

Seminário Técnico Internacional sobre Barragens de Rejeitos e o Futuro da Mineração em Minas Gerais

International Technical Seminar: Tailings Dams and the Future of Mining in Minas Gerais State

ORGANIZAÇÃO



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INSTITUTO BRASILEIRO DE MINERAÇÃO
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Managing Risks of Tailings Disposal

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Mining Association of Canada





- ◆ Established in 1935, MAC
 - ◆ promotes industry nationally and internationally
 - ◆ works with governments on policies affecting the sector
 - ◆ educates the public on mining
- ◆ Members account for most of Canada's production of metals and major industrial minerals
 - ◆ includes metals, diamonds, oil sands and metallurgical coal
- ◆ Associate members comprise a wide range of services and equipment supplied to the mining industry

- ◆ **TSM established in 2004**
 - ◆ intended to improve performance, starting with tailings management
- ◆ Evolved into industry-led, voluntary program to improve environmental and social performance in critical areas beyond regulations:
 - ◆ environmental footprint
 - ◆ energy efficiency
 - ◆ community and people
- ◆ Program strengths:
 - ◆ performance measured at facility-level, and results externally verified
 - ◆ monitored by external Community of Interest (COI) Advisory Panel
 - ◆ encourages continual improvement

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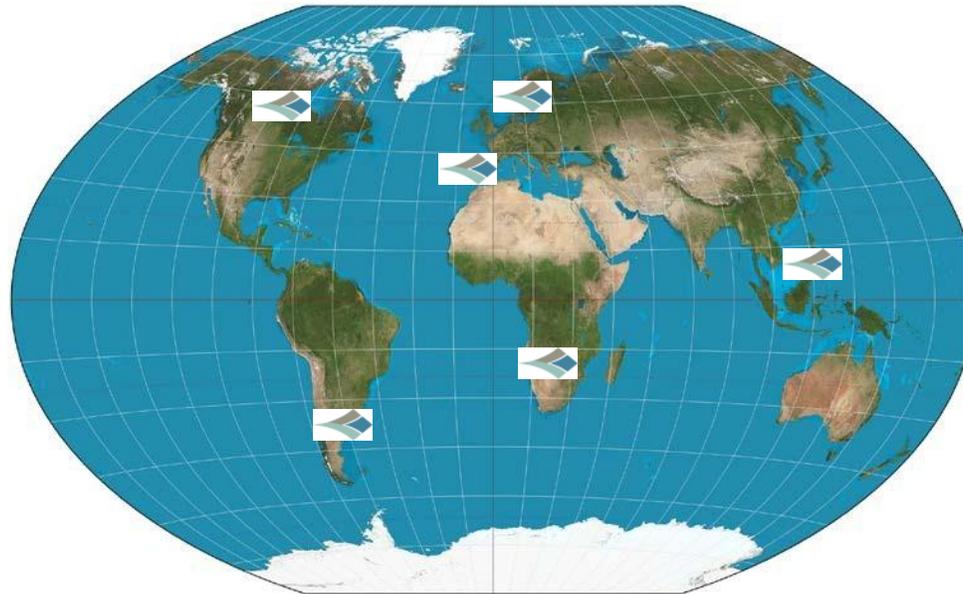
Crisis Management



Energy Use & Greenhouse Gas
Emissions Management

Community of Interest Advisory Panel

- ◆ Participation in *TSM* is mandatory for all MAC members for their operations in Canada
- ◆ Some MAC members also applying *TSM* at their operations in other countries: e.g., Finland, Turkey, Surinam, Burkina Faso, Mexico, Portugal
- ◆ Growing interest in *TSM* around the world adopted by industry
 - ◆ associations in Finland, Argentina, Botswana, the Philippines, and Spain
 - ◆ being seriously considered countries



- ◆ The first edition of MAC's *Guide to the Management of Tailings Facilities* (the Tailings Guide), released in 1998, was developed in response to tailings-related incidents in the 1990s
 - ◆ describes management systems approach for tailings management
- ◆ MAC introduced a companion document in 2003: *Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities* (the OMS Guide)
 - ◆ provides guidance on the preparation of OMS manuals to be used as tools to help implement tailings management systems
- ◆ In 2004, MAC established *TSM* with tailings management as a core component
 - ◆ *TSM Tailings Management Protocol* describes performance indicators for tailings management

