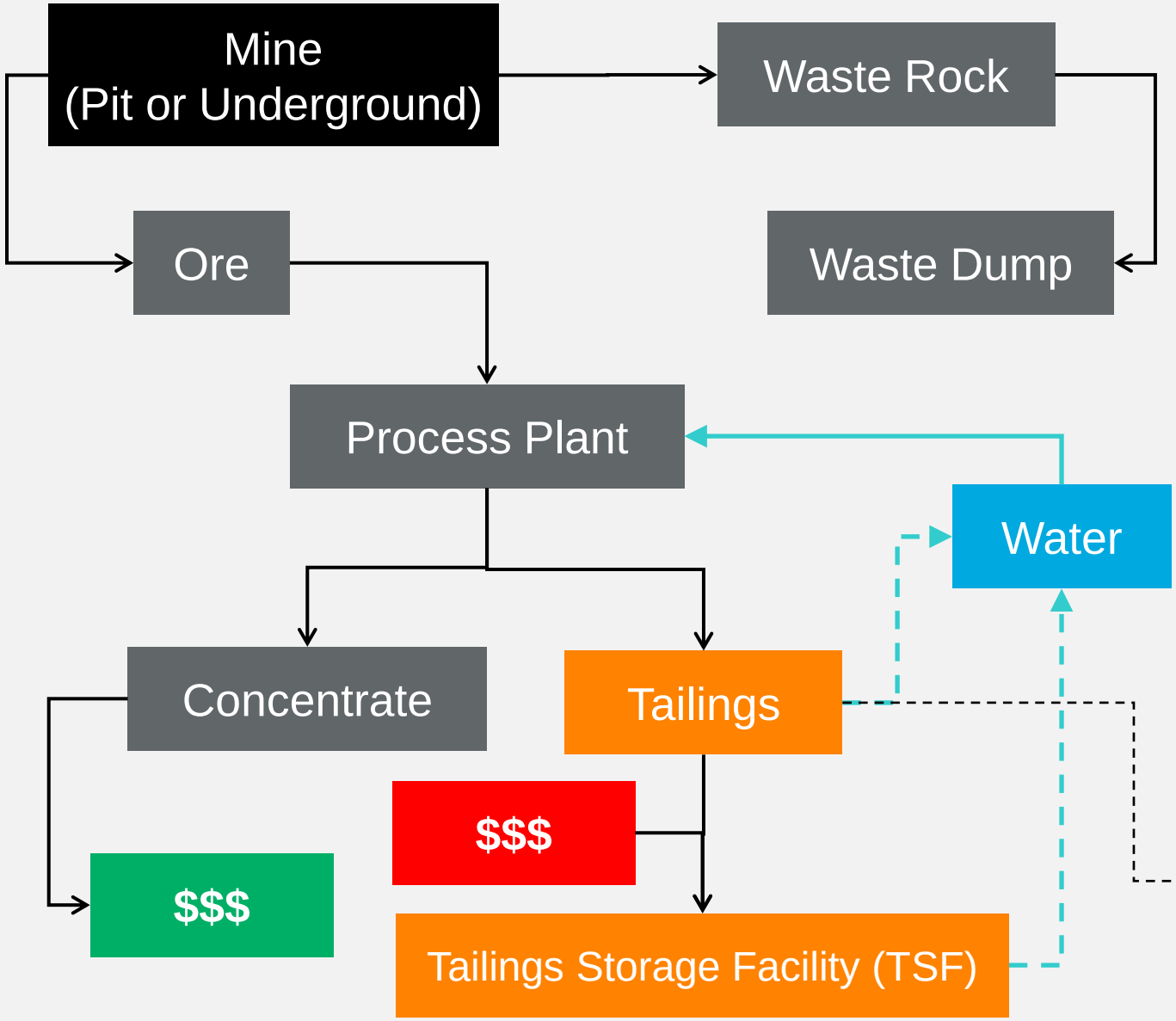

Photo Source:
https://www.goldrushtradingpost.com/how_to_pan_for_gold1

If possible, place portion underground (e.g., paste backfill)

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WHAT ARE TAILINGS?

- Mining and processing simplistically involves the separation of materials according to their particle size, specific gravity (SG) and mineralogy.
- The ore may be crushed and possibly ground to a “rock flour” followed by concentration and separation.
- Process chemicals, mechanical work and/or heat are applied to extract the valuable commodity.
- The fine-grained wastes produced during processing constitute tailings.

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TAILINGS >> PRODUCT

- **Base metals – up to a few % of ore = commodity**
- **Precious metals – up to a few ounces per tonne = commodity**
- **Oil sands – almost 100% of solids processed = tailings**

IN ALL CASES: PLUS PROCESS WATER AND CHEMICALS

Photo Source: Dillon Marsh, Artist
(Palabora Copper Mine – top; West O'okiep Copper Mine – bottom)

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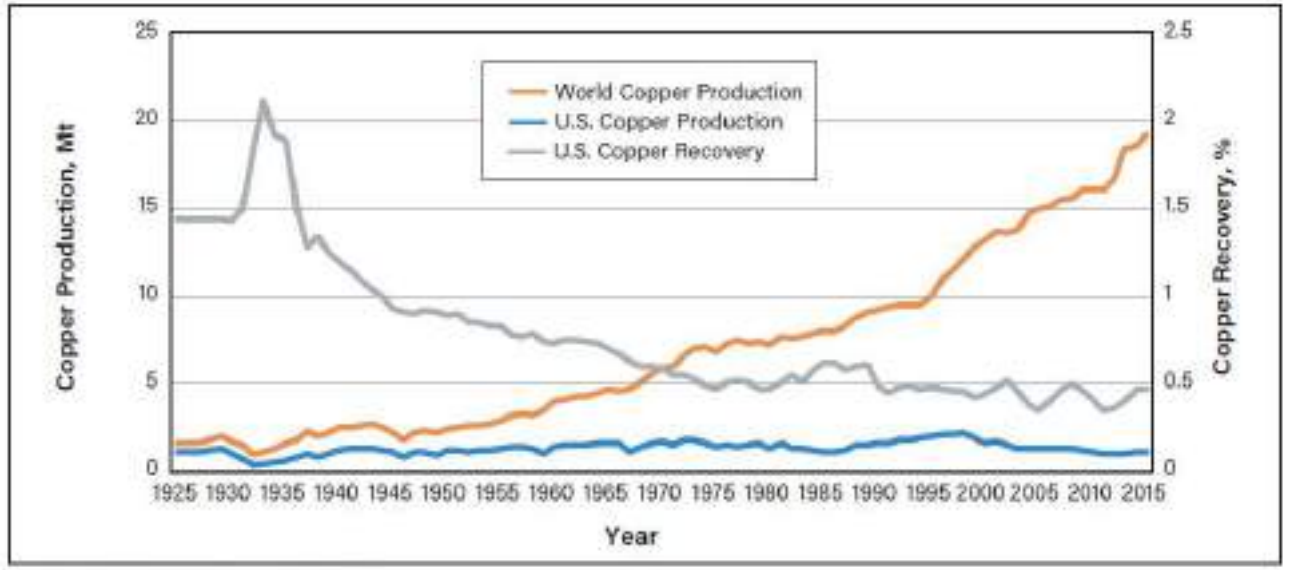
CURRENT TRENDS IN MINING PRODUCTION

- **Worldwide production increases with every decade**
  - Mines in the early days were only 1 to 100 tonnes per day (t/d)
  - Today getting close to 1M t/d (for open pit)!
- **More space needed:**
  - Tailings facilities getting larger
  - Tailings dams getting higher
- **More management and closure issues**
- **More potential impacts**
- **More risks**

Evolution in the price and production of copper over ~90 years

(statistics from the United States Geological Survey, Mineral Resources Program)



Data from USGS 1932-2015 and USGS 2015

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TAILINGS IMPOUNDMENTS CONSTITUTE SOME OF THE LARGEST MAN-MADE STRUCTURES IN EXISTENCE

Source: GoogleEarth

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Dr. Andy Robertson (1943-2023)

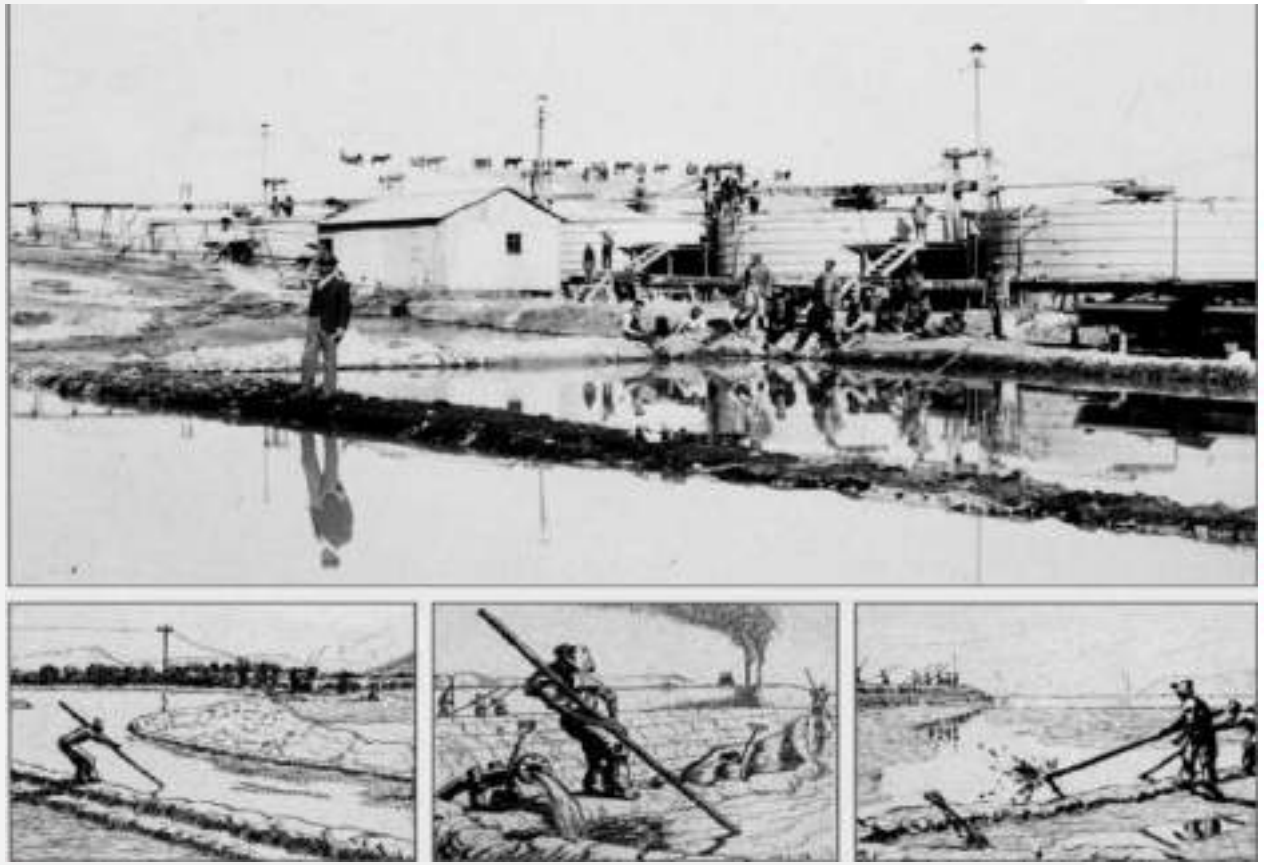
2011 KEYNOTE ADDRESS

- In a keynote address, Dr. Andy Robertson described this trend and its implications going forward as **“elevating risk potential by a factor of 20 every 1/3 century.”**
- His address called a **“red flag”** on the current Mining Metric which results in ever larger and higher TSFs.”

Photo Source: https://im-mining.com/2014/10/20/26009/

EARLY TAILINGS “CONTROL”

- **Controlled tailings, and containment, conjured up different connotations a hundred or more years ago than is the case today.**
- **Control basically meant keeping it out of the mine and getting it out of the mill.**



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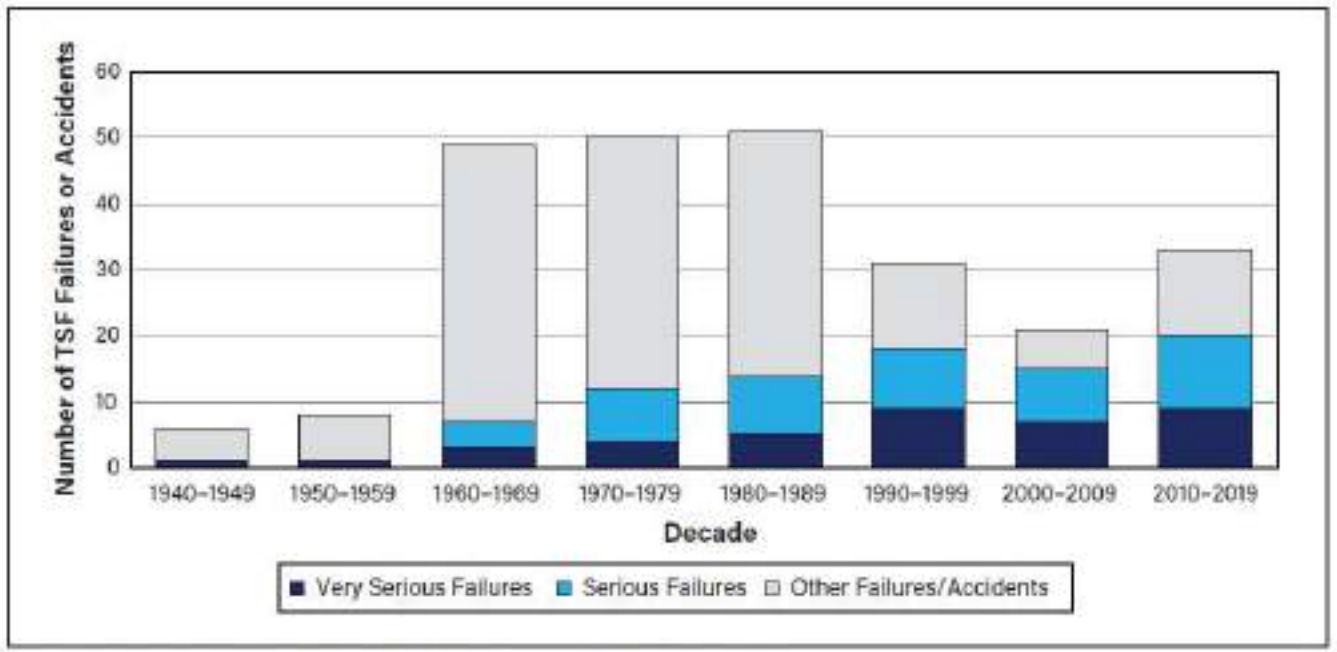
TAILINGS ENGINEERING – A RELATIVELY "NEW" CONCEPT

- **Initiated in 1960's and developed in 1970's**
- **On-going development:**
  - Increased environmental awareness
  - Tighter regulatory framework
  - Cost effectiveness paramount
- **Much effort in recent decades to improve tailings stewardship practices**



Adapted from Bowker and Chambers 2015 with data from WISE Uranium Project 2020

Still, there are > 2 major TSF failures annually on average!

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MAJOR TAILINGS & MINE WASTE FAILURES IN 2025

BUT – 2025 was an especially poor year for the industry with more than 7 failures reported !

- **4 November 2025 (Thailand): Mae Moh Mine**
  - **Incident Type:** Landslide in a large coal waste pile, triggered by heavy rainfall.
  - **Impact:** Damaged office buildings, maintenance facilities, and critical infrastructure like a major soil conveyor belt.
- **17 May 2025 (Malaysia): Bukit Mantri Gold Mine**
  - **Incident Type:** Collapse of a tailings dam.
  - **Impact:** Toxic water flooded workers' homes and nearby fruit orchards, raising serious concerns about **cyanide contamination** of the Kalumpang River.
- **22 March 2025 (Indonesia): PT IMIP**
  - **Incident Type:** Fatal tailings landslide that occurred despite being a supposedly safer “dry stack” facility following days of heavy rain.
  - **Impact:** Claimed the lives of 3 excavator operators.

Based on data from the Wise Uranium Project's "Chronology of major tailings dam failures” - Chronology of major tailings dam failures

MAJOR TAILINGS & MINE WASTE FAILURES IN 2025

- **16 March 2025 (Bolivia): Andavilque, El Kenko Dam**
  - **Incident Type:** Failure of the El Kenko tailings dam, resulting in a mudslide.
  - **Impact:** Two deaths reported and 47 homes completely destroyed after being buried under lead-coloured mud.
- **18 February 2025 (Zambia): Chambishi Copper Mine**
  - **Incident Type:** Tailings dam failure, releasing an estimated **50,000 cubic meters** of acidic slurry.
  - **Impact:** Acidic mine effluent caused a **massive fish kill** in the Mwambashi Stream and Kafue River, disrupting the primary source of drinking water for a large area.
- **17 February 2025 (Ghana): Iduapriem Gold Mine (Anglogold Ashanti)**
  - **Incident Type:** Failure of the Beposo tailings storage facility, releasing 80,000 m^3 of supernatant water.
  - **Impact:** Water with elevated **cyanide levels** flowed into multiple streams and the Ankobra river system.
- **13 January 2025 (Myanmar): Hpakant Jade Mining Area**
  - **Incident Type:** Mine waste pond failure, causing a mudslide.
  - **Impact:** Mud submerged more than 50 homes up to 20 feet deep in the Seikmu Village Tract.

Based on data from the Wise Uranium Project's "Chronology of major tailings dam failures" - Chronology of major tailings dam failures

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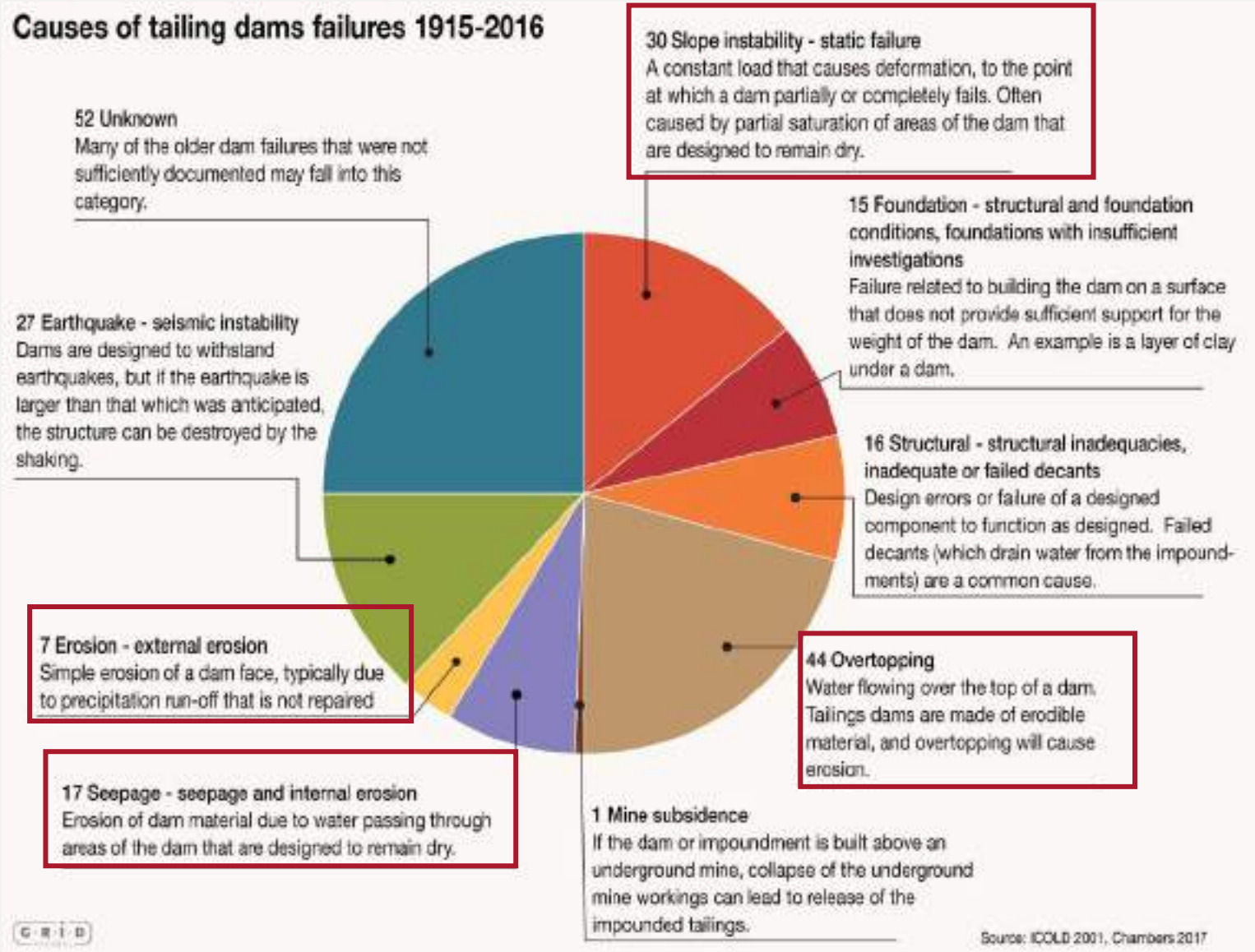
CAUSES OF TAILINGS DAM FAILURES | 1915-2016



Tailings management is fundamentally a **water management problem**

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WHAT DOES "TAILINGS ENGINEERING" INVOLVE?

