A Guide to the

Management of Tailings Facilities

THIRD EDITION

The Mining Association of Canada

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Management of Tailings Facilities

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Version date: October 2017

NOTICE TO READERS:

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- hyperlinks to external websites and documents;
- hyperlinks to other sections of the document; and
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Foreword

It is with pleasure that I present, on behalf of the Mining Association of Canada (MAC), the third edition of the *Guide to the Management of Tailings Facilities* (the Tailings Guide).

The first edition of MAC's Tailings Guide was released in 1998. At the time, it was one of the industry's first and most comprehensive management guides specific to tailings. Use beyond Canada led to this Guide being made available in Spanish and Portuguese, in addition to French and English.

MAC subsequently launched the *Towards Sustainable Mining® (TSM®)* initiative in 2004, and the Tailings Guide was integrated with the ***TSM Tailings Management Protocol***, which includes performance indicators for tailings management. An updated second edition of the Tailings Guide was released in 2011. The Tailings Guide is also accompanied by MAC's ***Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities*** (the OMS Guide), first released in 2003 and then revised in 2011.

Application of *TSM* is mandatory for MAC members for their operations in Canada. However, the Tailings Guide and the OMS Guide are designed to be stand-alone documents that can be applied by MAC members and non-MAC members alike, anywhere in the world. Exporting our expertise in sustainable and responsible mining practices, including for tailings management, is one important way that MAC and its members are contributing to improving mining performance globally.

Following the 2014 tailings failure at the Mount Polley Mine in British Columbia, MAC launched comprehensive external and internal reviews of the *TSM Tailings Management Protocol*, Tailings Guide, and OMS Guide. The external review was conducted by an Independent Task Force, and MAC's Tailings Working Group led the internal review. The Independent Task Force issued its report containing 29 recommendations in November 2015, which informed the work of the Tailings Working Group.

These reviews confirmed the strength and benefit of the management systems approach in the Tailings Guide, and made recommendations for further improvements. The recommendations of these reviews were highly convergent and complementary, and provided the basis for updating and strengthening the Tailings Guide.

The third edition of the Tailings Guide is another step in the continual improvement process for tailings management, moving towards the goal of minimizing harm: zero catastrophic failures of tailings facilities, and no significant adverse effects on the environment and human health.

We owe a debt of gratitude to the members of the Independent Task Force and MAC's Tailings Working Group who, together, have brought tremendous skill, dedication and enthusiasm to their important work. I trust that MAC members and others will find these improvements a useful contribution to strengthening tailings management in Canada and abroad.

Pierre Gratton

President & CEO

The Mining Association of Canada

Preface

First Edition of the Tailings Guide

The first edition of MAC's *Guide to the Management of Tailings Facilities*, released in 1998, was developed in response to a series of international **tailings**-related incidents that occurred in the 1990s. The purpose of the first edition was threefold:

- to provide information on the safe and environmentally responsible management of **tailings facilities**;
- to help companies develop tailings management systems that include environmental and safety criteria; and
- to improve the consistency of application of sound engineering and management principles to tailings facilities.

The first edition reflected sound management practices already in place at that time. It adopted principles and approaches from sources that included mining company manuals, proceedings of two MAC workshops, the MAC *Environmental Policy and Environmental Management Framework*, the ISO 14000 standards related to environmental management, the Canadian Dam Association's draft *Dam Safety Guidelines* (1997), and international guidelines and standards.

Building on the implementation of the Tailings Guide and lessons learned, MAC introduced a companion document in 2003: *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities* (the OMS Guide). This guide focuses on the need for a site-specific operation, maintenance and surveillance (OMS) manual as an integral component of an overall tailings management system. Such a document can help companies comply with government regulation and corporate policy, demonstrate voluntary self-regulation and due diligence, practice continual improvement, and protect employees, the environment and the public.

Introduction of MAC's *Towards Sustainable Mining*® Initiative

In 2004, MAC established the *Towards Sustainable Mining® (TSM®)* initiative. The objective of *TSM* is to enable mining companies to meet society's needs for minerals, metals and energy products in the most socially, economically and environmentally responsible way.

TSM is an award-winning performance system that helps mining companies evaluate and manage their environmental and social responsibilities. It is a set of tools and indicators to drive performance and ensure that key mining **risks** are managed effectively by mining operations. Mining companies that participate in the *TSM* initiative demonstrate their strong commitment to responsible mining. Adhering to the *TSM Guiding Principles*, mining companies exhibit leadership by:

- engaging with communities;
- driving world-leading environmental practices; and
- committing to the safety and health of employees and surrounding communities.

The key strengths of *TSM* are that:

- performance is measured primarily at the facility-level, and results are externally verified and publicly reported;
- implementation of the program is monitored by an external Community of Interest Advisory Panel; and
- the program encourages continual performance improvement.

Tailings management is a core component of *TSM*. Performance indicators for tailings management are described in the *TSM Tailings Management Protocol*. The Protocol refers to, and is supported by, the Tailings Guide and the OMS Guide. The tailings management component of *TSM* provides a strong and consistent message to tailings facility owners, operators and contractors: the key to safe and environmentally responsible management of tailings is the consistent application of sound engineering capability within an effective management system and throughout the full **life cycle** of a facility.

Second Edition of the Tailings Guide

In 2011, the second edition of the Tailings Guide was released. This edition reflected information and experience gained through the course of developing and implementing the tailings management component of *TSM*, and working with tailings management systems around the world.