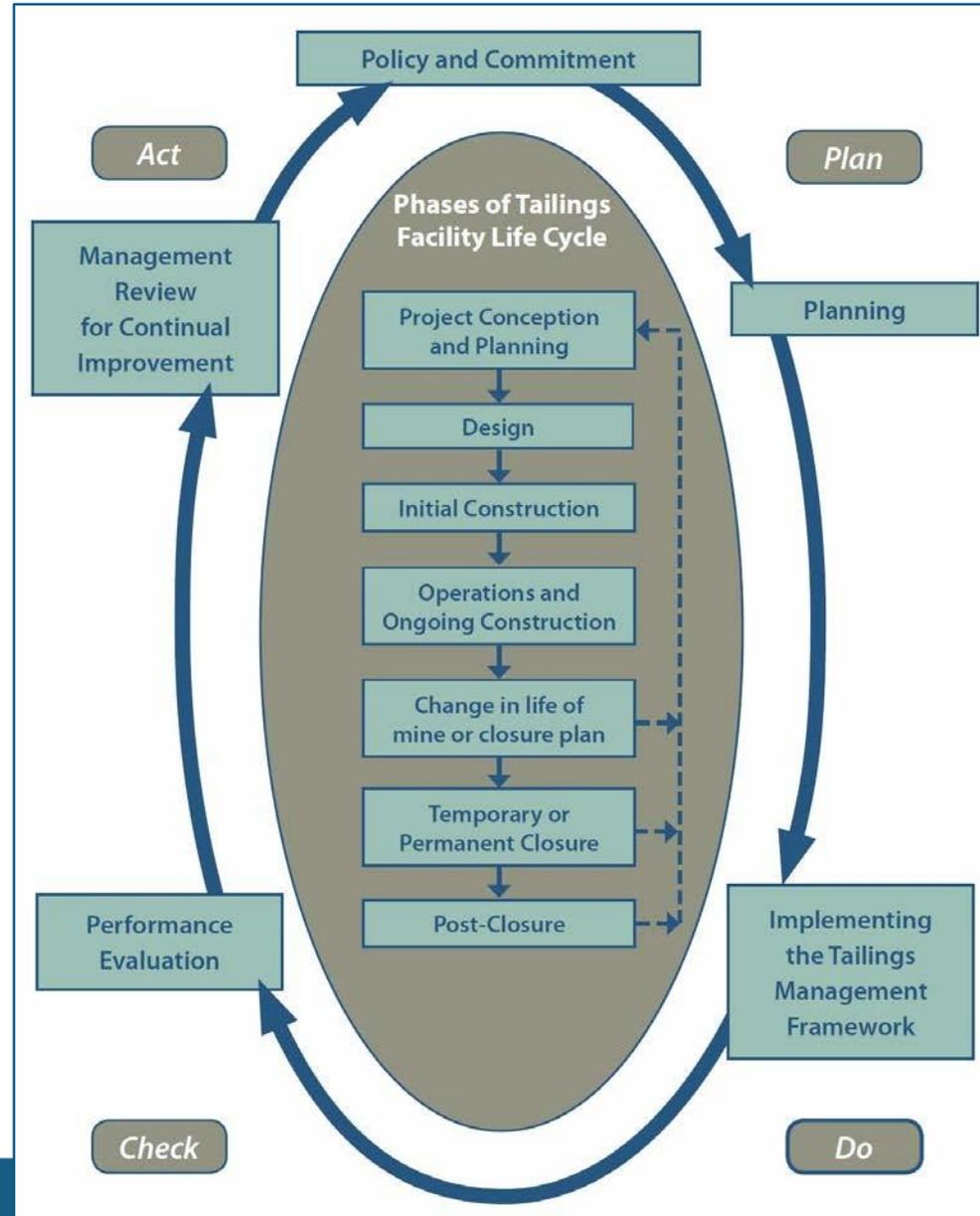
- ◆ After the Mount Polley tailings dam failure in Canada in 2014, independent and internal reviews were conducted
- ◆ 2017: (English and French):
 - ◆ Third edition of the Tailings Guide
 - ◆ Revised *Tailings Management Protocol*
- ◆ March 2019 (English and French):
 - ◆ Second edition of the OMS Guide
 - ◆ Version 3.1 of the Tailings Guide
 - ◆ Revised *Tailings Management Protocol*
- ◆ Spanish versions will follow in mid-2019
- ◆ All documents available for download free of charge

Objective is to continually work towards *minimizing harm*

Minimizing harm encompasses both physical and chemical performance and risks associated with tailings facilities, including:

- ◆ zero catastrophic failures of tailings facilities; and
- ◆ no significant adverse effects on the environment or human health