- **Scoping / Desktop Studies**
- **Site Inspections, Geologic Hazard Mapping**
- **Environmental Compliance Criteria**
- **Engineering Parameters**
- **Concept Designs**
- **Site Layouts and Trade-Off Studies**
- **Field Investigations (Geotech, Hydro, Enviro)**
- **Laboratory Testing**
  - Construction Materials
  - Tailings Physical Testing
  - Tailings Geochemical Testing
  - Tailings Rheological Testing
- **Design Analyses**
  - Final Landform
  - Stage Capacity Curves
  - Construction Sequencing
  - Deposition Modelling
  - Stability Modelling
  - Seepage Modelling
  - Surface Water Modelling
  - Consolidation Modelling
- **Risk Assessment**
- **Transport and Placement**
  - Pumping Design
  - Pipeline Selection & Design
  - Thickening Options
- **Detailed Engineering**
  - Tender Documentation
  - IFC Drawings & Construction Specifications
- **Construction**
  - QA/QC – Construction Monitoring
  - As-Constructed Documentation
- **Operations**
  - Operations, Maintenance & Surveillance (OMS) Manual
  - Deposition Management
  - Wall Raise Detailed Design
  - Wall Raise Construction Schedule
  - Operational Audits
- **Closure Planning**
  - Criteria Development
  - Concept Design
  - Detailed Engineering
  - Implementation
  - Monitoring
- **Dam Break & Emergency Response Planning**

Highland Valley Copper Mine, B.C.
Photo Source: Klohn Crippen Berger

And even more than this…

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WHY ARE TAILINGS STORAGE FACILITIES (TSFS) NEEDED?

- Legislation requires them!
- Because mining, power generation and chemical processes produce fine wastes that need to be contained
- To limit contamination arising from seepage, dust, erosion and radiation

For management of conventional tailings:

- Dams (termed “tailings dams”) are required for containment
- But tailings dams differ quite substantially from conventional dams…

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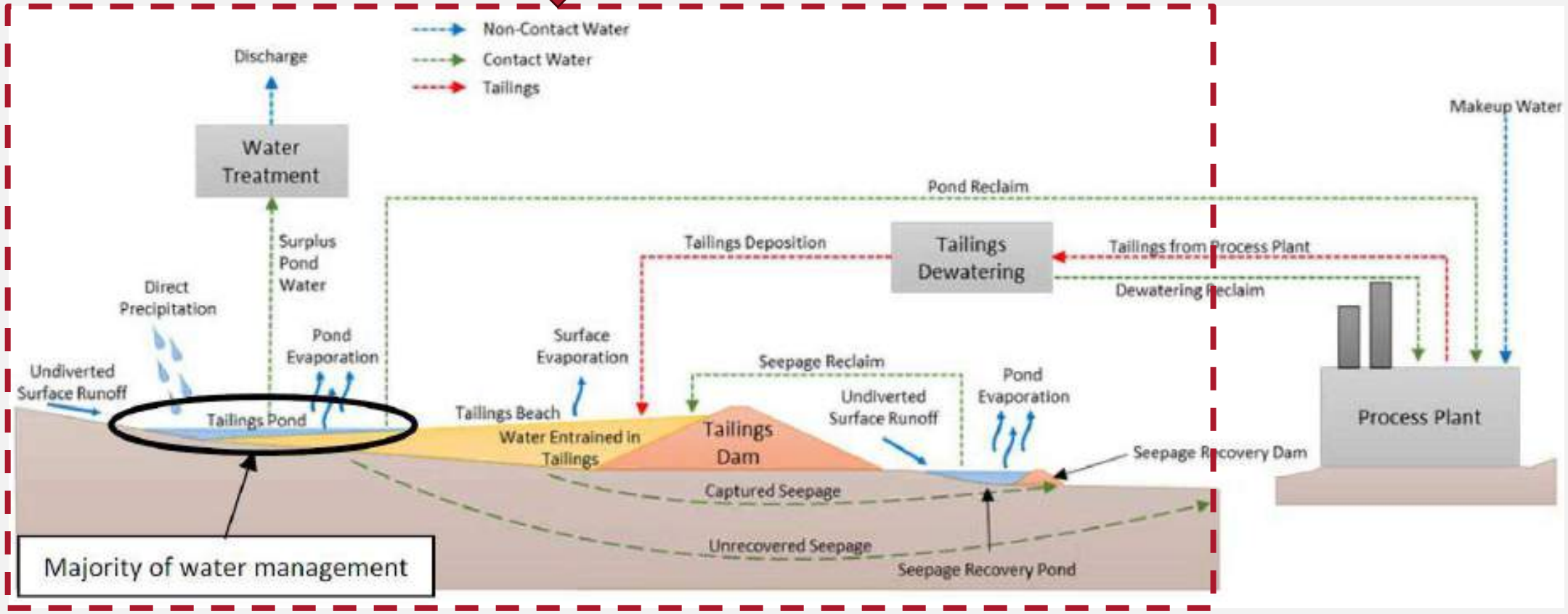
WHAT ARE TAILINGS STORAGE FACILITIES?

A TSF IS EVERYTHING INSIDE THIS BOX



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Morrison (2022) – SME Tailings Management Handbook

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LET'S TAKE A QUICK POLL!

Based on your experience and what you've read, how many tailings facilities do you think exist globally?

A. Less than 1,000

B. Between 3,500 and 5,000

C. Between 10,000 and 15,000

D. Over 20,000

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ANSWER & KEY FACT

Data is difficult to pin down exactly, but current estimates from sources like the World Mine Tailings Failures database suggest a number closer to 29,000 to 35,000 active, inactive, abandoned and closed tailings facilities

This is a massive portfolio that requires a global effort!

World Mine Tailings Failures—from 1915 – supporting global research in tailings failure root cause, loss prevention and trend analysis

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CONVENTIONAL DAMS VS. TAILINGS DAMS

East Branch Dam; Elk Co., PA

Conventional Dams

- Constructed in single stage
- Steady state achieved early
- Owner focused on dam operation & surveillance
- Owner has substantial resources available
- Viewed as an asset
- In-house expertise
- Finite operating life
- Well established process for closure

Highland Valley Tailings Dam, B.C.

Tailings Dams

- Construction ongoing for facility life
- Steady state only at closure
- Owner not focused on dams, focused on mining
- Constraints imposed by mining economics
- Not an asset
- Reliance on consultants
- Complicated process for closure; permanent tailings containment a must

These differences are reflected in the differing types of tailings containment structures that have been developed…

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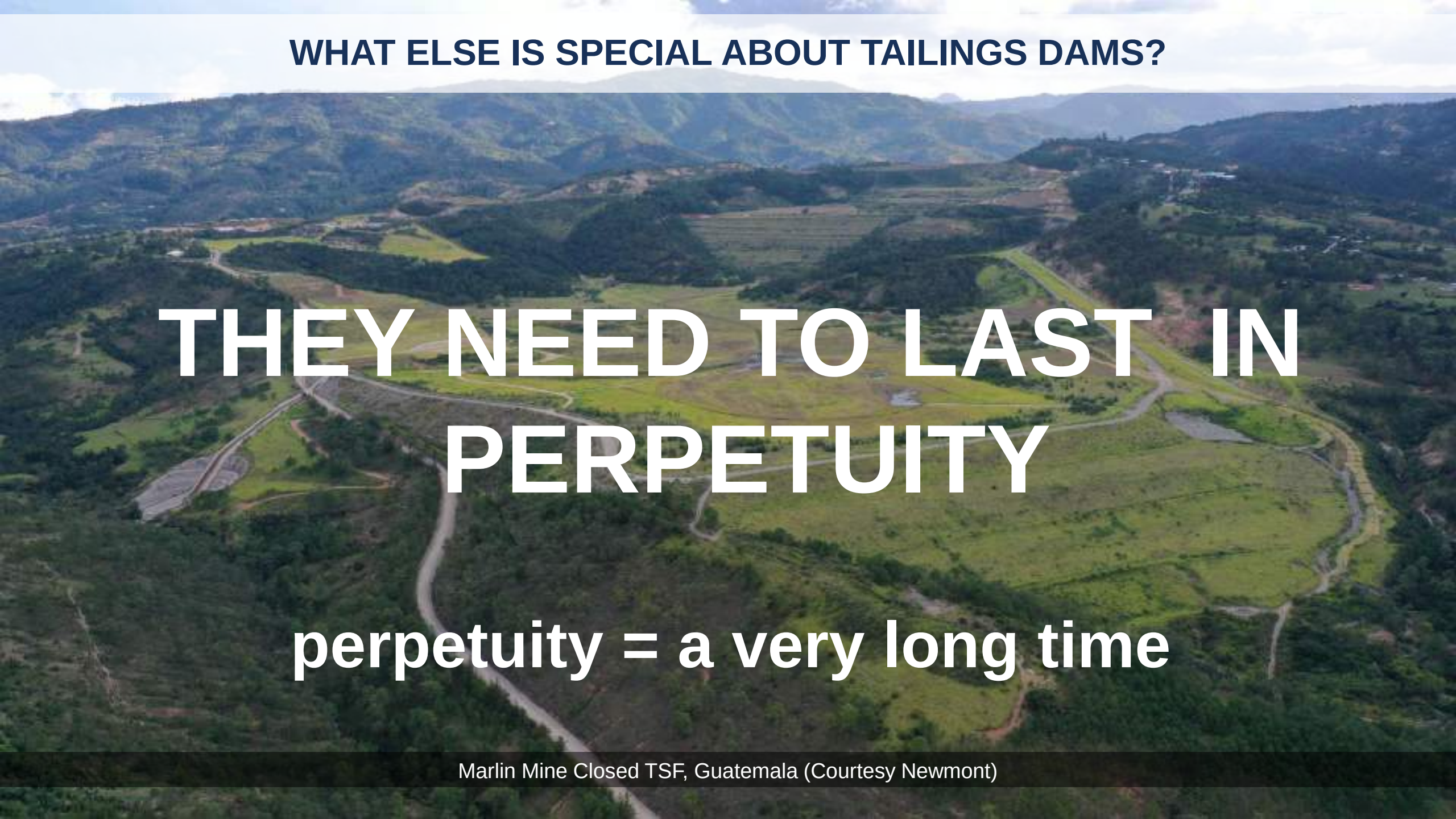
WHAT ELSE IS SPECIAL ABOUT TAILINGS DAMS?



THEY NEED TO LAST IN PERPETUITY

perpetuity = a very long time

Marlin Mine Closed TSF, Guatemala (Courtesy Newmont)

PERPETUITY IS A VERY LONG TIME…

World's Oldest Mine:

~43,000 years (Ngwenya, Swaziland)

Ngwenya Mine
(By Heather Dowd - Flickr: Ngwenya Mine, CC BY-SA 2.0 https://commons.wikimedia.org/w/index.php?curid=14734105)

World's Oldest Recently Operating Mine:

~2,000 years (Almaden, Spain)

Closed in 2003

Almaden Mine
(© Parque Minero de Almadén)

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THESE ARE NOT EQUIVALENT PROPOSITIONS…

This is the only one of the seven wonders of the ancient world still standing….

≠

This will require a much higher degree of stewardship than the Great Pyramid.

Our experience with large engineered structures is ONLY ~5,000 years

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TAILINGS LIFE-CYCLE

Design (site selection, design, permitting)

Construction (initial construction, raises)

Operations (i.e., tailings disposal)

Transition / Closure (preparation for the closure phase, may include flushing out contamination)

25 to 50 years

Long-term Treatment (dam operation continues in the sense of regulated water levels)

50 – 100 years?

Post-closure Care & Maintenance (dam is no longer operated in the sense of regulated water levels)

Perpetuity....

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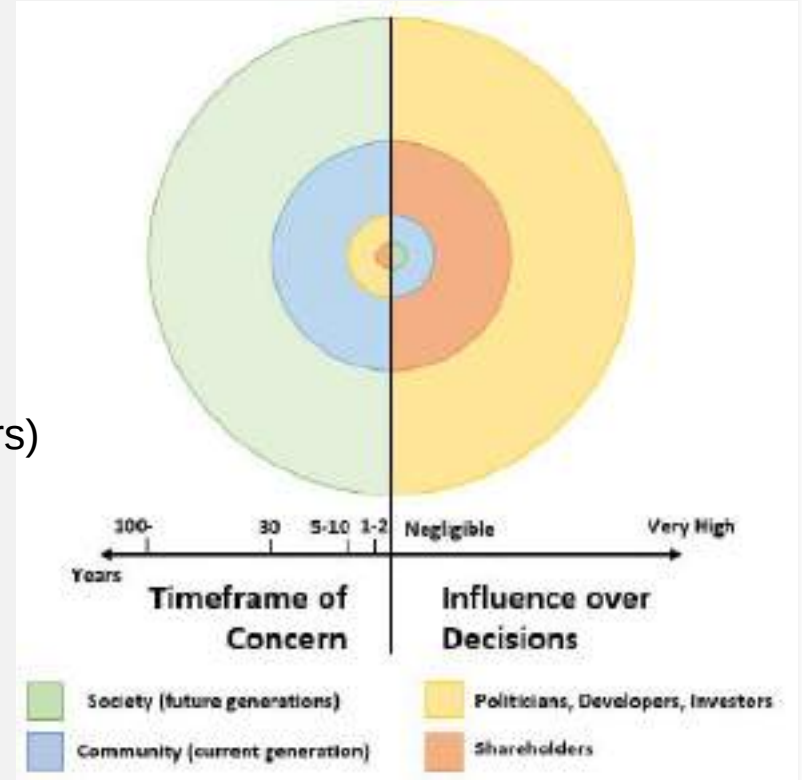
WHAT'S THE COST OF TAILINGS DEPOSITION?

Many factors affect cost of tailings management:

- Topography
- Dam construction method
- Extent of engineering controls (e.g., lined vs. unlined)
- Borrow material source (e.g., mine waste vs. developed borrow)
- Tailings characteristics
- Selected tailings disposal methodology (e.g., cyclones, spigots, filters)
- Water management requirements
- Geochemistry (e.g., PAG vs. non-PAG)
- Distance from process plant
- Closure requirements
- Among others…

Misaligned project development horizons of mining stakeholders

(after Espinoza & Morris 2016; in Carneiro & Fourie, 2018)



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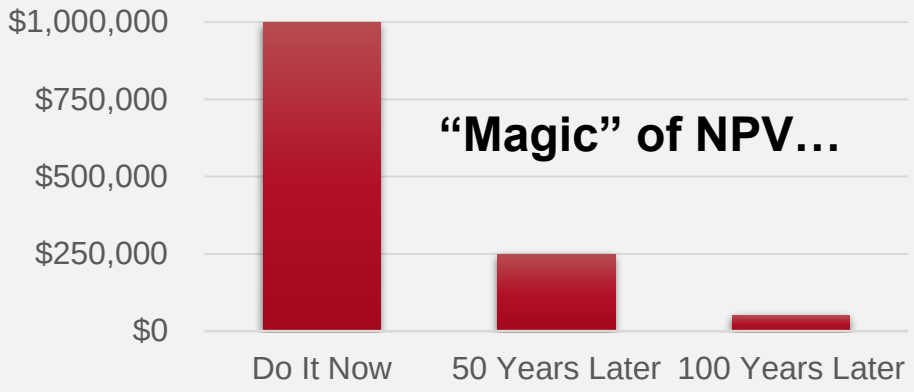
PAYING THROUGH PERPETUITY…

- **Who's paying?**
  - Financial assurance for closure in many jurisdictions is 50 to 100 years
- **How will finance of NPV work in the future?**
- **Are NPV-based approaches a sound way to close / finance your mine closure?**
- **Ages of Financial Organizations:**
  - Oldest Bank: 539 years
    Banca Monte dei Paschi di Siena S.p.A. (Italy)
    1472 - present
  - Oldest Governments (relatively stable): 235 - 500 years
  - Oldest Business: 1,400 years
    Kongo Gumi (Japan) 578 - 2006



The NPV adjusted costs of deferring a $1M expense

Long-term water cover, TSF, British Columbia

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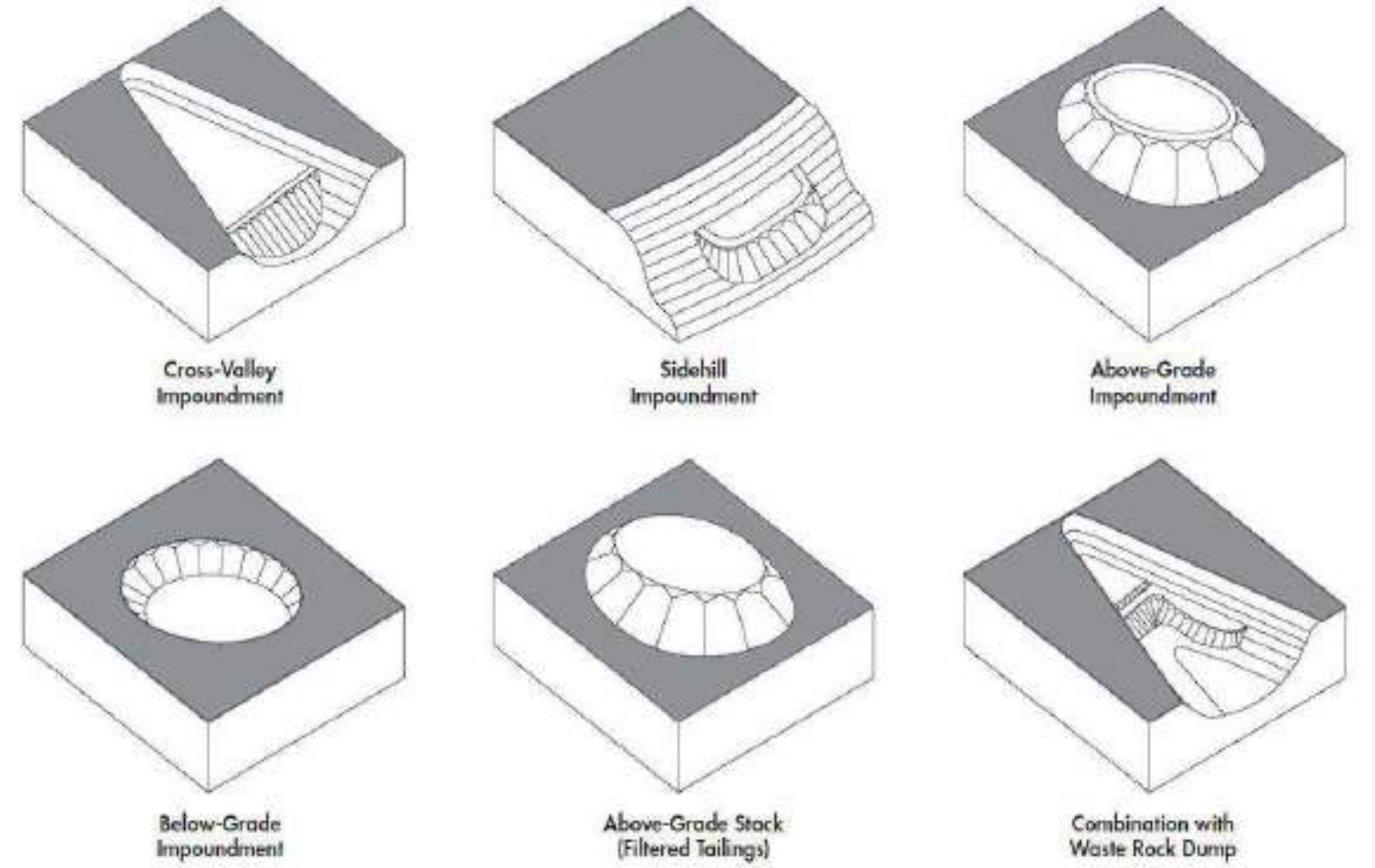
TAILINGS MANAGEMENT STRATEGIES AND FACILITY TYPES

Facility Types:

- **Cross Valley**
- **Sidehill**
- **Above-Grade**
- **Below Grade**
- **Above Grade Stack (filtered tailings)**
- **Co-deposition with Waste Rock**



Morrison (2022) – SME Tailings Management Handbook

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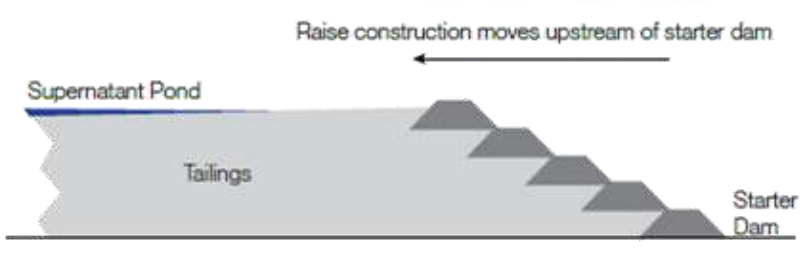
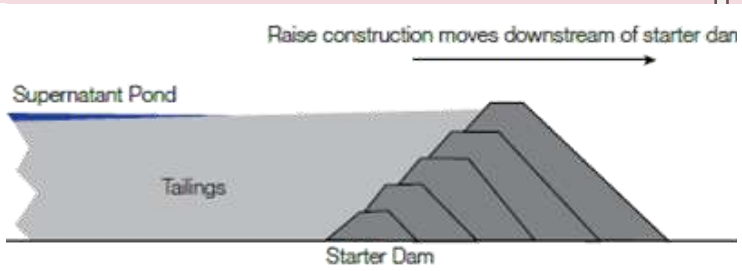
TAILINGS DAM CONSTRUCTION METHODS

Upstream Method



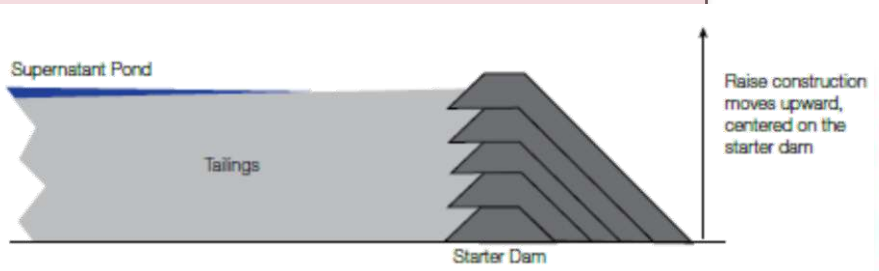
- **Pros** – Uses least material to build wall, least $
- **Cons** – Least stable configuration, illegal in some jurisdictions, cannot safely contain water

Downstream Method



- **Pros** – Reduced risk, zero reliance on tailings for stability, most stable in EQ zones, may retain water
- **Cons** – Highest $, uses more material to build the wall

Centreline Method



- **Pros** – Uses less material than d/s (reduced $), tailings often used for dam construction
- **Cons** – Requires good control of phreatic surface, depends on temporary support from tailings beach

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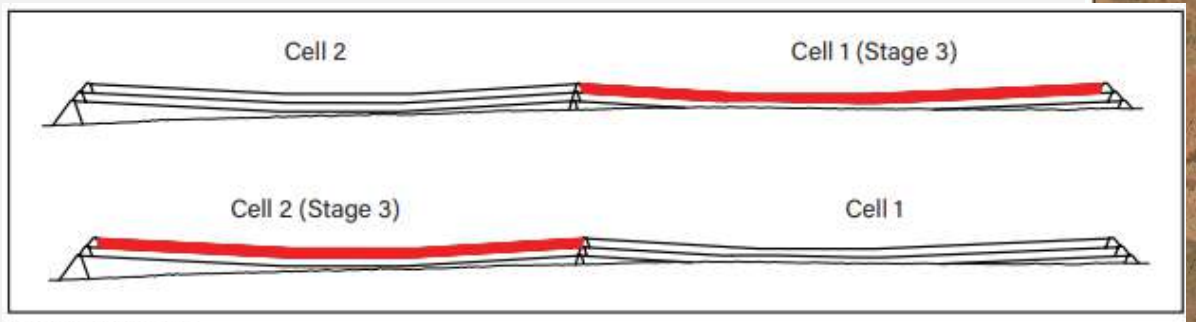
UPSTREAM METHOD | EXAMPLE

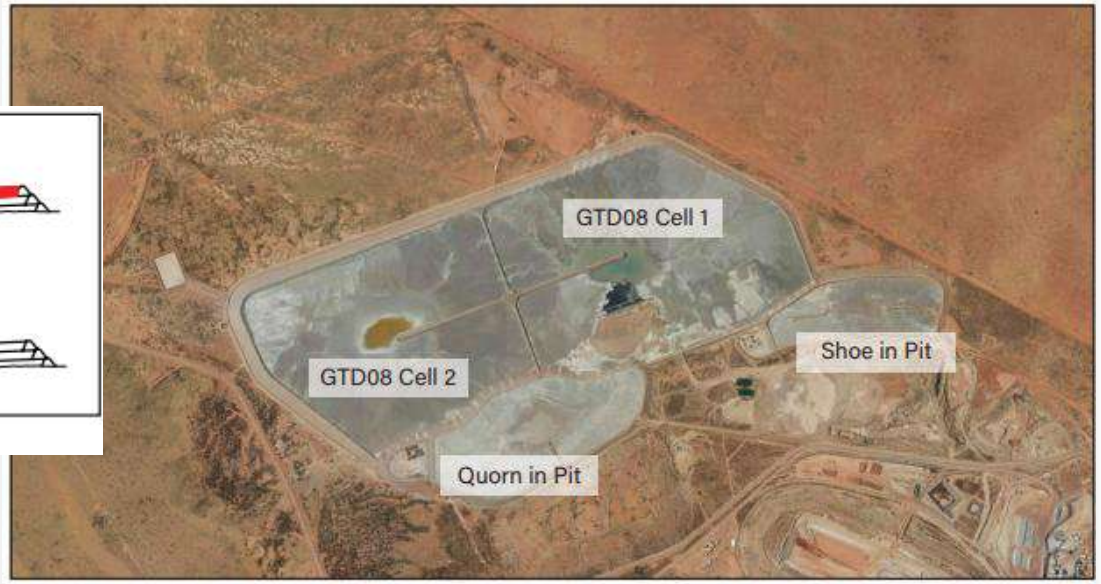
Tanami Mine – Northern Territory, Australia

- Seismic hazard: Low (designed for 10,000-yr AEP event)
- Dam material: earthfill and rockfill (including mine waste)
- Maximum height: 15m (agreement with transitional owner aspirations to limit visual impact)



Courtesy of Newmont

See Case Study in: Morrison (2022) – SME Tailings Management Handbook



Courtesy of Newmont

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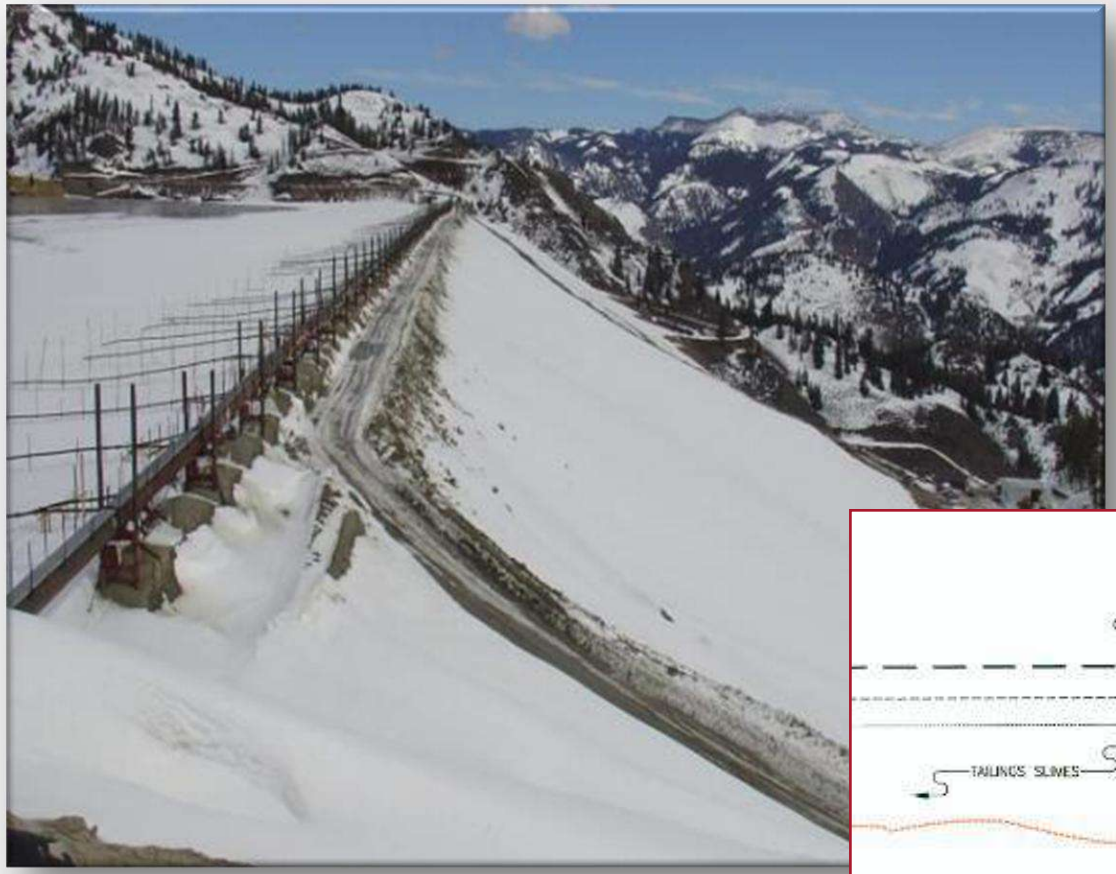
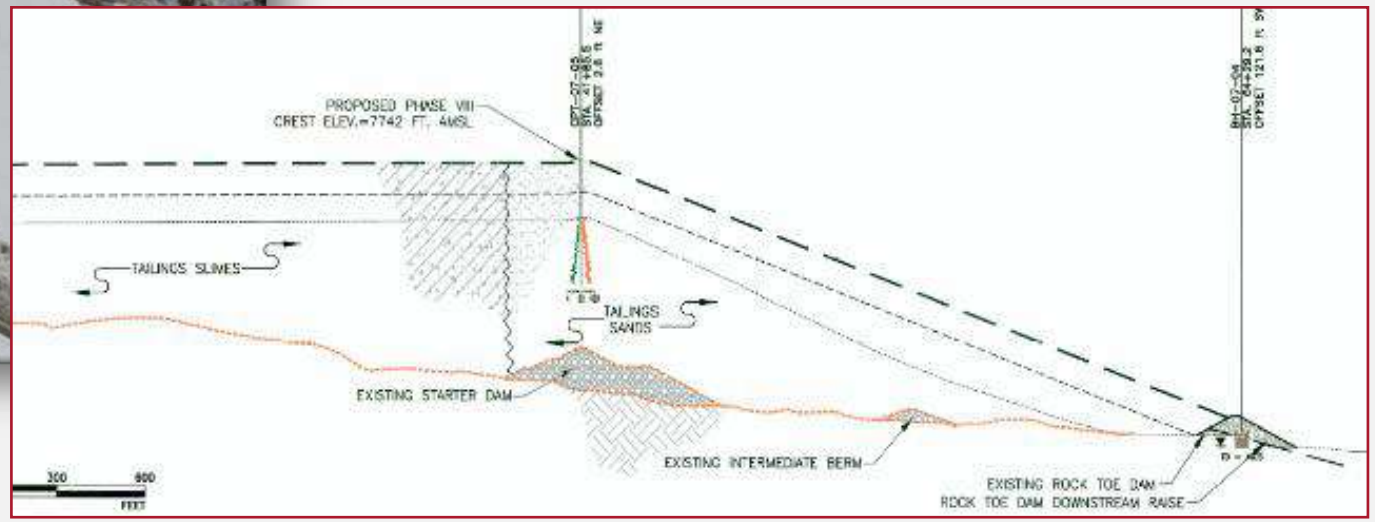
CENTERLINE METHOD | EXAMPLE



Thompson Creek – Idaho, USA

- Seismic hazard: Moderate
- Dam material: compacted cyclone sand (i.e., coarse-grained tailings)
- Downstream slope: 2.75H:1V to 3H:1V



Morrison et al. (2010) “Innovative expansion of a large centerline constructed TSF in a seismically-active area.” Mine Waste 2010. Perth, WA, Australia.

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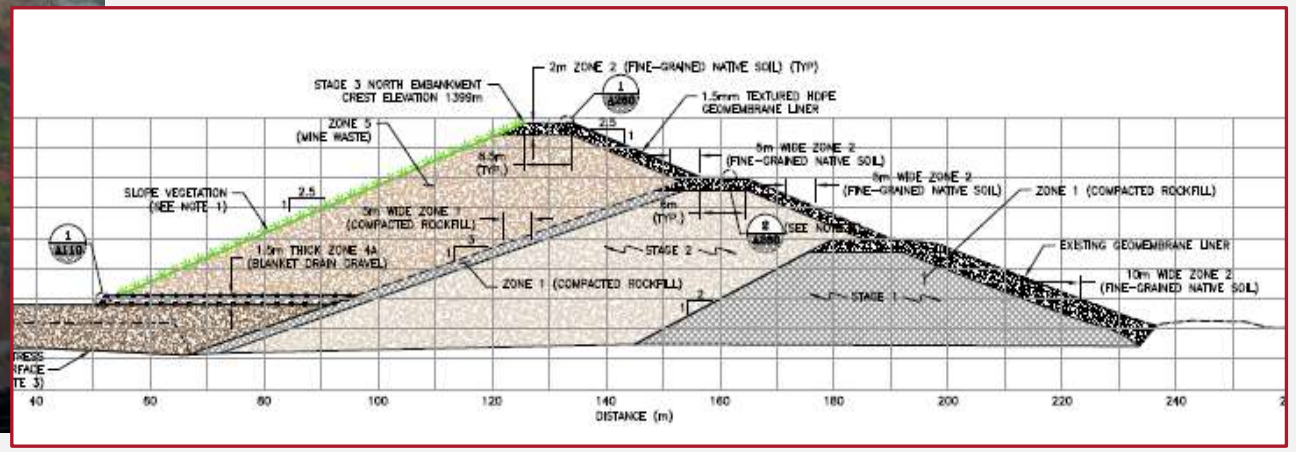
DOWNSTREAM METHOD | EXAMPLE

Tenke Fungurume Mine – DRC

- Seismic hazard: Low
- Dam material: earthfill and rockfill (including mine waste)
- Geomembrane-lined
- Downstream slope: 2.5H:1V



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COMPARISON OF DAM CONSTRUCTION METHODS (AFTER VICK, 1990)

	Conventional Water Dam	Upstream	Downstream	Centreline
Mill Tailings Requirements	Suitable for any type of tailings	At least 40-60% sand in whole tailings.	Suitable for any type of tailings	Sands or low-plasticity slimes
Discharge Requirements	Any discharge procedure suitable	Peripheral discharge and well-controlled beach necessary	Varies according to design details	Peripheral discharge of at least nominal beach necessary
Water Storage Suitability	Good	Not suitable for significant water storage	Good	Not recommended for permanent storage; temporary flood storage acceptable with proper design
Seismic Resistance	Good	Poor in high seismic areas	Good	Some vulnerability during stage raises, good for final configuration with buttressing by tailings deposit.
Raising Rate Restrictions	Entire embankment constructed initially	Less than 4.5 - 9 m/yr most desirable.	None	Height restrictions for individual raises may apply
Embankment Fill Requirements	Natural soil borrow	Natural soil, sand tailings, or mine waste	Sand tailings, mine waste, or natural soil	Sand tailings or mine waste if production rates are sufficient, or natural soil
Relative $	**High**	**Low**	**High**	**Moderate**

A rate of rise of less than **~2.5 m/year** is recommended (rule of thumb) in more recent literature P J Chapman, D A Williams, 2018

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UPSTREAM: MISCELLANEOUS “EVENTS”

Some examples of why upstream constructed dams have earned a poor reputation for themselves…

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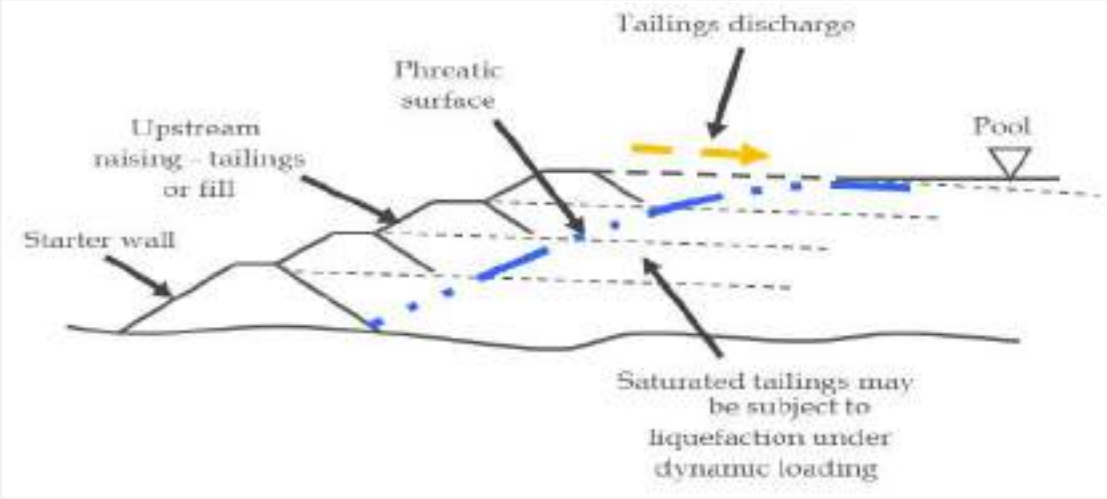
10 “RULES” FOR UPSTREAM TAILINGS DAMS

1. **Upstream dams can be safe given appropriate design and site conditions.**
2. **Beach-below-water tailings should not underlie the slope unless Rule 5 is satisfied**
3. **Rate of rise sufficiently slow to dissipate construction-induced pore pressures**
4. **Under-drainage to maintain low pore pressures**
5. **Design analyses – Undrained Stress Analysis (USA) & Effective Stress Analysis (ESA), not ESA alone**
6. **Ongoing designer/EoR involvement, monitoring, confirm design assumptions**
7. **Not appropriate for regions of moderate to high seismicity**
8. **Design and operational requirements must be compatible**
9. **Understand pore pressures – hydrostatic is rarely the case**
10. **Slope steeper than 4H:1V more susceptible to spontaneous liquefaction failure with minimal trigger application**



Sources: Martin & McRoberts (1999) “Some considerations in the stability analysis of upstream tailings dams.” Wates (2023) “Design criteria for upstream raised tailings storage facilities.”

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MINE TAILINGS TYPES

Tailings are classified into five major tailings types:

Tailings Type	Symbol	Description	Examples
Coarse tailings	CT	Silty **sand**, nonplastic	Salt, mineral sands, coarse coal refuse, iron ore sands
Hard rock tailings	HRT	Sandy **silt**, nonplastic to low plasticity	Copper, massive sulfide, nickel, gold
Altered rock tailings	ART	Sandy **silt**, trace to some clay-sized particles, low plasticity	Porphyry copper with hydrothermal alteration, oxidized rock
Fine tailings	FT	**Silt**, with trace to some clay-sized particles, low to moderate plasticity	Fine coal refuse, bauxite residue (red mud), leachate processes, metamorphosed/weathered polymetallic ores
Ultra-fine tailings	UFT	Silty **clay**, high plasticity, very low density, and hydraulic conductivity	Oil sand (mature fine tailings), phosphate fines, some kimberlite and coal fines

Source: ICOLD 2017

Note: Ultra-coarse tailings from dense media separation circuits excluded.

Source: Morrison (2022)

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COMMON TAILINGS CHARACTERIZATION PARAMETERS

Index (and Indicator) Properties:

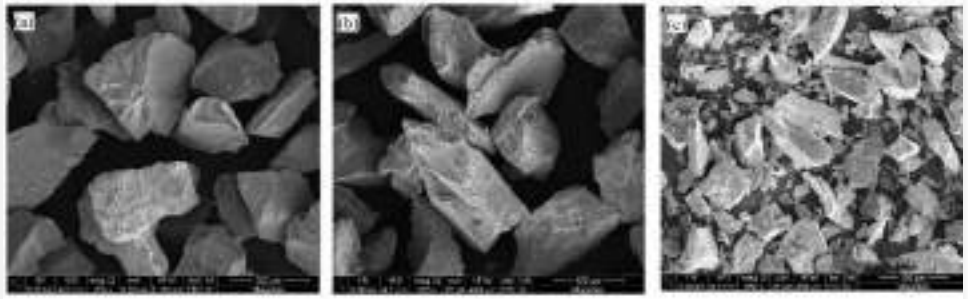
- Particle shape
- Mineralogy (particularly presence of clay minerals)
- Particle size distribution (PSD)
- Specific gravity (SG)
- Dry density: in-place, initial settled density, long-term density
- Solids content (or water content)
- Plasticity: liquid limit, plastic limit

Geochemistry:

- Mineralogy
- Fluid chemistry (salinity, pH, metals concentration)
- Chemical and/or mineralogical static and/or kinetic tests (e.g., acid generating potential)

Engineering Properties:

- Rheology: flow, viscosity, yield stress
- Compaction: maximum dry density, optimum moisture content (e.g., filtered tailings, tailings as engineered fill)
- Consolidation: small-strain and large-strain properties and behavior
- Shear strength
- Permeability



Torres-Cruz & Santamarina (2019): SEM images of (a) coarse, (b) medium, and (c) fine platinum tailings

Tailings mechanics is NOT the same as soil mechanics!