- ◆ Applies across the life cycle, from conceptual planning to closure and post-closure
- ◆ Describes a management framework for tailings based on the ISO 14000 *Environmental Management Standard* but tailored to tailings management



- ◆ Provides guidance on:
 - ◆ establishing a corporate policy for tailing management
 - ◆ accountability and governance for tailings management
 - ◆ risk assessment, risk management and critical controls management
 - ◆ establishing performance objectives
 - ◆ managing change
 - ◆ emergency preparedness (added in Version 3.1)
 - ◆ performance evaluation
 - ◆ management reviews
 - ◆ assurance mechanisms, including independent review

- ◆ Provides guidance on:
 - ◆ integration of OMS activities with tailings management system, risk management plan and critical controls management
 - ◆ integration of OMS into effective decision-making
 - ◆ preparing effective, site-specific OMS manuals
 - ◆ reviewing and updating OMS manuals
 - ◆ document control
 - ◆ OMS governance
 - ◆ designing and implementing OMS activities
 - ◆ linkages with emergency preparedness

- ◆ Describes five performance indicators:
 1. Having a corporate tailings management policy or commitment
 2. Developing and implementing a site-specific tailings management system, and emergency preparedness
 3. Assigning accountability and responsibility for tailings management
 4. Conducting an annual tailings management review
 5. Developing and implementing a site-specific OMS manual

- ◆ Sixth Victor de Mello Lecture was given in Salvador, Brazil in August 2018 by Prof. Norbert Morgenstern (Emeritus) of the University of Alberta
 - ◆ distinguished expert in the field of geotechnical engineering
 - ◆ involved in investigations of failures of many dams and tailings facilities worldwide including Mount Polley and Samarco
- ◆ Stated that there is “no set of simple prescriptions will resolve the crisis” with tailings dams
 - ◆ e.g, ban upstream dams, required minimum factor of safety
- ◆ “One of the most important learnings can be seen in failure of other structures in the world. This is that a highly integrated team effort and success of an individual structure relies on the operational discipline of planning, technology, operations, geotechnical engineering and regulatory bodies.” McRoberts *et al.* (2017), cited by Morgenstern

- ◆ Morgenstern concluded that the “dominant cause of these failures arises from deficiencies in engineering practice associated with the spectrum of activities embraced by design, construction, quality control, quality assurance and related matters”
- ◆ ICMM Tailings Governance Framework (2016) not adequate
- ◆ Recommended Performance-Based, Risk-Informed Safe Design, Construction, Operation, and Closure (PBRISD) of tailings facilities
- ◆ Underlying principle is accountability, achieved by multiple layers of review, recurrent risk assessment and performance-based validation from construction through closure
- ◆ Recommended that “ICMM support the tailings management system based on PBRISD, as outlined here, and fund the development and publication of a guidance document that would facilitate its adoption in mining practice”

Performance-Based, Risk-Informed Safe Design, Construction, Operation, and Closure (PBRISD)

- ◆ Stage 1: (Conceptual)
 - ◆ Qualified Operator
 - ◆ Establish Independent Review Board
 - ◆ Uncertainty Assessment
 - ◆ Potential Problems Analysis (PPA)
 - ◆ Multiple Account Analysis (MAA)
- ◆ Stage 2: (Feasibility)
 - ◆ Engineer-of-Record (EoR)
 - ◆ Designer
 - ◆ Design Basis Memorandum (DBM)
 - ◆ Risk Assessment
 - ◆ Quality Management
 - ◆ Documentation
- ◆ Stage 3: (Construction and Operations)
 - ◆ Operations
- ◆ Stage 4: (Closure Implementation)

- ◆ Paper by me and Michael Davies (Teck Resources) for ICOLD 2019 proposes a suite of holistic, interlinked principles for tailings management:
 - ◆ accountability and responsibility
 - ◆ effective planning and design
 - ◆ performance-based, risk-informed approach
 - ◆ management systems approach
 - ◆ operation, maintenance, and surveillance
 - ◆ emergency preparedness
 - ◆ assurance, including independent review
- ◆ Builds upon:
 - ◆ PBRISD
 - ◆ MAC Tailings Guide and OMS Guide
 - ◆ ICMM Tailings Governance Framework