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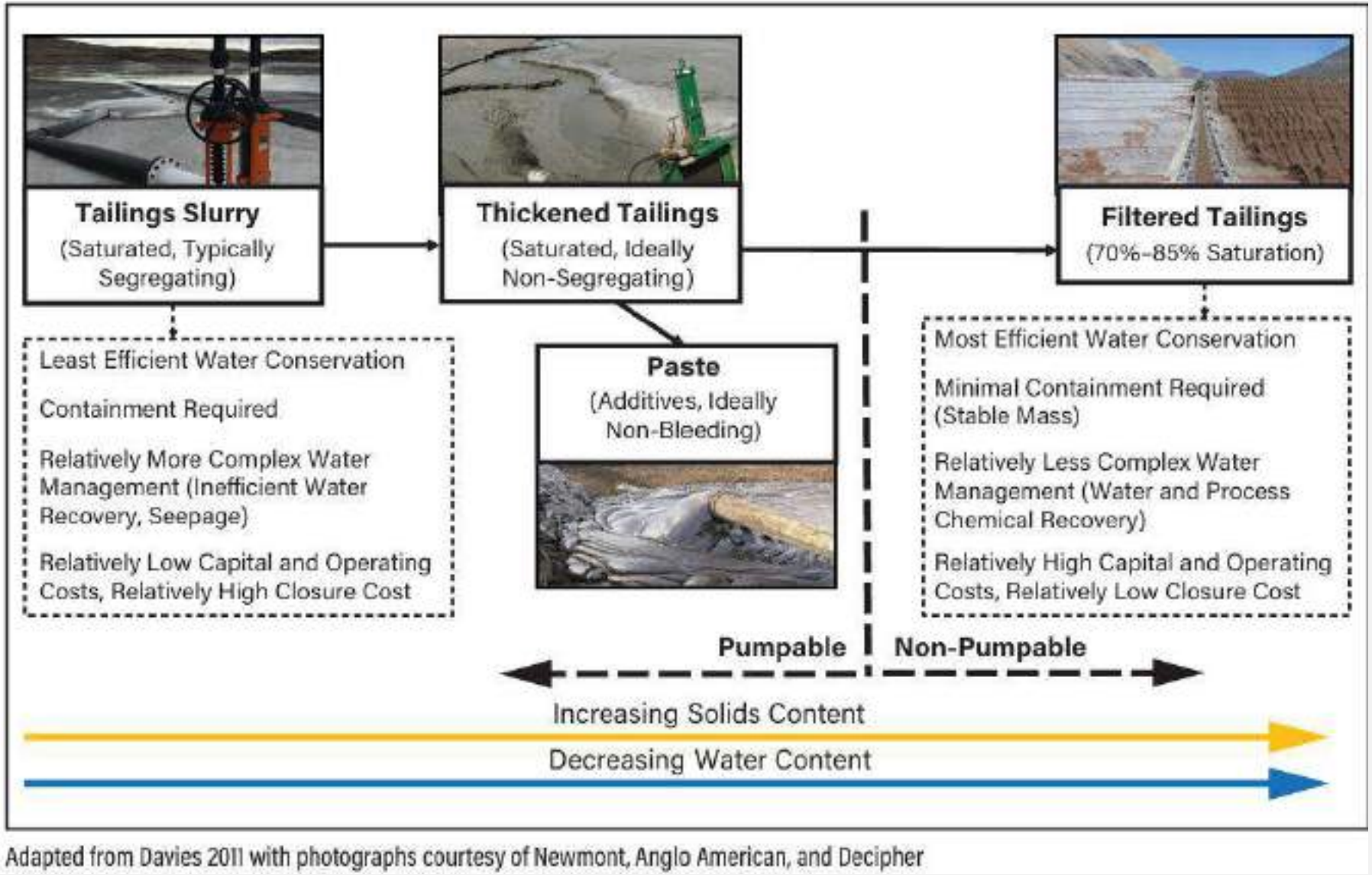
TAILINGS DEWATERING CONTINUUM



Adapted from Davies 2011 with photographs courtesy of Newmont, Anglo American, and Decipher

Morrison (2022) – SME Tailings Management Handbook

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Slurry tailings: solids content ≈ 20-40%

Filtered tailings: solids content >75%

Thickened and paste tailings: solids contents 40-70%, 70-75%

Tailings.info / Morrison (2022)

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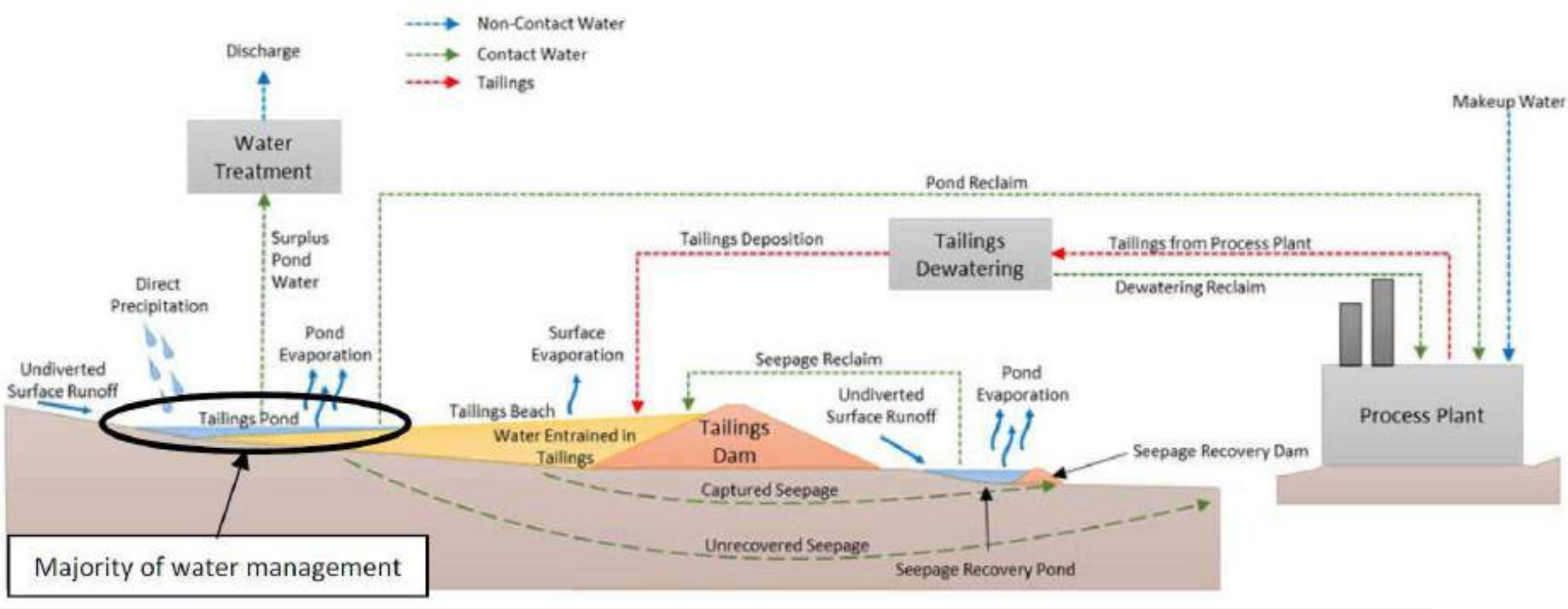
CONVENTIONAL TAILINGS | ILLUSTRATION



Morrison (2022) – SME Tailings Management Handbook

CONVENTIONAL TSF | EXAMPLE

Cerro Verde Expansion Project

- Arequipa, Peru

TSF Initial Starter Dam Construction

TSF after 5 Years of Operation

Morrison (2022) – SME Tailings Management Handbook

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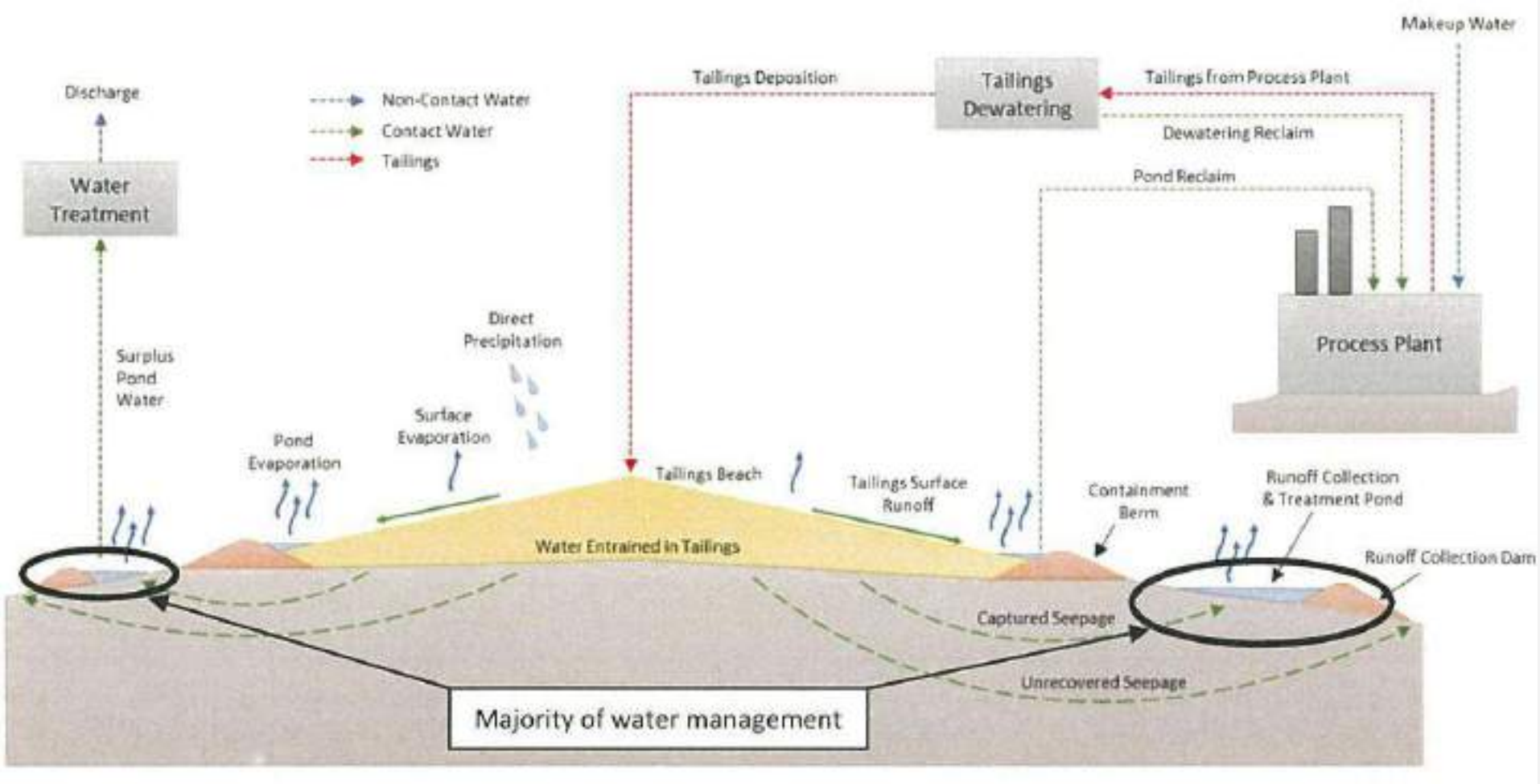
THICKENED/PASTE TSF | ILLUSTRATION



Morrison (2022) – SME Tailings Management Handbook

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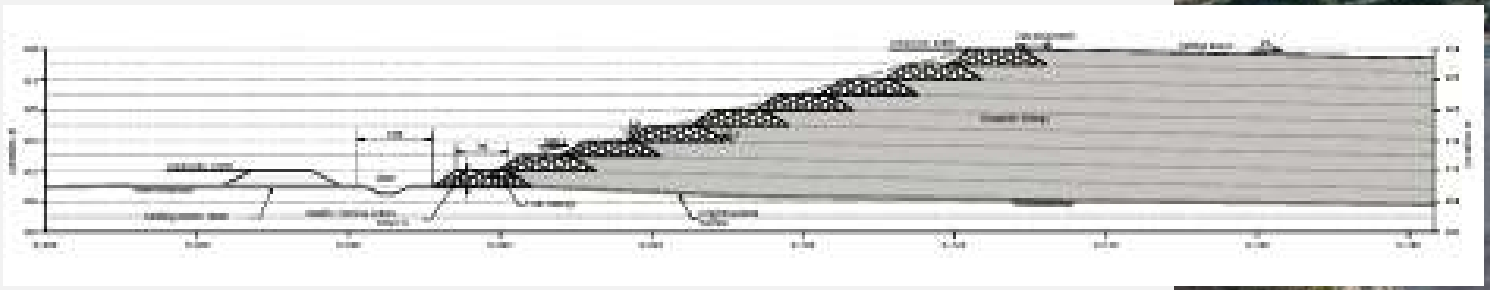
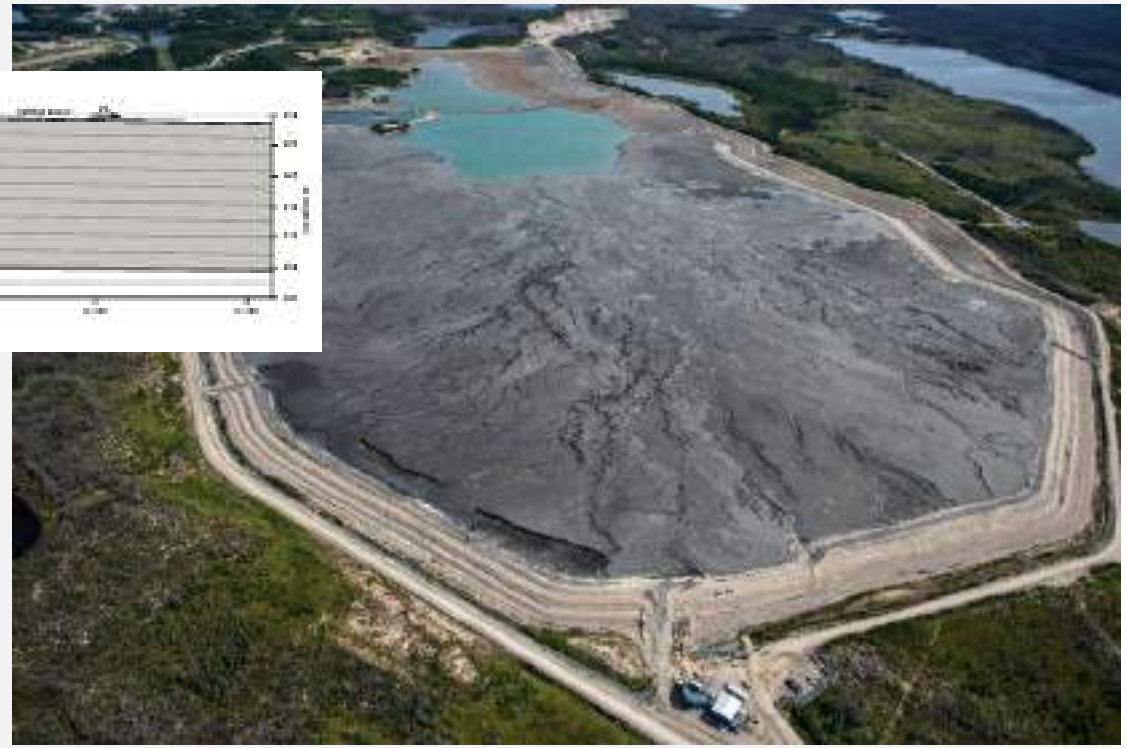
THICKENED/PASTE TSF | EXAMPLE

Musselwhite Mine

- Ontario, Canada
- Conversion of TSF from Conventional Slurry to Thickened Tailings Deposition



Source Kam and Li 2008



Thickened Tailings Deposition at Target Density of 70% Solids

Morrison (2022) – SME Tailings Management Handbook

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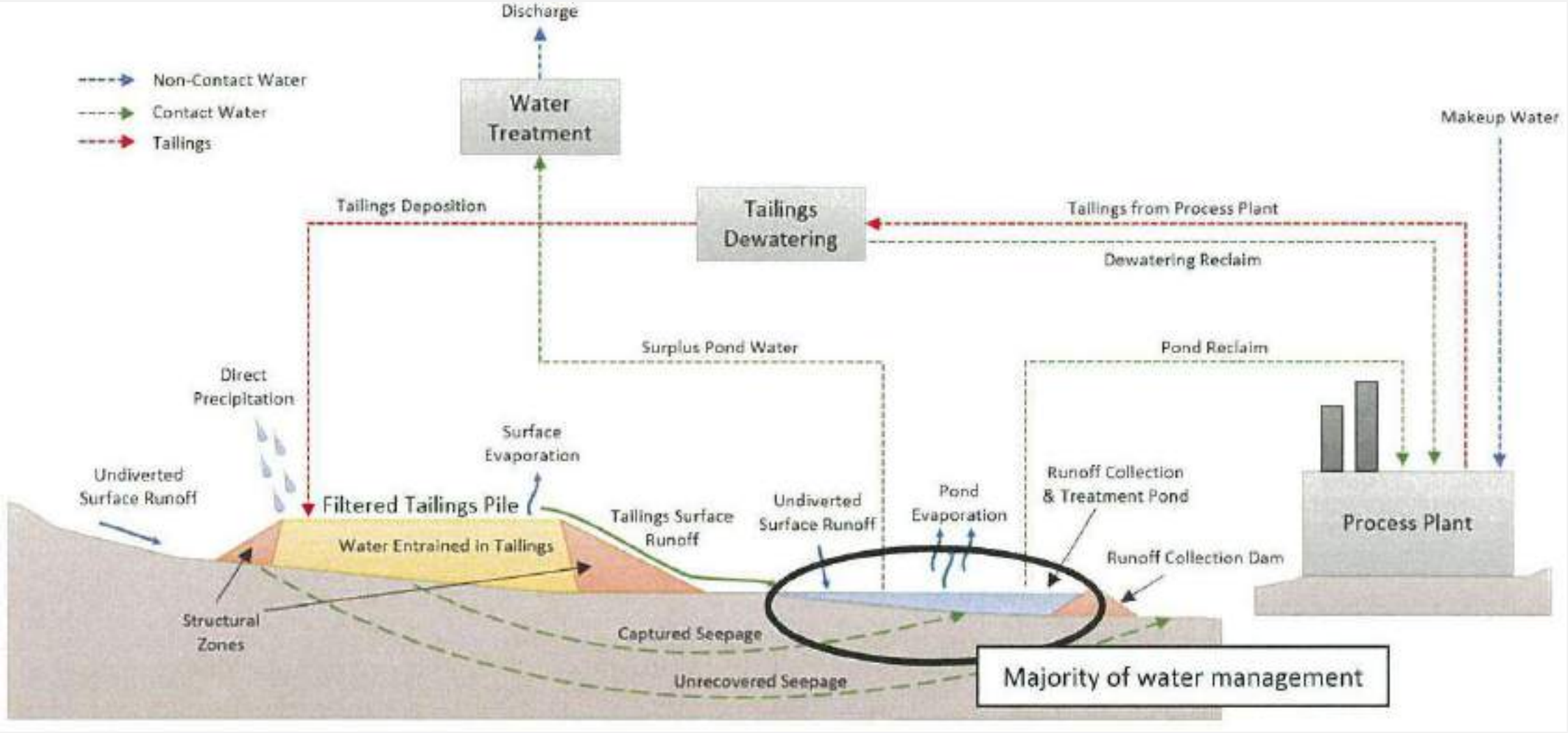
FILTERED TSF | ILLUSTRATION



Morrison (2022) – SME Tailings Management Handbook

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FILTERED TAILINGS FACILITY | EXAMPLE

Conversion of Slurry TSF into Filtered Tailings Deposition

- Cupias TSF - Durango, Mexico
- Guanacevi TSF - Durango, Mexico

Courtesy of Wood

Cupias Filtered TSF, First Majestic Silver Corp., Durango, Mexico

Courtesy of Wood

Guanacevi Filtered TSF, Endeavour Silver Corp., Durango, Mexico

Morrison (2022) – SME Tailings Management Handbook

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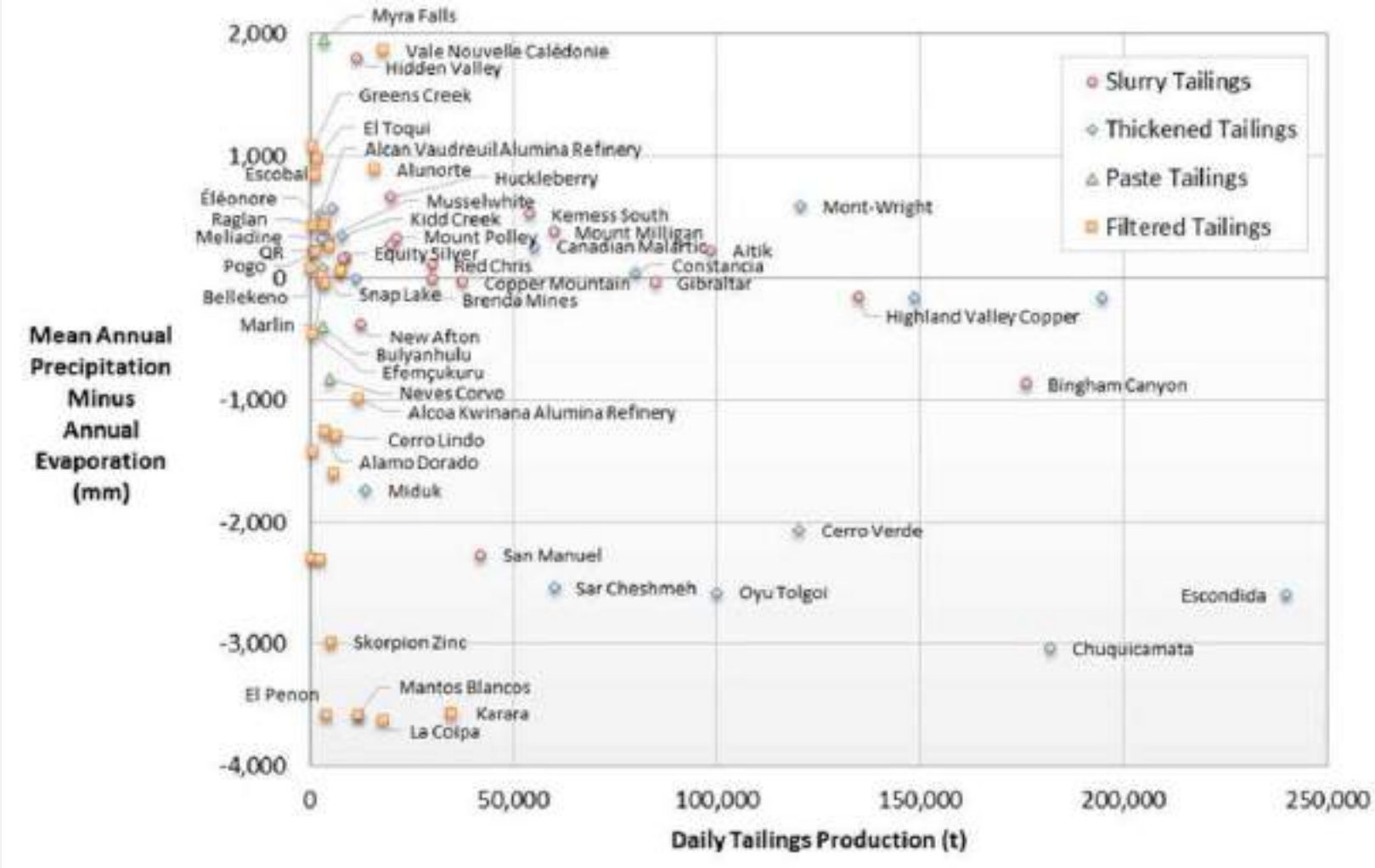
BENCHMARKING TAILINGS TECHNOLOGIES

MEND (2017) study is a bit dated but provides useful industry tailings technology benchmark.

Sites and technologies considered in 2017 evaluation are shown in figure to the right.

Influence of climate on technology selection was a key focus.



http://mend-nedem.org/wp-content/uploads/2.50.1Tailings_Management_TechnologiesL.pdf

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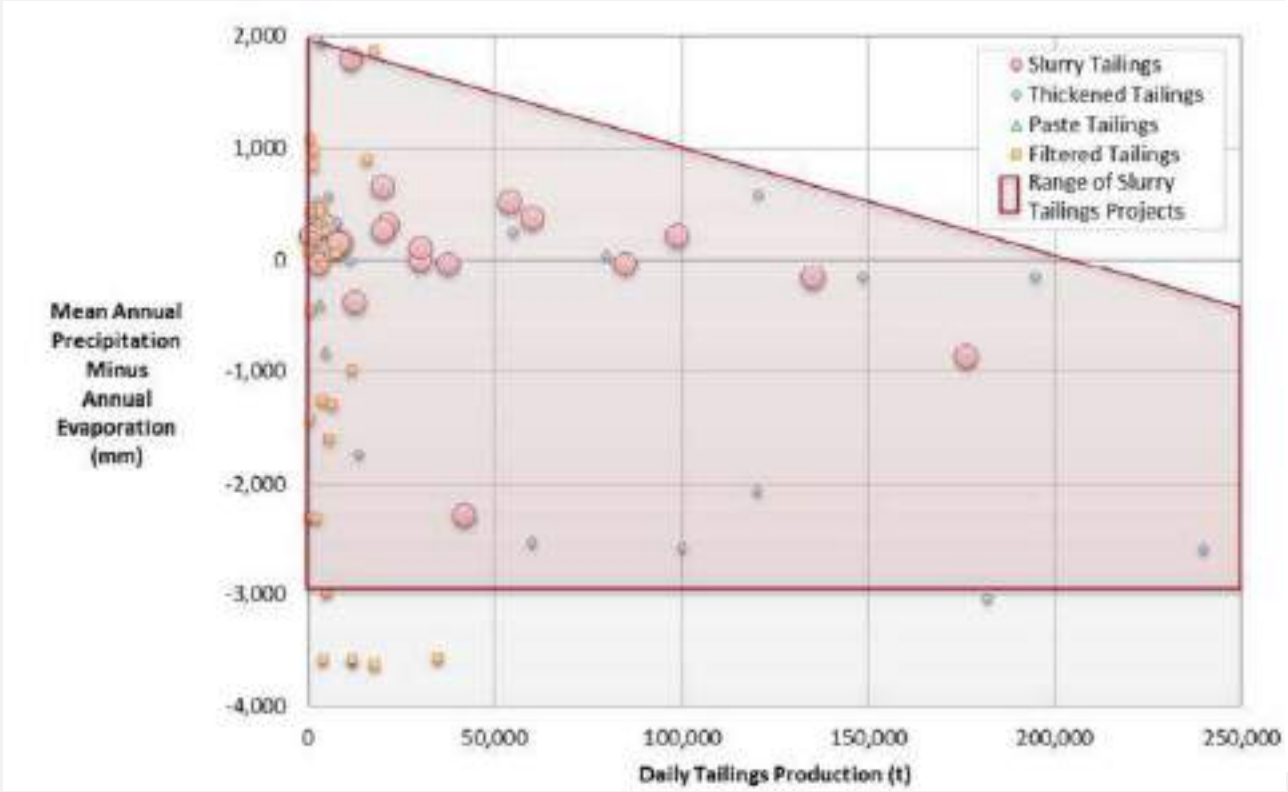
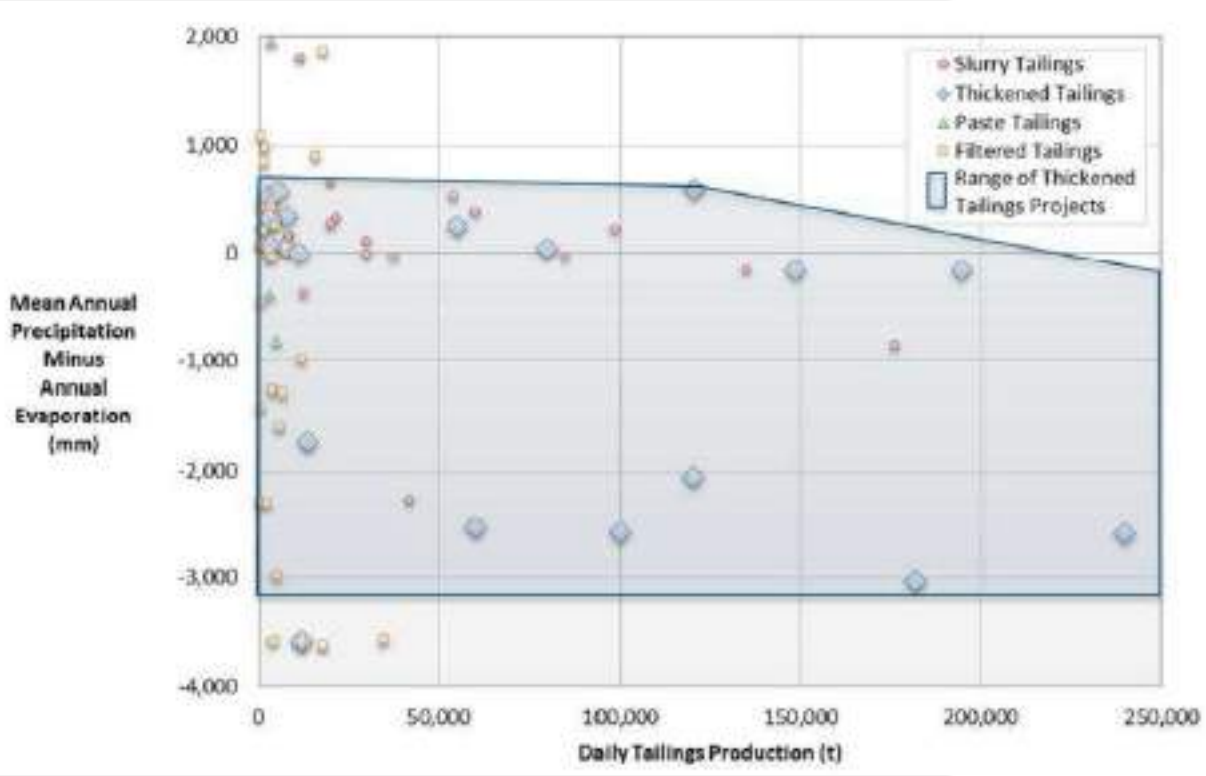
BENCHMARKING TAILINGS TECHNOLOGIES



Conventional Slurry



Source: MEND (2017)

Thickened Tailings

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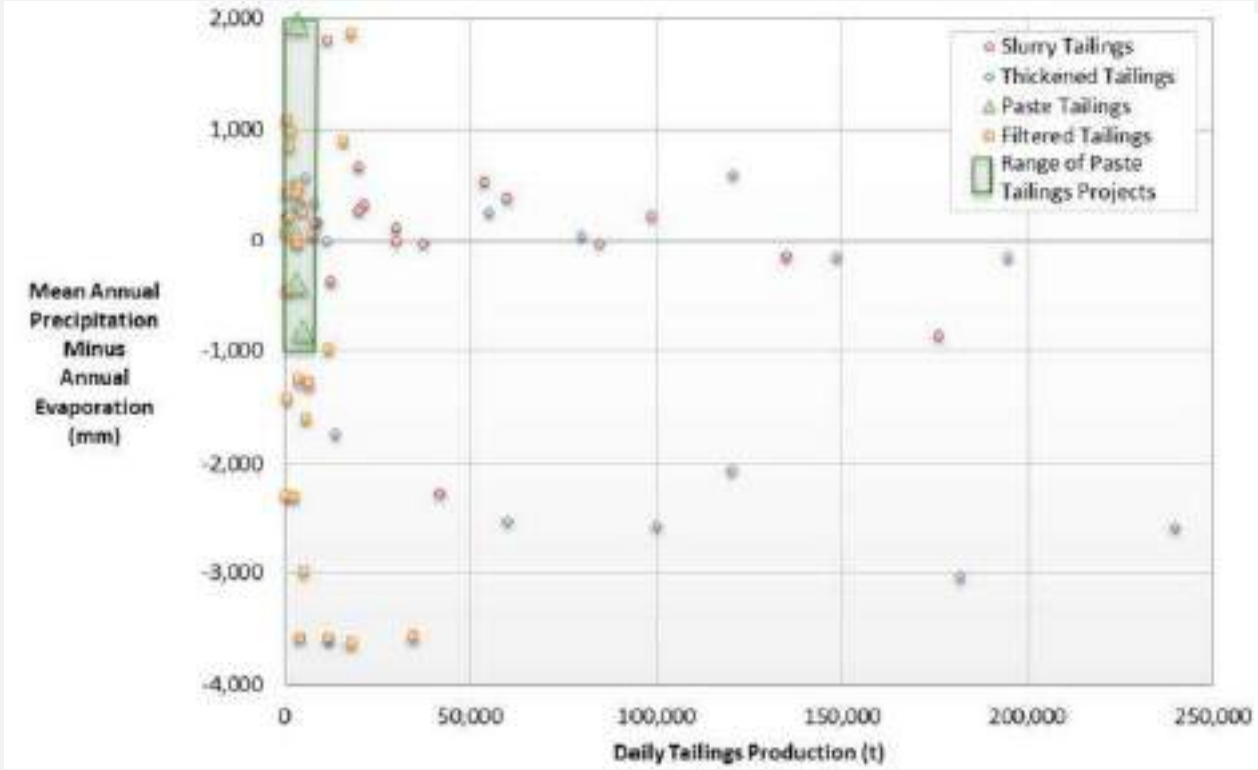
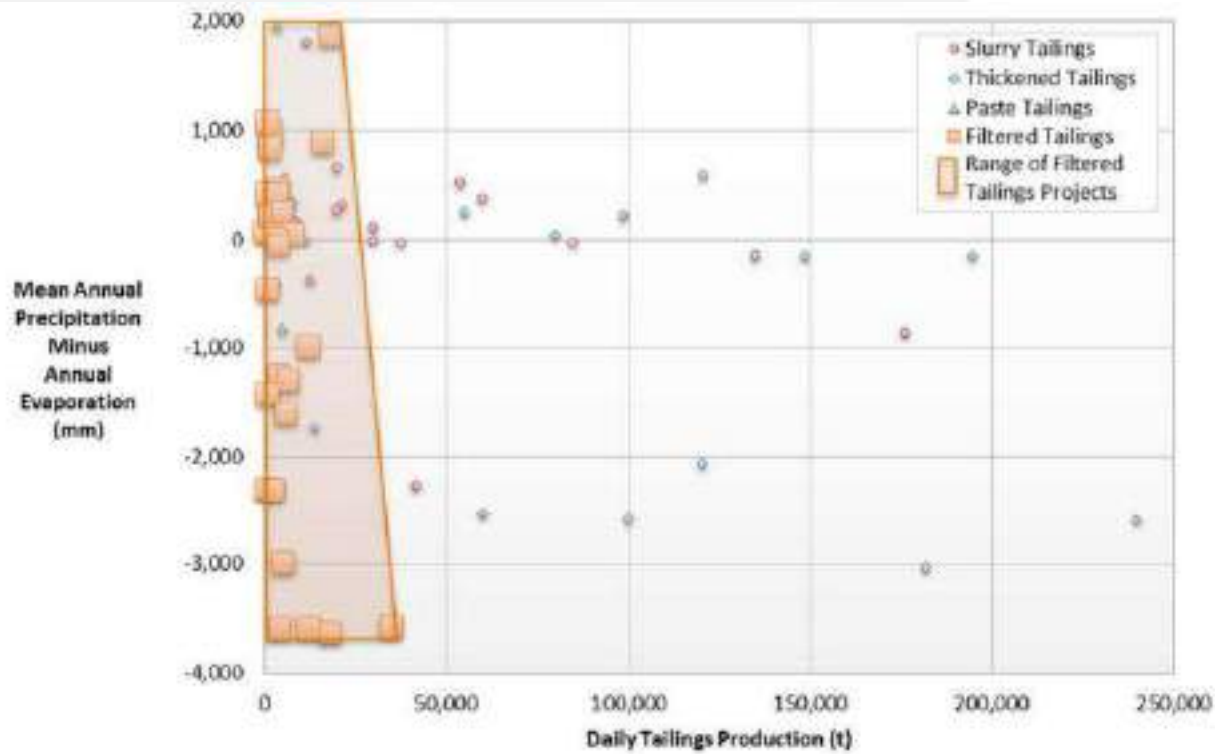
BENCHMARKING TAILINGS TECHNOLOGIES



Surface Paste Tailings



Filtered Tailings

Source: MEND (2017)

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TAILINGS STORAGE

Source: Paterson & Cooke (2025)

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PAST FAILURES → THE SHIFT FROM TRUST TO CONTROL

Tailings: *Fundamentals, Failures, and the New Standard of Care*

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HOW ARE TAILINGS VIEWED BY THE PUBLIC?

“The strongest argument of the detractors of mining is that the fields are devastated by mining operations…further, when the ores are washed, the water used poisons the brooks and streams and either destroys the fish or drives them away…thus it is said, it is clear to all that there is greater detriment from mining than the values of the metals which the mining produces.

—GEORGIUS AGRICOLA (1556) –
DE RE METALLICA LIBRI XII


GEORGII AGRICOLAE
DE RE METALLICA LIBRI XII
BASILEAE M D LVI

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TAILINGS DAM FAILURES AND REGULATORY OR SOCIAL RESPONSE:
A REFLECTION OF LACK OF TRUST?

Notable Failures & Responses

✓ El Cobre N°1 Dam Failure, Chile – 1965

✓ Mufulira No. 3 Dam Failure, Zambia – 1970

✓ Stava Tailings Failure, Italy – 1985

✓ Mount Polley Tailings Failure, Canada – 2014

✓ Samarco Fundão Dam Failure, Brazil – 2015

✓ Córrego do Feijão Dam I Failure, Brazil – 2019

The Trust-Control Relationship

EL COBRE N°1 DAM FAILURE, CHILE | 28 MARCH 1965

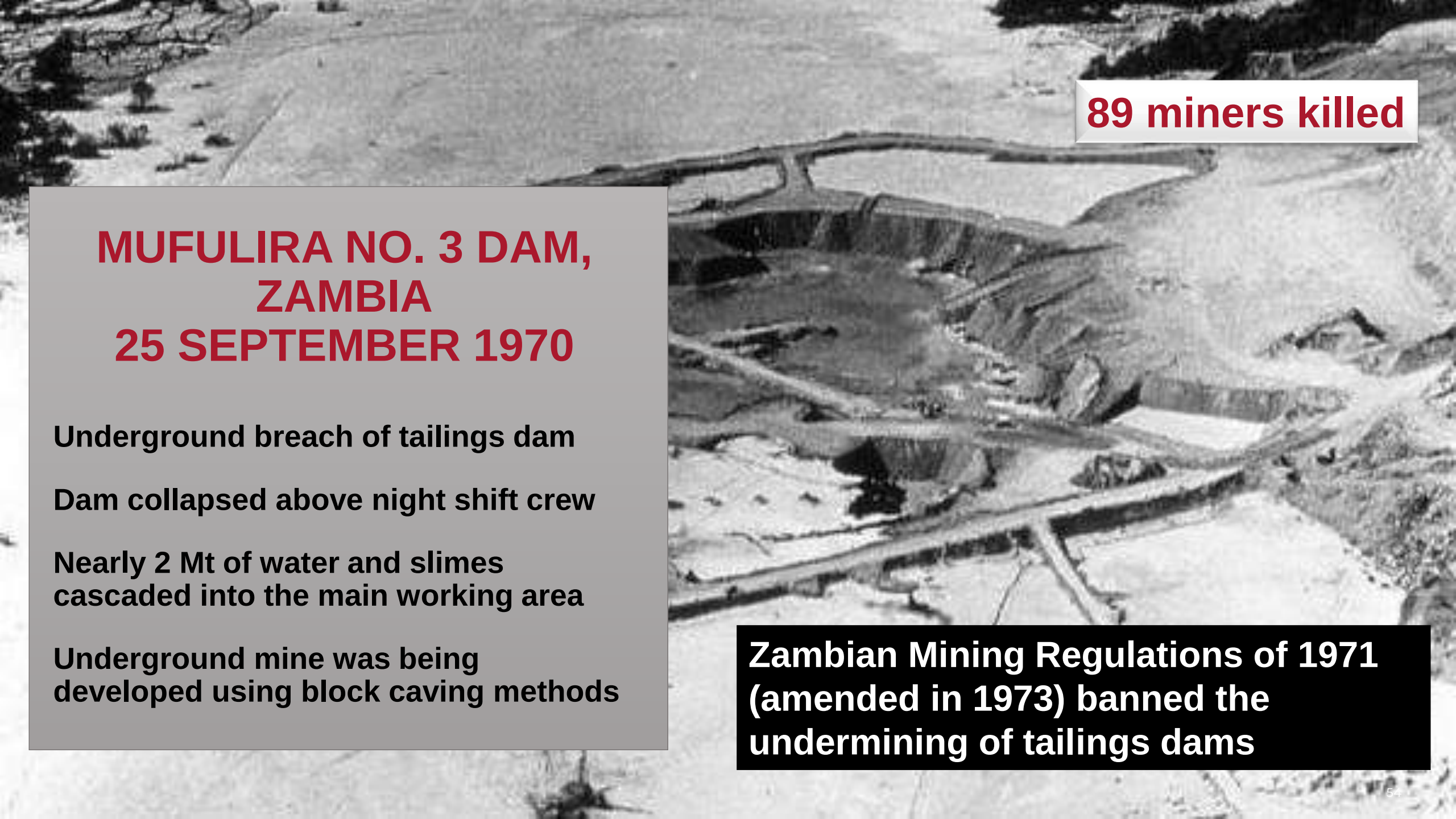
Failure occurred after the M7.4 La Ligua earthquake with an epicenter 40km away

Numerous tailings dams failed or badly damaged in central Chile as a result of this earthquake

>200 fatalities

Construction of upstream tailings dams banned in Chile in 1970

Source: YouTube



MUFULIRA NO. 3 DAM, ZAMBIA 25 SEPTEMBER 1970

Underground breach of tailings dam

Dam collapsed above night shift crew

Nearly 2 Mt of water and slimes cascaded into the main working area

Underground mine was being developed using block caving methods

89 miners killed

Zambian Mining Regulations of 1971 (amended in 1973) banned the undermining of tailings dams

STAVA TAILINGS FAILURE, ITALY | 19 JULY 1985

Source: YouTube

Source: https://www.stava1985.it/

- Prestavèl fluorite mine
- Above the village of Stava, near Tesero, North Italy
- 180,000 m^3 of tailings flowed 4.2 km downstream
- Destroyed 62 buildings and affected 43.5 ha

LEGAL LIABILITY – STAVA FAILURE

Monument to the disaster in Trento, Italy

10 criminal convictions for manslaughter in 1992 in the aftermath of the Stava disaster

Source: https://www.stava1985.it/

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MOUNT POLLEY TAILINGS FAILURE, CANADA | 4 AUGUST 2014

Canada's Mount Polley disaster: experts warned tailings pond 'getting large'

Mount Polley mine spill: a hazard of Canada's industry-friendly attitude?