- ◆ To improve tailings management, reduce risks, and minimize harm a systematic, holistic approach that effectively addresses all aspects encompassed by these principles must be implemented at the site-level
- ◆ Systematic approach to tailings management, following these principles, helps to mitigate what can perhaps be the greatest risk of all: *the human element*
 - ◆ Humans, however professional and qualified, make judgments and decisions based on their own experiences and biases
 - ◆ Sometimes, humans make mistakes
 - ◆ A systematic approach, with checks-and-balances, helps reduce the risk that human errors, experiences, or biases can ultimately lead to ineffective tailings management, or worse, a failure of a tailings facility

- ◆ Accountability must rest with the owner and at the highest level of the company
 - ◆ stakes are too high for accountability to rest at the site level
 - ◆ accountability must not be delegated or offloaded, either internally or to a consultant
- ◆ Accountability needs to be backed-up by the owner's commitment to manage tailings in a manner consistent with these principles
 - ◆ includes providing resources needed to support objectives for responsible tailings management

- ◆ Decisions made at the planning and design phases affect entire life cycle and have implications for long-term risks and liability
- ◆ Considerations:
 - ◆ Designing for closure
 - ◆ Integrated mine-planning: a holistic approach to planning all aspects of a mine to optimize design, minimize short and long-term risks and achieve closure objectives
 - ◆ Risk analysis
 - ◆ Alternatives assessment: selection of tailings management technology and facility location using a rigorous, transparent decision-making tool
 - ◆ Independent review
 - ◆ Consideration of engineering standards (e.g., ICOLD, Canadian Dam Association)
 - ◆ Community engagement

- ◆ **Performance-based approach** includes setting performance objectives, operating in accordance with those objectives, and assessing whether objectives are being met
- ◆ **Risk-informed approach** involves managing tailings in a manner commensurate with the risks they pose and making decisions based on those risks, including:
 - ◆ risk assessment to understand all potential risks
 - ◆ development and implementation of a risk management plan
 - ◆ regular reviews and updates as needed
- ◆ **Rigorous decision-making approach** to ensure that decisions are:
 - ◆ carefully considered
 - ◆ based on relevant information, including surveillance results
 - ◆ taken by persons with appropriate authority and competencies
 - ◆ properly documented and communicated

- ◆ “help organizations improve their performance by specifying repeatable steps that organizations consciously implement to achieve their goals and objectives, and to create an organizational culture that reflexively engages in a continuous cycle of self-evaluation, correction and improvement of operations and processes through heightened employee awareness and management leadership and commitment” (ISO)
- ◆ Management systems approach to tailings management: encompasses
 - ◆ governance and decision-making
 - ◆ provides a mechanism to systematically and rigorously implement the other principles described

- ◆ Tailings management system, performance objectives, and risk management plan provide a framework, but OMS is needed to operationalize them on a day-to-day basis
- ◆ Owners that do not effectively implement OMS activities cannot adequately understand their risks, proactively manage tailings, make informed decisions, or have any assurance that tailings and associated risks are being effectively managed
- ◆ OMS activities must be aligned with performance objectives, tailings management system, risk management plan and critical controls
- ◆ Outcomes of OMS, particularly surveillance results, provide feedback for decision-making, including identifying:
 - ◆ deficiencies or opportunities for improvement
 - ◆ upset or emergency conditions requiring immediate response

- ◆ Emergency planning needed for all tailings facilities, taking into consideration the risk profile and risk management plan
- ◆ Level of detail and aspects addressed commensurate with potential consequences if an emergency occurs
- ◆ Owners need to:
 - ◆ plan for potential tailings-related emergencies
 - ◆ assist local communities and others in the development of their own plans for an emergency
- ◆ For tailings facilities that could lead to an inundation risk in the event of a failure, emergency planning needs to include inundation mapping
- ◆ Regular review and testing needed to ensure that:
 - ◆ plans are adequate and up-to-date
 - ◆ all relevant personnel are familiar with the plans and their roles and responsibilities if an emergency occurs

- ◆ Oversight process to provide outside perspective on whether tailings are being managed effectively and responsibly
- ◆ Outcomes can be used to help demonstrate the current state of tailings management to the owner, regulators, communities, and others
- ◆ Several assurance mechanisms and all need to be used as they serve different purposes
 - ◆ Independent Review: independent evaluation of all aspects of tailings management by competent, objective, third-party reviewers on behalf of the Owner
 - ◆ Audits: formal, systematic and documented examinations of the conformance of tailings management with prescribed criteria (e.g., legal requirements, tailings management system)
 - ◆ Evaluation of Effectiveness: considers extent to which planned activities have been realized, and extent to which performance objectives have been achieved

For more information:

<http://mining.ca/our-focus/tailings-management>

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