Breach of tailings pond results in 'Largest environmental disaster in modern Canadian history'

AMS[illegible]

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CANADIAN RESPONSES TO MOUNT POLLEY

Canadian Dam Association (CDA):

- ✓ Established a Mount Polley Task Group
- ✓ Regulatory roles and responsibilities
- ✓ Improving tailings dam safety (BAPs, BATs)
- ✓ Revisions to factor of safety (FS) criteria
- ✓ Assessment of consequences of dam failure
- ✓ Improve definition of the Engineer of Record (EoR)

British Columbia Ministry of Energy & Mines (BCMEM):

- ✓ Revised Health, Safety and Reclamation Code for Mines (i.e., Mining Code)
- ✓ Contains new tailings management requirements
- ✓ Several key legislated requirements for TSFs in BC

Also, disciplinary action pursued against three engineers associated with the project

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SAMARCO FUNDÃO DAM FAILURE, BRAZIL | 5 NOVEMBER 2015

- **Iron ore mine in State of Minas Gerais, Brazil**
- **Joint venture: Vale & BHP**
- **Tailings travelled 400 miles down the Doce River into the Atlantic Ocean**
- **>600 people lost their homes**
- **19 people died (mine staff and contractors)**
- **Regulations in Brazil overhauled after this disaster; global responses**

(Photo: AGU Blogosphere)

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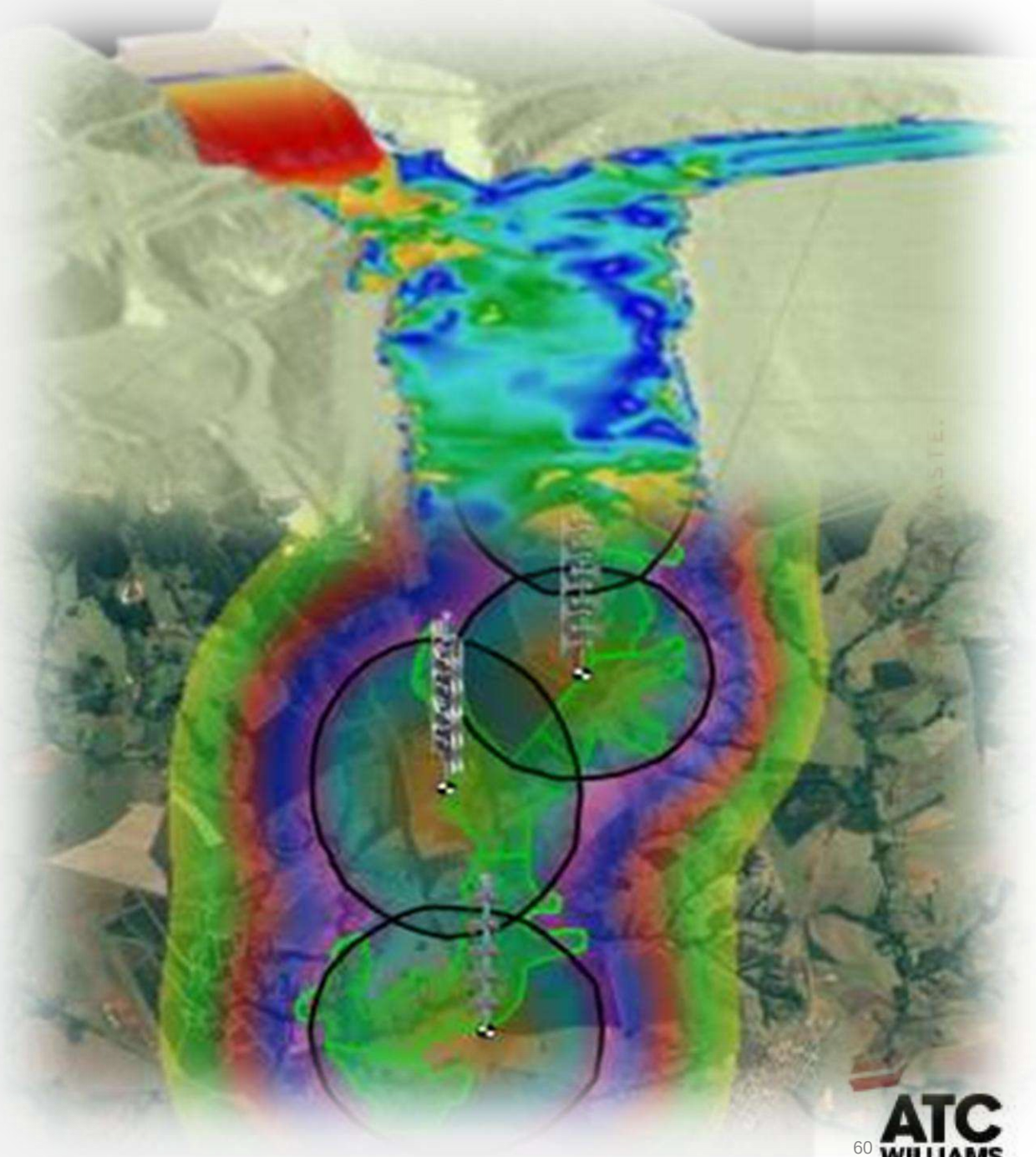
POST-SAMARCO BRAZIL REGULATIONS (MAY 2017)

National Mining Agency (ANM) Ordinance No. 70,389

- Established SIGBM
- Designation of a Technical Manager
- Modifications to dam classification criteria
- Additional EAP requirements: identification of a self-rescue zone (ZAS) and a secondary security zone (ZSS)
- Deployment of early warning systems, training, and stakeholder participation in simulated emergency drills
- Semi-annual audits followed by a statement of stability (DCE)
- Periodic dam safety reviews based on risk (2- to 7-year interval)
- Real-time monitoring of dam instrumentation including continuous 24/7 video monitoring

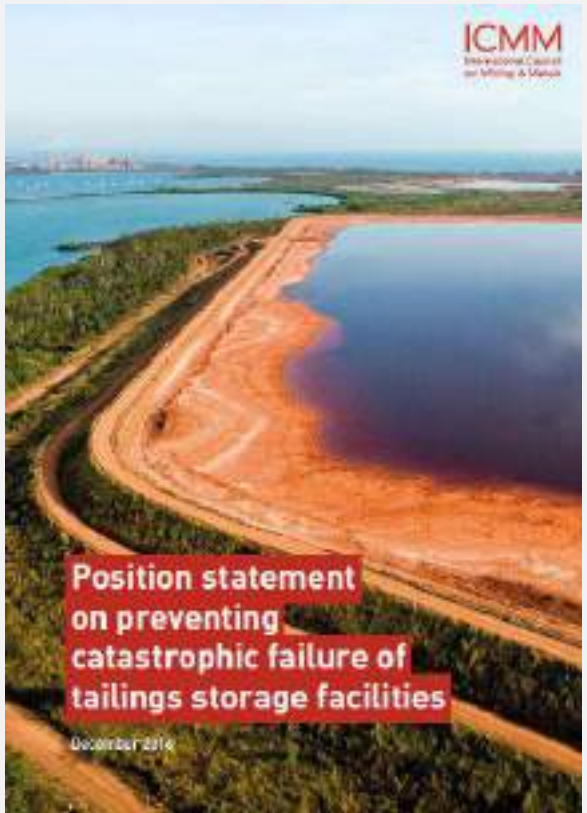


ICMM | RESPONSE TO MOUNT POLLEY & SAMARCO

Bringing together 26 of the world's largest mining and metals companies (as of Jan 2026), the ICMM is a multi-stakeholder initiative launched in 2001

In December 2016, released position statement establishing ICMM's framework for the governance of TSFs:

- Accountability, responsibility, and competency
- Planning and resourcing
- Risk management
- Change management
- Emergency preparedness and response
- Review and assurance
- JV partners of Samarco (i.e., Vale and BHP) are members of ICMM



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CÓRREGO DO FEIJÃO DAM 1, BRAZIL | 25 JANUARY 2019

In April 2022, the Securities and Exchange Commission (SEC) charged Vale for misleading investors

In January 2023, Brazil Federal Court accepted complaint against 16 people (including Vale CEO) and the companies of Vale and TÜV SÜD


SEC Charges Brazilian Mining Company with Misleading Investors about Safety Prior to Deadly Dam Collapse

Since 2016, Vale manipulated safety audits and obtained fraudulent stability certificates

FOR IMMEDIATE RELEASE
2022-72

Washington D.C., April 28, 2022 — The Securities and Exchange Commission today charged Vale


ENVIRONMENT FEBRUARY 4, 2021 / 6:59 AM / UPDATED 3 YEARS AGO

Brazil's Vale agrees to $7 billion Brumadinho disaster settlement


Brumadinho investigation could lead to murder charge for Vale executives

BY THE BRAZILIAN REPORT

(Photo Source: Agencia Brasil)

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A MERE 5 DAYS AFTER FAILURE AT BRUMADINHO…

January 30th in the State of Minas Gerais:

Brazil: Joint Resolution SEMAD/FEAM No. 2.765 /2019: De-characterization of Upstream Tailings Dams in Minas Gerais

Required:

"Decharacterization" of all tailings dams using the upstream construction method

- For "inactive" dams, mining companies have 180 days from the date of the Resolution to present their plan for decharacterization to the regulatory authority
- For "active" dams, promote migration to alternative technology and present plans to the regulator with a schedule for implementation within 360 days from the date of the Resolution. Implementation within 2 years (max.) from the date the work plan is presented.

RESOLUTION ANM NO 13/2019 (AUGUST 2019)

"Establishes regulatory measures aimed at ensuring the stability of mining dams, notably those built or raised by the so-called "upstream" method or by a method declared to be unknown and other measures"

DIÁRIO OFICIAL DA UNIÃO

Publicado em: 12/08/2019 | Edição: 154 | Seção: 1 | Página: 44

Órgão: Ministério de Minas e Energia/Agência Nacional de Mineração

RESOLUÇÃO Nº 13, DE 8 DE AGOSTO DE 2019

Estabelece medidas regulatórias objetivando assegurar a estabilidade de barragens de mineração, notadamente aquelas construídas ou alteadas pelo método denominado "a montante" ou por método declarado como desconhecido e dá outras providências.

RECENT TAILINGS FAILURES INDICATE THAT STEP CHANGES IN OPERATIONAL PERFORMANCE ARE NEEDED

Mount Polley, Canada - 2014

- Largest environmental disaster in Canada's history
- Resulted in significant changes to the regulatory environment in B.C. and guidelines in North America
- Emphasized importance of the Engineer of Record (EoR) role

Samarco, Brazil - 2015

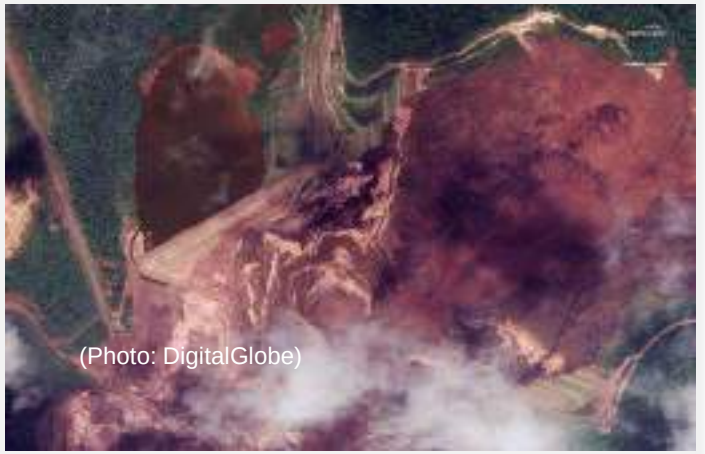
- **19 fatalities**; largest environmental disaster in Brazil's history
- Resulted in significant changes to the regulatory environment in Brazil
- Followed by ICMM position statement on preventing catastrophic failures

Córrego do Feijão, Brazil - 2019

- **270 fatalities**; worst industrial accident in Brazil's history
- Resulted in additional regulations in Brazil (e.g., banning upstream construction) and far-reaching global impacts


(Photo: Cariboo Regional District's YouTube channel)


(Photo: AGU Blogosphere)


(Photo: DigitalGlobe)

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THE GISTM AND “OTHER ACTIONS” THAT LIFTED THE BAR

Tailings: *Fundamentals, Failures, and the New Standard of Care*

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INVESTOR RESPONSE TO BRUMADINHO FAILURE

Investor Mining & Tailings Initiative founded in 2019 after the disaster at Brumadinho, Brazil

Initiative led by the Church of England Pensions Board and the Swedish Council on Ethics

A coalition of over than 100 investors with more than $25 trillion AUM

Developed though three phases:

- **Phase 1:** Understanding the Issue and **Call to Action**
- **Phase 2:** Developing a **Global Tailings Portal** and **Global Industry Standard** on Tailings Management together with UNEP and industry (i.e., ICMM)
- **Phase 3:** Adoption of the Standard, Independent **Global Tailings Management Institute** (GTMI)

THE CHURCH OF ENGLAND PENSIONS BOARD

Council on Ethics Swedish National Pension Funds

Source: https://www.churchofengland.org/about/leadership-and-governance/national-church-institutions/church-england-pensions-board/pensions

PHASE 1: UNDERSTANDING THE ISSUE

An urgent letter to 727 listed extractives companies was sent by the Church of England Pensions Board and the Swedish Council on Ethics for AP Funds on 5 April 2019

- Requested specific disclosures on every individual tailings facility under company control
- Letter supported by investors with $13.5 trillion (USD) in assets under management
- Engagement supported by the Principles for Responsible Investment (PRI)

THE CHURCH OF ENGLAND PENSIONS BOARD

[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:

- All tailings facilities where the company has any interest, through subsidiaries, partnerships, joint ventures both incorporated and unincorporated and any other enterprises of whatever legal form.
- All joint venture partners reporting on jointly owned facilities, even if you are not the operating partner ("NOJV's"), should use the same facility name/identifier in the disclosure statement.

Given the urgency and magnitude of this issue, we request that the public disclosure of this information, certified by either the Chairperson of the Board of Directors and/or the Chief Executive Officer*, be placed on your company website within 45 days of the date of this letter. We are in the process of developing a public investor register of those companies that make the disclosures requested.

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COE DISCLOSURE RESPONSES

Of the 727 companies contacted, breakdown of respondents:

- 45 of the top 50 largest mining companies in the world responded
- 114 companies confirmed they have tailings facilities and disclosed details
- 87% of the mining industry by market capitalization responded
- All publicly-owned companies that are members of ICMM responded and fully disclosed TSFs

Non-disclosure of dam safety risks could prompt big investors to pull out

Technology

After Dumping Vale, Church of England Says Miner Has 'Way to Go'

By Isis Almeida and Sabrina Valle
September 24, 2019 7:04 AM
Updated on September 24, 2019 6:00 PM

- Church sold its holdings in Vale after the Brumadinho accident
- Vale has 'a long way to go' before any reinvestment: church

Source: https://www.churchofengland.org/investor-mining-tailings-safety-initiative

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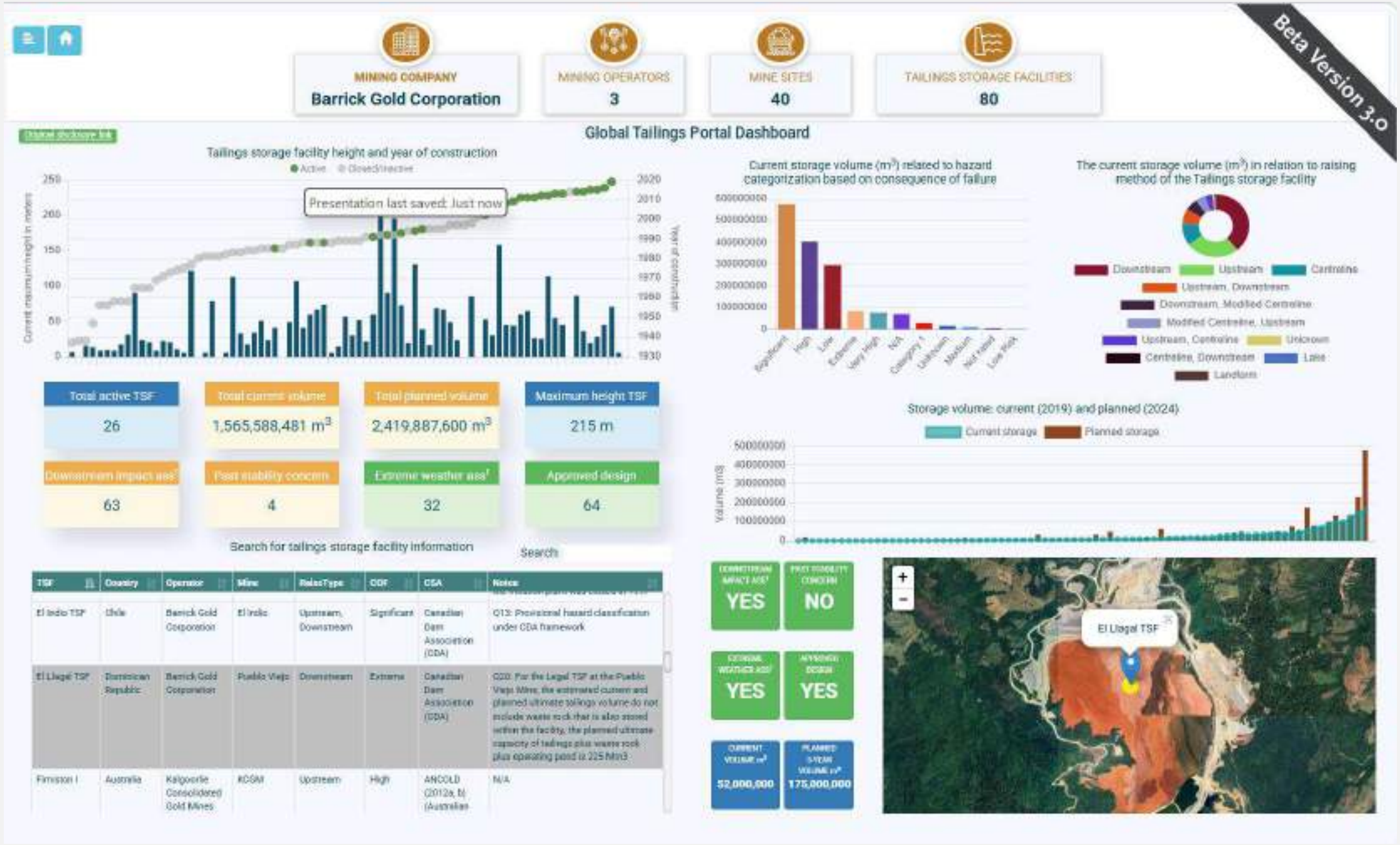
PHASE 2A: GLOBAL TAILINGS PORTAL DEVELOPED

Launched in January 2020, portal built and hosted by GRID-Arendal in collaboration with the Investor Mining and Tailings Safety Initiative

Source: https://tailing.grida.no/



Source: https://tailing.grida.no/ (Accessed 11 May 2026)

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PHASE 2B: GLOBAL INDUSTRY STANDARD ON TAILINGS MANAGEMENT (GISTM)

GlobalTailingsReview.org

Co-convened by ICMM International Council on Mining & Metals · UN environment · PRI Principles for Responsible Investment

- **Independent review co-convened to develop an international standard on tailings facilities in response to the January 2019 failure at Brumadinho, Brazil**
  - Co-convenors – *International Council on Mining & Metals (ICMM), Principles for Responsible Investment (PRI) and United Nations Environment Programme (UNEP)*
  - Standard published – *5 August 2020*
  - A schedule and plan for implementation proposed – *three (3) years to implement for priority facilities, with five (5) years total for implementation*
- **ICMM's Tailings Working Group developed technical guidance to support implementation – Tailings Management Good Practice Guide and Conformance Protocols – and training program for operators and executives**

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THE GISTM

- Topic Area I: Affected Communities
- Topic Area II: Integrated Knowledge Base
- Topic Area III: Design, Construction, Operation & Monitoring of Tailings Facilities
- Topic Area IV: Management & Governance
- Topic Area V: Emergency Response & Long-Term Recovery
- Topic Area VI: Public Disclosure & Access to Information

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APPLICABILITY OF THE GISTM

APPLIES TO LEGACY, CLOSED, OPERATING AND NEW TSFS (PLANNING AND PROJECTS)

A "Tailings Facility" is defined in the Standard as:

- A facility that is designed and managed to contain the tailings produced by the mine.
- Tailings facilities are >2.5 m OR have a combined water and solids volume >30,000 m^3, unless the Consequence Classification* is 'High', 'Very High' or 'Extreme', in which case the structure is considered a tailings facility regardless of its size.

**Consequence classification is based on a hypothetical breach with assessment of downstream consequences (PAR, PLL, environment, economics, etc.).*
***Clear guidance for "safe closure" is not yet available with work underway by several organizations to define.*

Standard does not apply to facilities that have been "safely closed**"

Photo source: At the Red Chris Mine, a dam contains a tailings pond. that collects mine waste. Northwest B.C., 2017. (Courtesy of Garth Lenz) Global tailings dam standards rest on voluntary compliance

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PHASE 3A: ADOPTION OF THE GISTM

In December 2020, the Initiative contacted over 300 mining companies requesting that they support and confirm their timeline of adoption of the GISTM

A full list of company responses to this request was published in early 2022: public-database-gistm-13.05.24.xlsx (live.com)

In January 2024, the Church of England Pensions Board announced that over half of the mining sector (by market capitalization) is committed to implement the GISTM

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PHASE 3B: GLOBAL TAILINGS MANAGEMENT INSTITUTE (GTMI)

In 2021, UNEP and PRI (represented by the Church of England Pensions Board and Swedish Council on Ethics) partnered to establish an independent Global Tailings Management Institute

- A senior consultant, David Cooling, was recruited and based at UNEP to lead the process.
- The multi-stakeholder international advisory panel was convened and met regularly during 2022 and 2023 and supported by the ICMM

Core function of the Institute will be to oversee implementation of, and conformance with, the GISTM.

The Institute's core priority will be:

- *Assurance*: Managing an assurance framework where tailings facilities will be audited and certified against the GISTM by qualified, independent third-party assessors.

In January 2025, formation of the GTMI was announced to be housed in South Africa

- Inaugural Board of Directors announced in July 2025 with Mark Cutifani as Chair
- Technical Committee recently appointed with focus on auditing process

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Sources: https://www.churchofengland.org/investor-mining-tailings-safety-initiative
New Independent Global Tailings Management Institute announced to drive mining industry safety standard (unep.org)

CONSOLIDATED MINING STANDARD INITIATIVE (CMSI)

- **Global collaboration** between **The Copper Mark, ICMM, the Mining Association of Canada (MAC), and the World Gold Council** to consolidate existing responsible mining standards into one global standard

- Brings together the strongest elements of:
  - MAC's Toward Sustainable Mining (TSM)
  - ICMM Mining Principles
  - Responsible Gold Mining Principles
  - The Copper Mark framework

- **Purpose:** CMSI aims to streamline ESG expectations for mining while strengthening independent governance, assurance and global comparability.

- **Tailings Focus:** CMSI does not formally adopt GISTM for tailings management; instead, it consolidates MAC's TSM and ICMM Mining Principles into a single global governance and assurance standard that is intended to be interoperable with GISTM, not a replacement for it.

THE TRUST-CONTROL RELATIONSHIP…

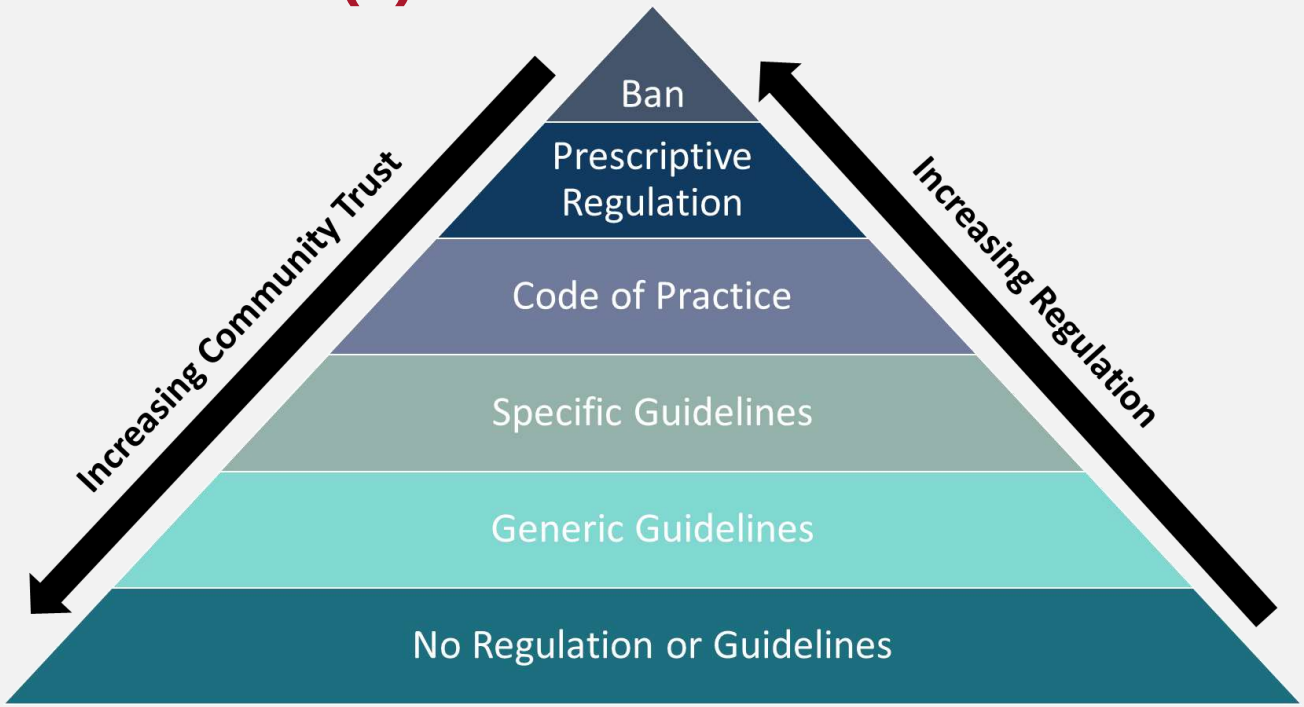
Regulatory framework for tailings management is a function of trust:

Trust x Control = Constant (k)

TRUST

"Trust is a fragile thing. Easy to break, easy to lose and one of the hardest things to ever get back."

- Unknown



Source: Morrison & Gomide (2019)

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HOW I GOT INTO TAILINGS…

Tailings: *Fundamentals, Failures, and the New Standard of Care*

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HOW DID I GET INTO TAILINGS?

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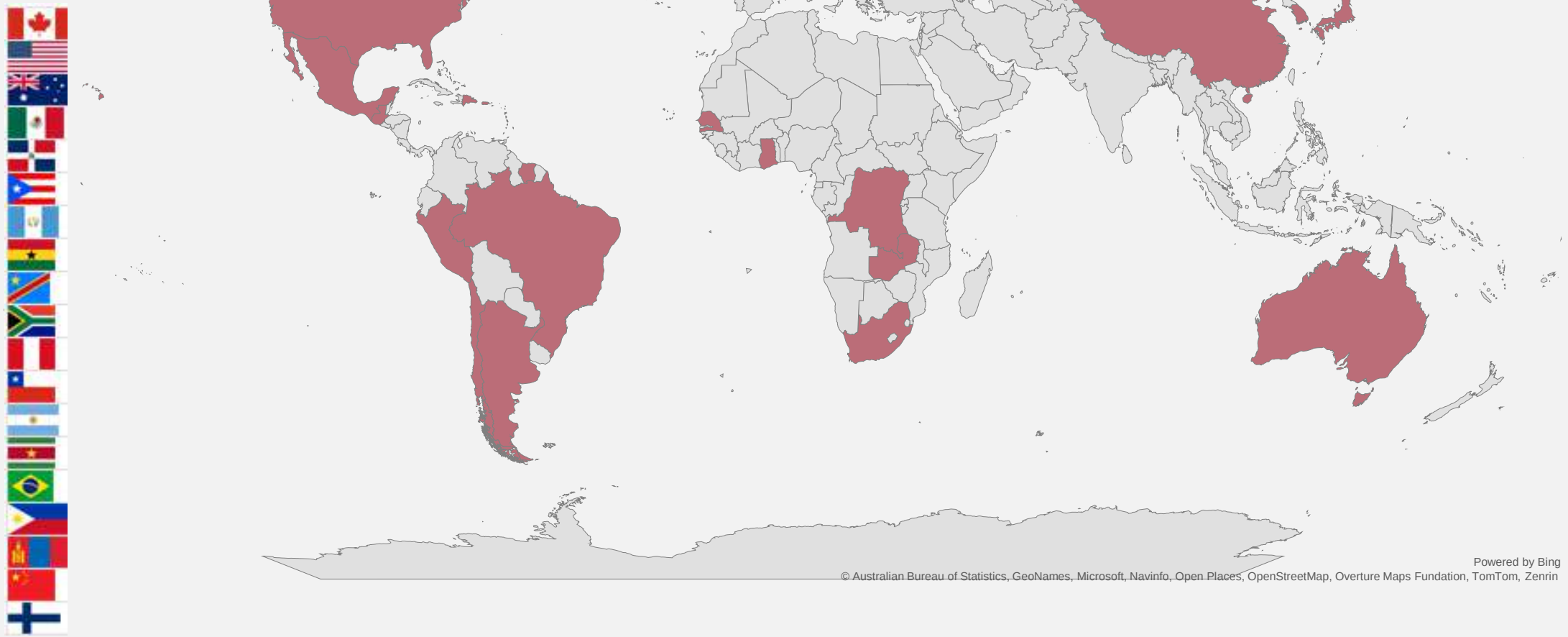
A Global Classroom: *Experience On 6 Continents*



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PERU

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ARGENTINA

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GHANA

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CONGO

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MONGOLIA

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DOMINICAN REPUBLIC

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WHEN WORK BECOMES PURPOSE…

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Answering The Call…

In 2015, a mere 5 days after the Samarco tailings dam failure, I received a phone call from Joel Carson, GBA's Executive Director

I was on the Board of Directors at the time (2014-2018)

An employee of a member firm was asking for guidance on Engineer of Record (EoR) for tailings dams

GEOPROFESSIONAL BUSINESS ASSOCIATION

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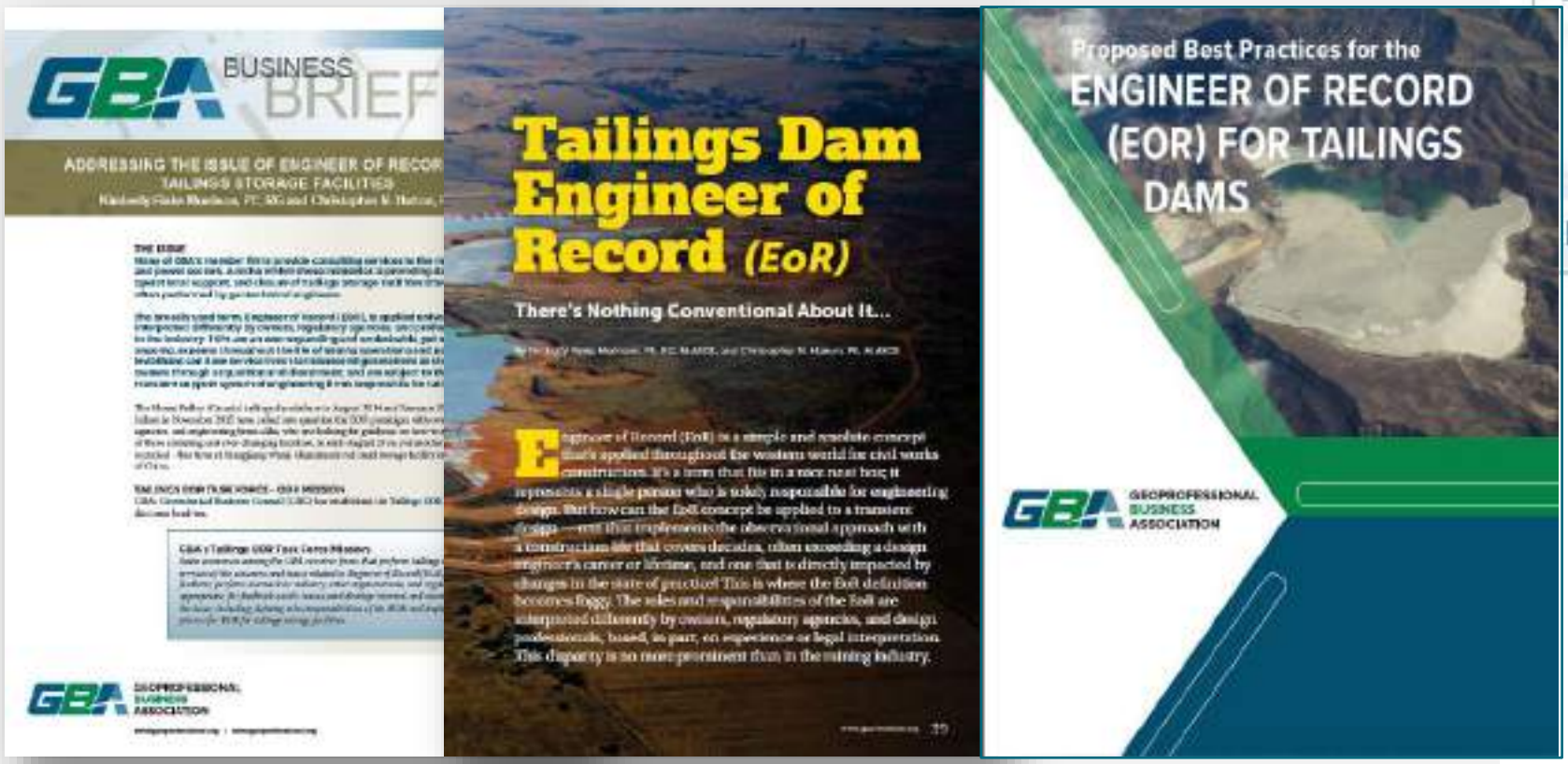
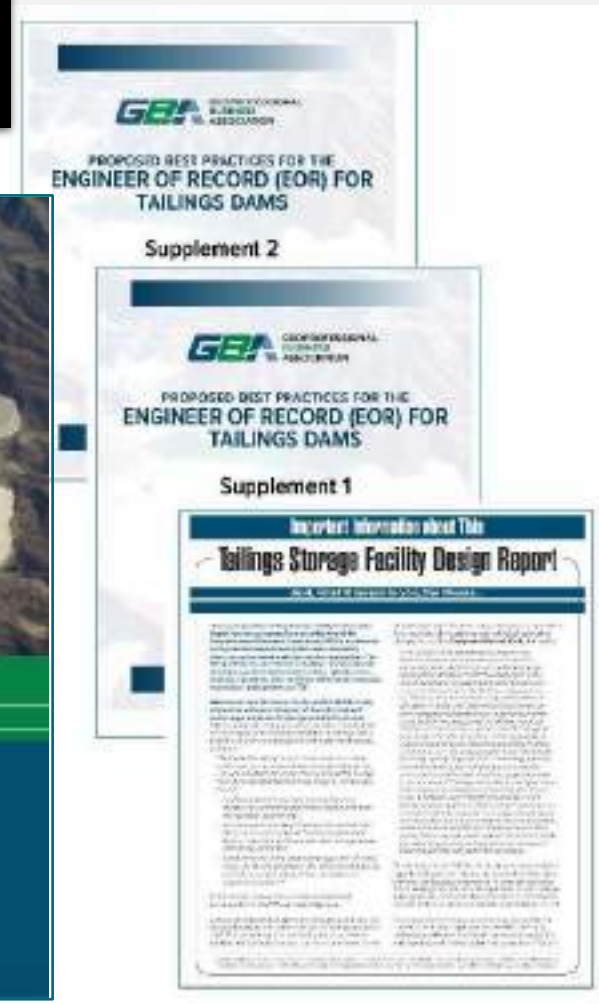
Engineer Of Record Task Force (2015-2017)

EoR Task Force Mission:

Raise awareness among the GBA member firms that perform tailings storage facility design services of the concerns and issues related to Engineer of Record (EoR) for these ever-changing facilities.





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6 Days Before Failure At Brumadinho…

I was in Brumadinho enjoying my Saturday afternoon

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And I Was On My Last Flight Home When The Failure Occurred

A tailings dam just failed at a Vale mine…

Remember where we were on Saturday? We could see the mine in the distance…

We had to shut down the plant because we are down river and lost our water supply...

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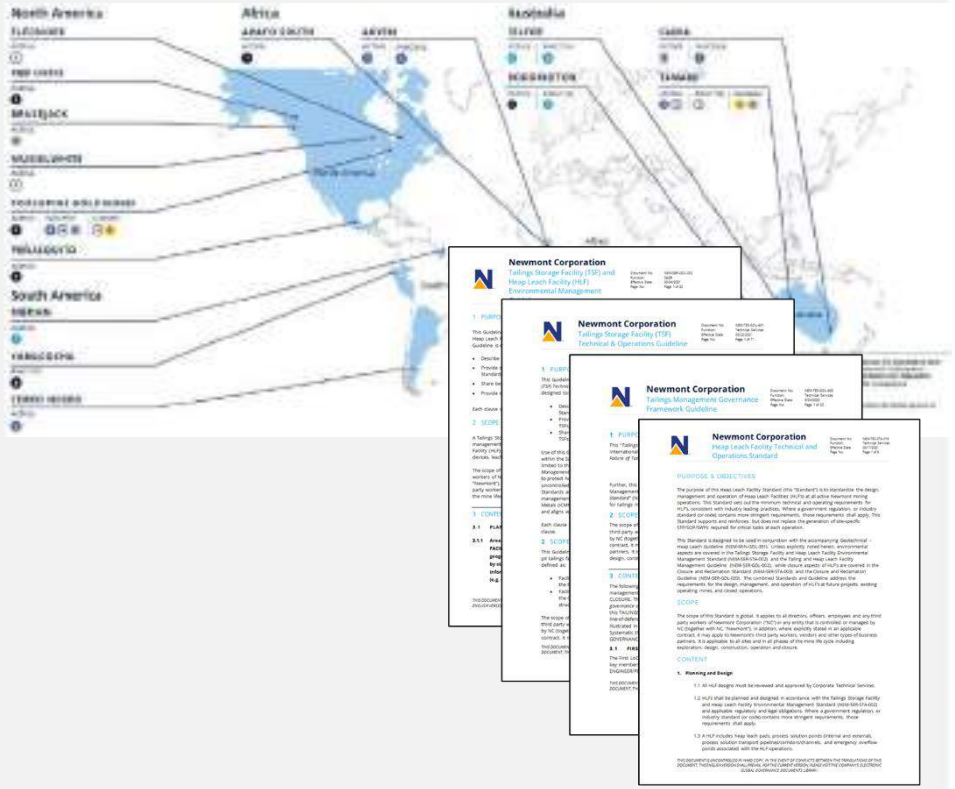
Answering Another Call…

Leadership Highlights at Newmont (2019-2024)

- **Global lead** for tailings, dams, and heap leach function.
- Led enterprise-wide implementation of the **Global Industry Standard on Tailings Management** (GISTM).
- Authored and rolled out new **standards, guidelines, and procedures** for tailings and dam safety.
- **Established governance systems**, including 17 Independent Tailings Review Boards (ITRBs).
- **Directed risk assessments** across all active operations and key legacy sites.
- **Designed and delivered internal training** (webinars, workshops) and a competency framework.
- **Acted as delegate to the Accountable Executive**, reporting monthly to the AE and quarterly to the Board's Safety & Sustainability Committee.



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Instrumental in forming the GeoStable Tailings Consortium…

- **A joint multi-year initiative of eleven leading mining companies**
- **Dedicated to fostering collaboration among member mining companies**
- **Aiming to develop and implement improved approaches to tailings and waste management that prioritize safety, sustainability, and environmental stewardship.**

GeoStable Tailings Consortium

Source: https://www.geostabletailings.com/
Morrison (2024) "Leading Advancement of GeoStable Tailings Technology through Industry Collaboration," presented at 1st International Symposium of Tailings Storage Facilities, Chihuahua, Mexico, March 2024)

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International Council On Mining & Metals (ICMM) Tailings Working Group (TWG)

Supported development of the Tailings Management Good Practice Guide, Conformance Protocols, and related training materials

ICMM - Tailings Management: Good Practice Guide

ICMM - Conformance Protocols: Global Industry Standard on Tailings Management

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Global Action on Tailings (GAT)

GMPA

Global Action on Tailings

FROM MANAGEMENT TO ELIMINATION

The Global Action on Tailings is a GMPA initiative, engaging and connecting technical experts to advance discussions and solutions relating to tailings management, tailing reprocessing, repurposing and driving toward tailings elimination.

Following the catastrophic failure of a tailings dam at Brumadinho, Brazil in January 2019, the Global Action on Tailings (GAT) Initiative was established to address challenges concerning tailings disposal and storage.

An international taskforce is working together to build awareness and knowledge in good tailings practice as well as identifying ways for the mining industry to eventually reduce or eliminate tailings storage facilities. A key goal is to support professionals in ways that lead to greater trust by society about industry's ability to manage tailings risks.

AusIMM

CIM ICM Canadian Institute of Mining, Metallurgy and Petroleum

I·M3 Institute of Materials, Minerals & Mining

INSTITUTO DE INGENIEROS DE MINAS DE CHILE

INSTITUTO DE INGENIEROS DE MINAS DEL PERÚ

SAIMM THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY

SME Society for Mining, Metallurgy & Exploration

WAIMM

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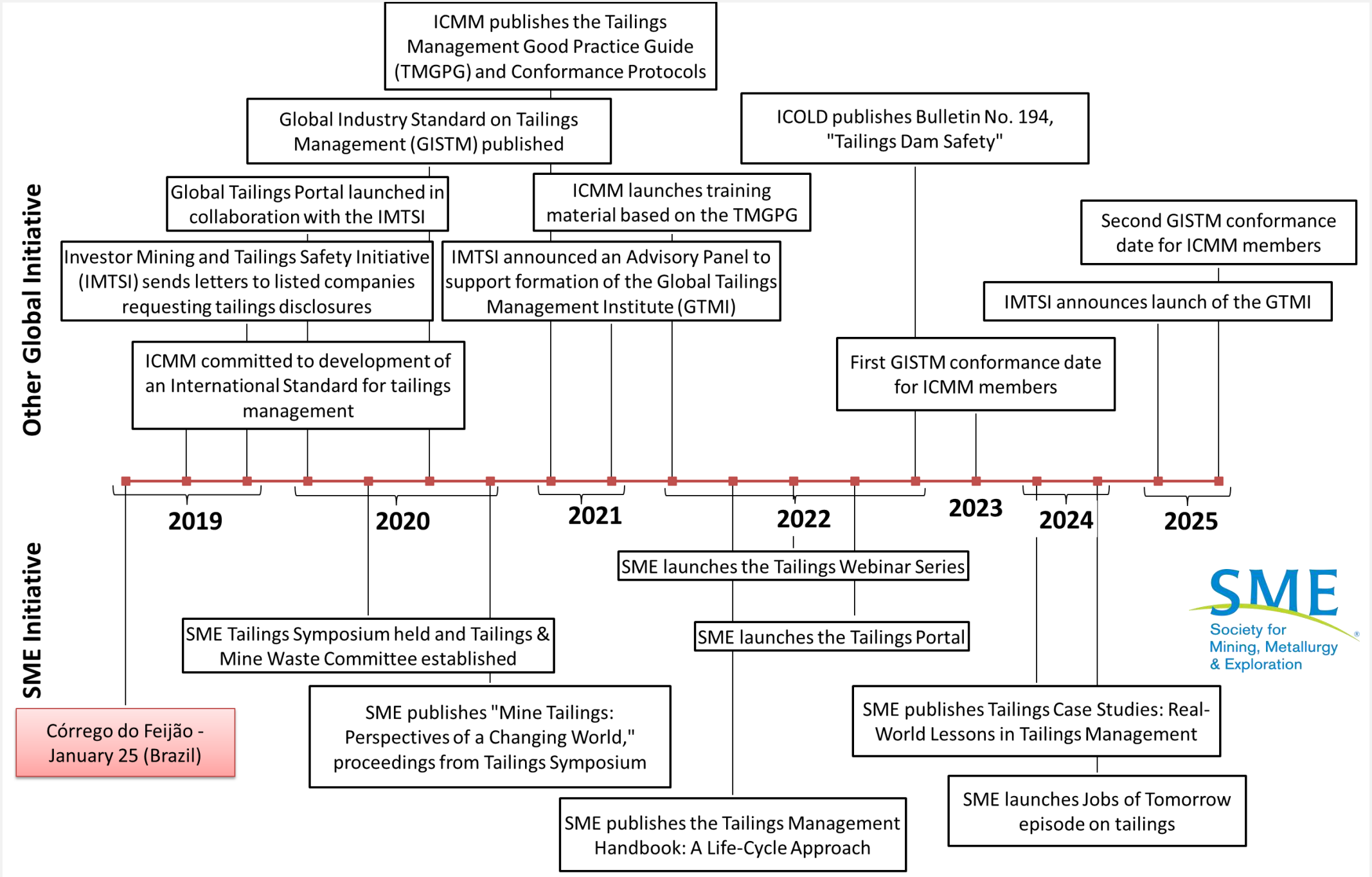

SME
Society for Mining, Metallurgy & Exploration

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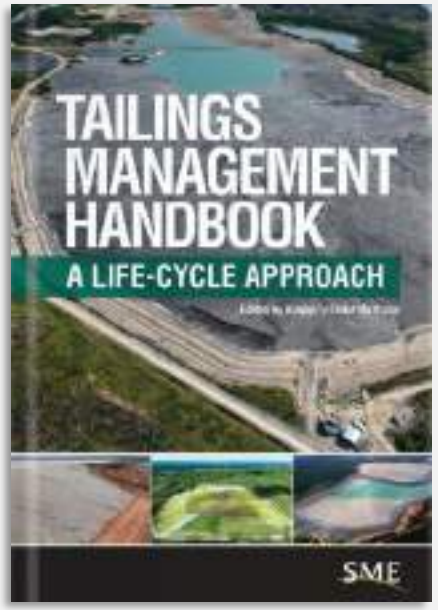
Tailings Management Handbook: *A Life-cycle Approach* (FEB 2022)

Handbook focuses on the basics, life-cycle planning, site and tailings characterization, TSF design and construction, as well as systems and operations of TSFs

- **Available in hard-copy or as an e-book *(English only currently)***
- **C**ontributions by **more than 100 individuals** including numerous world-renowned experts



"The Tailings Management Handbook is an outstanding contribution …its publication is a remarkable achievement given the short time when it was first conceived and the breadth of its contents…I expect that the Handbook will be the centerpiece in the library of all committed to tailings facility safety in the broadest sense."

– Dr. Norbert Morgenstern

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TMH BOOK LAUNCH RECEPTION (FEB 2022)

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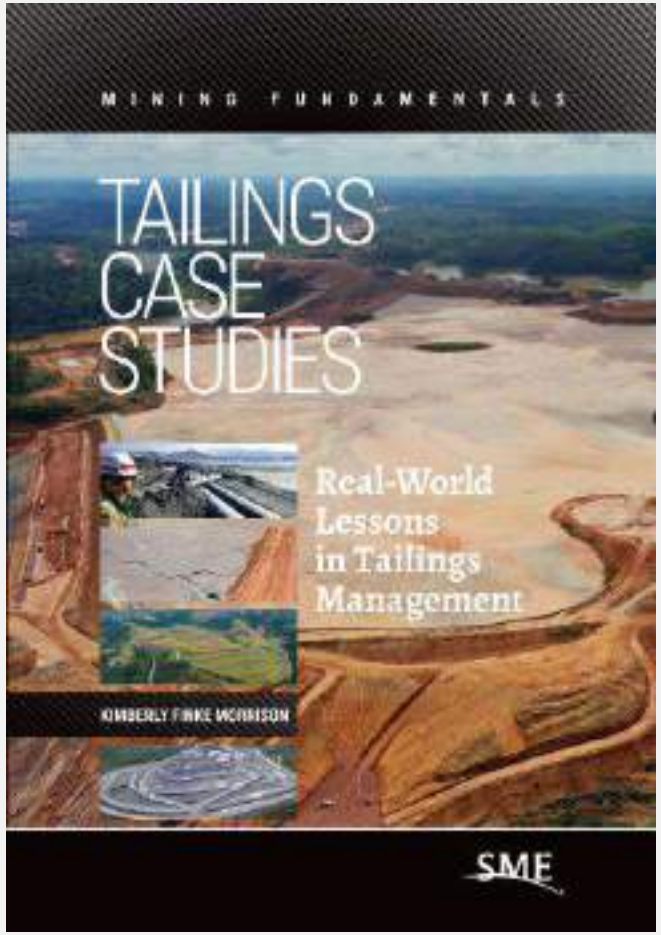
Tailings Case Studies:
Real-world Examples In Tailings Management
(FEB 2024)



- **A curated collection of 43 case studies from the acclaimed Tailings Management Handbook, offering 11 updated and 3 new case studies that shed light on the ever-evolving challenges of tailings management**
- **Divided into six comprehensive categories:**

- Closure & Reclamation
- Design & Construction
- Environmental & Regulatory
- Geotechnical Studies
- Lessons Learned from Failures
- Operations & Monitoring

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Tailings Closure Handbook:
Begin With The End In Mind

This book will expand a single chapter from the ***Tailings Management Handbook*** into a standalone resource

- Plan to focus on how early closure planning minimizes long-term risks, enables progressive rehabilitation, engages stakeholders on post-mining land use, ensures adequate financial provisions, and aligns with leading industry standards like the GISTM.
- Currently, no standalone book specifically addresses tailings facility closure.
- **Anticipated publish date: Q4 2026**

Marlin Closed/Reclaimed TSF (Courtesy Newmont)

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SME'S Tailings Webinar Series (AUG 2022)

The Webinar series has been developed to leverage the important content published in SME's Tailings Management Handbook: A Life-Cycle Approach, which is available from the SME Bookstore in print or as an eBook

- Attendees are encouraged to refer to the Book to take a deeper dive into the topics discussed in this Webinar
- Webinar series sponsored by Newmont and Freeport-McMoRan to reduce price (i.e., ½ of normal webinar rate)

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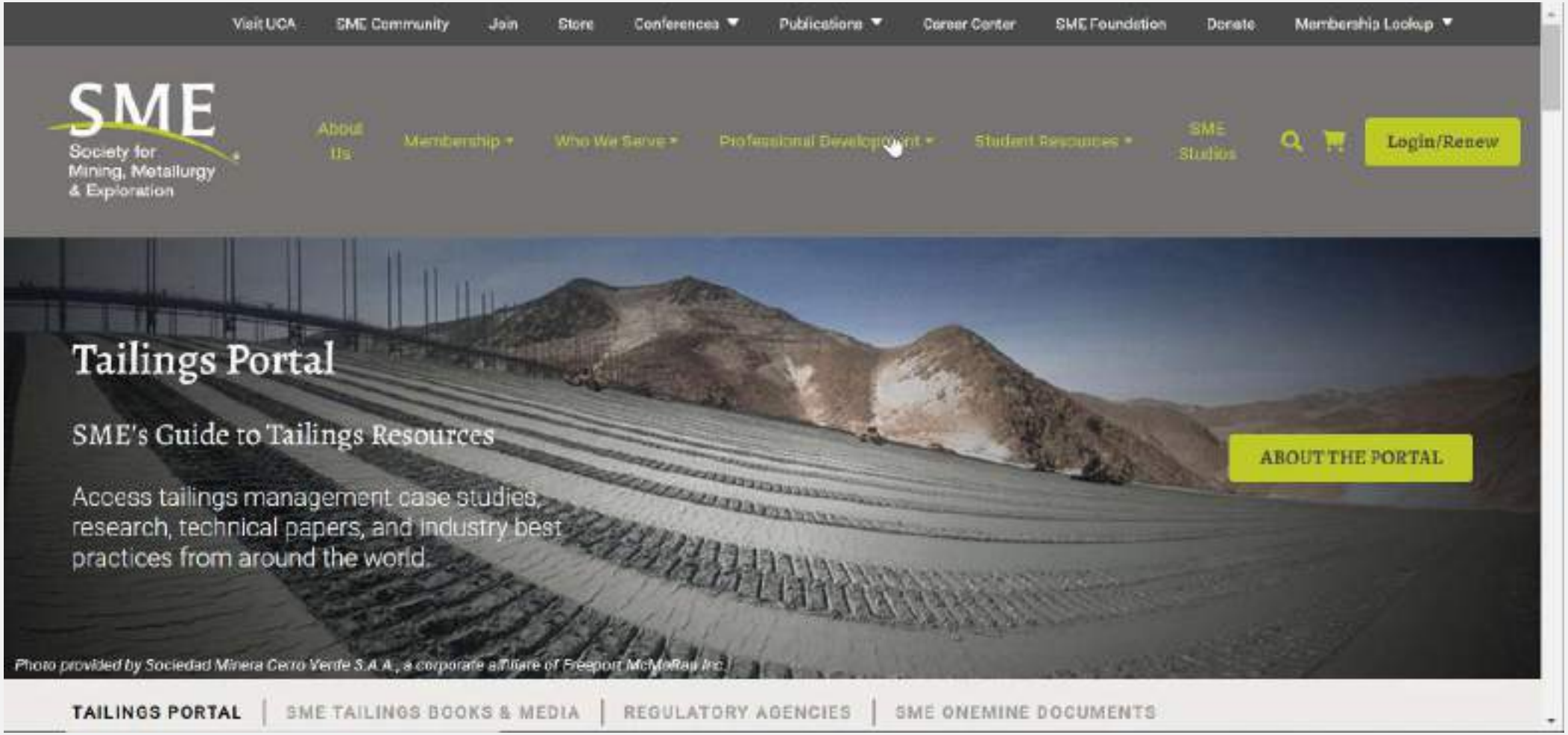
SME'S Tailings Portal
(OCT 2022)



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SME'S "Jobs Of Tomorrow" Campaign
(APR 2024)

Tailings episode sponsored by Freeport-McMoRan & Newmont

- Filmed on location in Colorado (Freeport-McMoRan) and Ghana (Newmont) in 2023
- Two primary staff identified to 'star' in the episode – George Afriyie (Newmont) & Cassandra Hall (Freeport-McMoRan)

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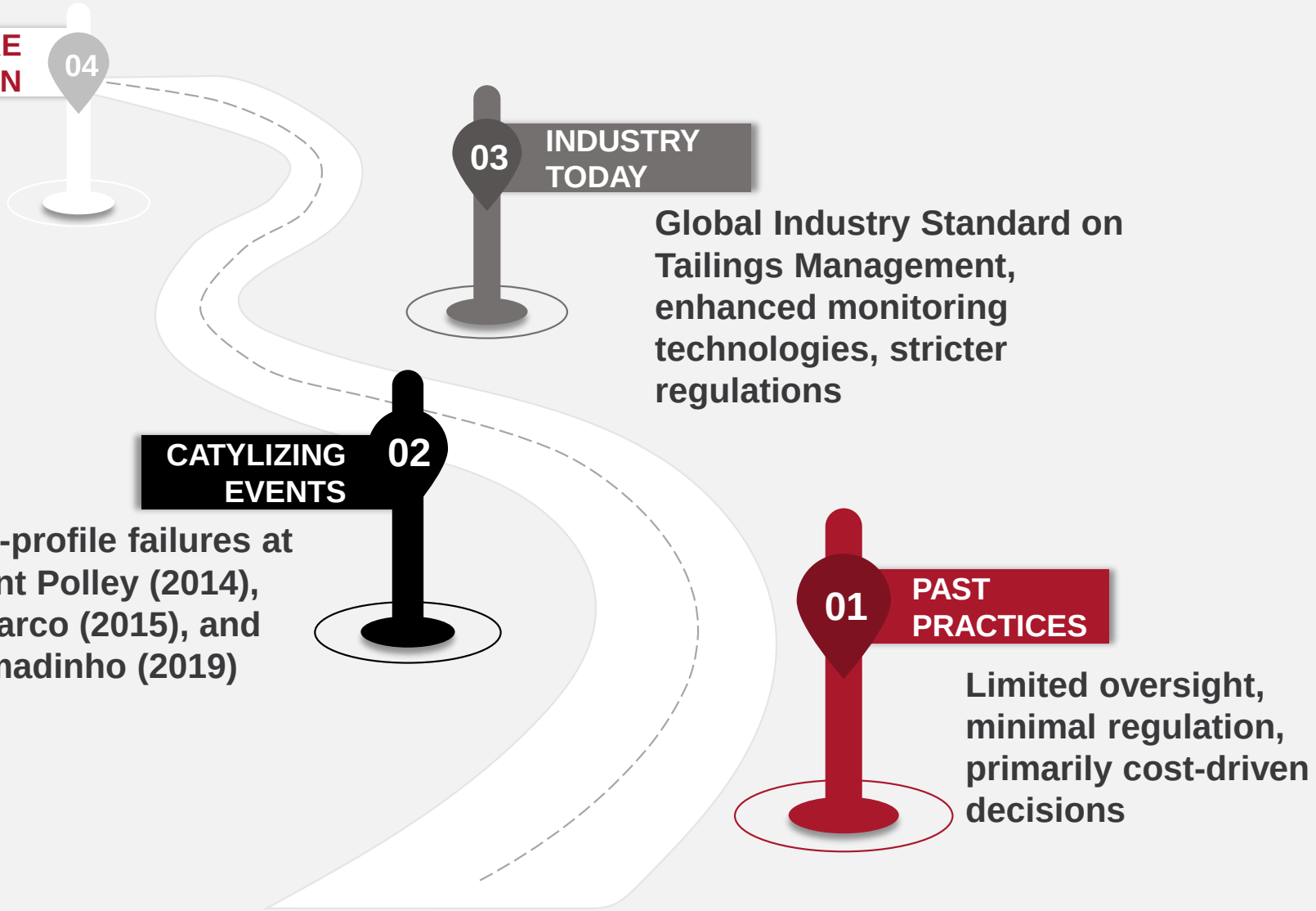
We Stand At A Pivotal Moment In Tailings Management History…



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The future of our industry depends on how effectively we transfer knowledge to the next generation

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We Need to Accelerate “Phronesis”…

- Defined as the “*wisdom in determining ends and the means of attaining them, practical understanding, sound judgment*” (www.dictionary.com)
- In essence, phronesis is the knowledge gained through experience
- Industry can support acceleration of phronesis in students by sharing their wisdom through lessons learned

phronesis

noun [froh-**nee**-sis]

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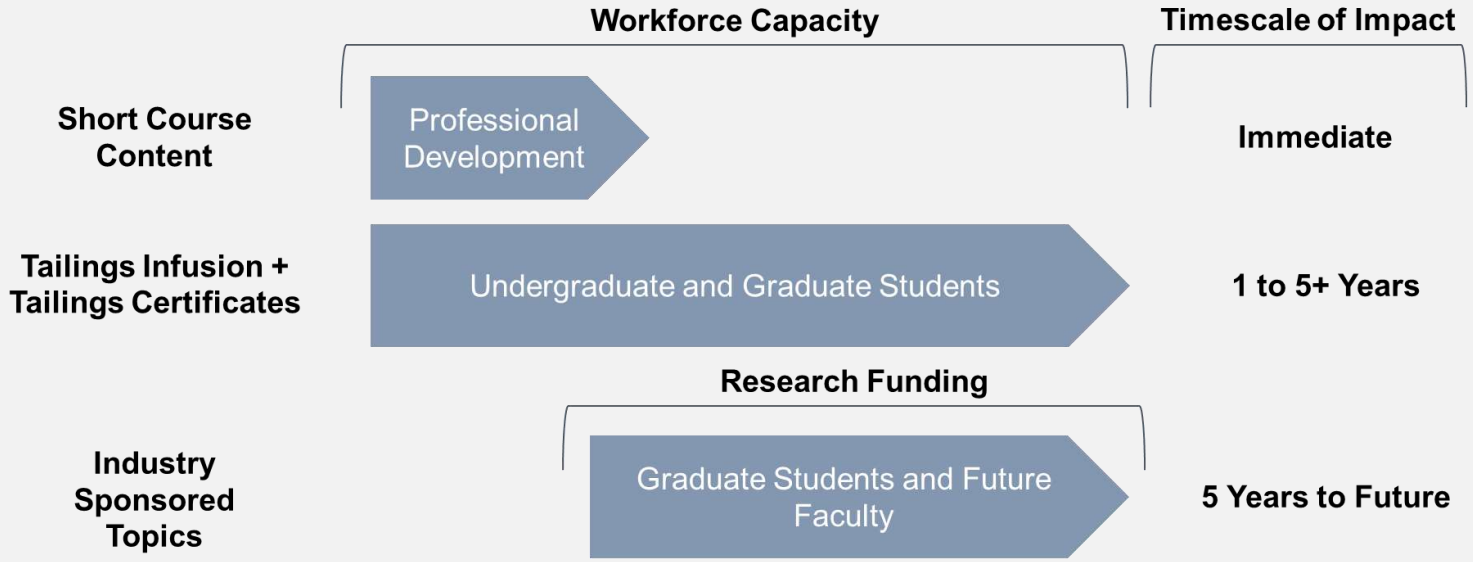
Industry-Academia Partnerships: *Tailings Center*

Founded in 2020, the Tailings Center is an industry-university collaboration with a mission to advance research, education and training in tailings stewardship



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Industry-Academia Partnerships: *Tailings Center*

Experience at Colorado School of Mines combined with Tailings Center leadership has reinforced the critical importance of bridging theoretical foundations with practical application

The most effective programs:

- Incorporate real-world case studies and field experiences
- Bring industry practitioners into the classroom
- Develop research projects addressing current industry challenges
- Create internship pathways for students to gain hands-on experience

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Tailings Center Accomplishments

Graduate Certificate in Tailings

- Implemented successfully at CSU (Tailings Engineering) and CSM (Tailings Management) via development of two required tailings-specific courses

Short Courses (2020-2025)

- 6 modules ran 4 times (over 220 lectures and panels)
- Short course to ADEQ
- “Filtered Tailings Workshop” at Relaves 2024 in Lima

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Teaching, Lecturing & Leading At CSM

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Industry-Academia Partnerships: *TAILENG*

The TAILENG foundation is a non-profit 501(c)(3) organization that promotes educational activities and cutting-edge research activities of faculty at U.S. leading universities:

- Georgia Tech – Dr. Jorge Macedo
- University of California-Berkeley – Dr. Jonathan Bray
- University of Illinois at Urbana-Champaign – Dr. Scott Olson
- Colorado State University – Dr. Christopher Bareither

I've served on the Advisory Board since commencement of the foundation in 2020.

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KEY LESSONS FOR THE NEXT GENERATION

Tailings: *Fundamentals, Failures, and the New Standard of Care*

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Key Lessons For The Next Generation…

Collaborative Professional Networks

Build relationships beyond your immediate team. The most innovative solutions often come from cross-company and cross-border knowledge sharing.

Interdisciplinary Approaches

The most effective tailings professionals combine geology, engineering, environmental science, and social sciences. A narrow technical focus is insufficient for today's complex challenges.

Technical Courage

Develop the confidence to question conventional practices, especially when data suggests better approaches. Some of my most valuable contributions came from challenging "the way it's always been done."

Leadership Skills

Technical excellence alone isn't enough. You must be able to lead diverse teams, communicate effectively with stakeholders, and navigate complex regulatory environments.

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The Future Of Tailings: *Your Role In The Journey*

Technical Excellence

Master the fundamentals while staying current with emerging technologies and methodologies

Collaborative Leadership

Develop the skills to work across disciplines, cultures and stakeholder groups

Ethical Courage

Build the confidence to advocate for best practices, though they are often not the easiest or cheapest options

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The Future Of Tailings: *Your Role In The Journey*

The tailings profession needs resilient, innovative thinkers who can balance technical excellence with genuine care for communities and environments

Contact: KimM@atcwilliams.com.au

LinkedIn: /in/kmorrison73

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