The second edition provided alignment with *TSM* principles and terminology, as well as with the OMS Guide. The scope of application was broadened slightly compared to the first edition, and the second edition expanded on some concepts described in the first edition, and introduced some new concepts. The second edition retained a strong focus on a management systems approach, and reduced the level of technical detail compared to the first edition.

Third Edition of the Tailings Guide

In August 2014, a tailings dam foundation failure occurred at the Mount Polley Mine in British Columbia. Soon after this incident, the MAC Board of Directors initiated a review of the tailings management component of *TSM*. The key question was whether there were any improvements to the tailings management component of *TSM* that could be made to prevent such an event from happening again.

This review, formally launched in March 2015, consisted of two parts:

- an external review by an Independent Tailings Review Task Force established by the MAC Board of Directors; and
- internal analysis by the MAC Tailings Working Group, which had developed the previous editions of the Tailings Guide as well as the OMS Guide.

The Task Force was broad-based, and its seven members represented a variety of expertise and interests:

- specialists in engineering and geotechnical issues;
- First Nations representatives;
- environmental specialists; and
- individuals with experience in executive management.

The Independent Task Force's review focused primarily on the *TSM Tailings Management Protocol*, but also considered the Tailings Guide and the OMS Guide. The ***Report of the Towards Sustainable Mining Tailings Review Task Force*** was presented to the MAC Board of Directors in November 2015, and included 29 recommendations. Of these recommendations, five related to the Tailings Guide:

- Amend the Tailings Guide to require an independent review of site investigation and selection, design, construction, operation, closure, and post-closure of tailings facilities;
- Evaluate how best to include in the Tailings Guide assessment and selection of both Best Available Technology (BAT) and Best Applicable Practices (BAP) for tailings management;
- Develop and include definitions and/or guidance related to managing a change of Engineer-of-Record and a change of ownership in the change management section;
- Include a risk-based ranking classification system for non-conformances and have corresponding consequences. Guidance on risk assessment methodology should be included; and
- Include more specific technical guidance related to site selection and design, including how to select objectives and set design criteria.

Upon receiving the Task Force's report, the MAC Board of Directors committed to expeditiously identify how to best integrate the recommendations into *TSM* for implementation. The Board Chair stated that "it is imperative that the industry continuously improves how it works to ensure the safe operation of its tailings facilities."

The Tailings Working Group, consisting of MAC members and associate members, and representing a wide range of expertise related to tailings management, developed a suite of recommendations that were highly convergent with and complementary to those of the Task Force.

Once both internal and external reviews were complete, the Tailings Working Group began revising the Tailings Guide, leading to the third edition of the Guide. The *TSM Tailings Management Protocol* was also updated and revised to respond to the Task Force's recommendations.

The third edition of the Tailings Guide retains the second edition's strong emphasis on management systems. However, it has an increased emphasis on technical aspects, especially those critical to the physical and chemical stability of tailings facilities. The third edition also strengthens key concepts that were described in previous editions, and introduces others, including:

Risk-Based Approach: managing tailings facilities in a manner commensurate with the physical and chemical risks they may pose. Managing risk includes:

- regular, rigorous risk assessment;
- application of most appropriate technology to manage risks on a site-specific basis (**BAT**);
- application of industry best practices to manage risk and achieve performance objective (**BAP**); and
- use of rigorous, transparent decision-making tools to select most appropriate site-specific combination of BAT and location for a tailings facility.

Critical Controls: identification, implementation and performance monitoring that defines actions designed to manage high-consequence risks relating to a tailings facility.

Engineer-of-Record: The **Owner**, in assuring that a tailings facility is safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the Owner. The EoR verifies whether the tailings facility (or components thereof) has been:

- Designed in accordance with performance objectives and indicators, applicable guidelines, standards and regulatory requirements; and
- Constructed, and is performing, throughout the life cycle, in accordance with the design intent, performance objectives and indicators, applicable guidelines, standards and regulatory requirements.

Independent Review: independent evaluation of all aspects of the planning, design, construction, operation, maintenance of a tailings facility by competent, objective, third-party review on behalf of the Owner.

The third edition also updates the tailings management framework presented in the Tailings Guide as a key tool to help in the implementation of site-specific tailings management systems. Descriptions of the elements of the framework have been strengthened and clarified, and the framework is more aligned with the *ISO 14001 Environmental Management System* standard.

In addition to strengthened technical guidance throughout the body of the Tailings Guide, the third edition provides further guidance in appendices on:

- Risk management framework and approach;
- Integration of BAT and BAP;
- Assessment of alternatives;
- Integration of Independent Review;
- Considerations for managing throughout the life cycle of a tailings facility;
- Technical considerations;
  - Tailings transportation and deposition plans;
  - Water management plans; and
  - Closure plans.

The third edition of the Tailings Guide is another step in the continual improvement process for tailings management, moving towards the goal of minimizing harm: zero catastrophic failures of tailings facilities, and no significant adverse effects on the environment or human health. The Tailings Guide; however, is but a roadmap on this journey – to succeed, it is incumbent on MAC members and the mining industry as a whole to achieve effective implementation of the principles embodied in the Tailings Guide.

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1. Introduction

This Tailings Guide provides guidance on best practices for the safe, and environmentally and socially responsible management of tailings facilities. Its purpose is threefold:

- to provide a framework for the management of tailings facilities;
- to help Owners of tailings facilities develop tailings management systems that include environmental and safety criteria; and
- to improve the consistency of application of reasonable and prudent engineering and management principles to tailings facilities.

Reference to a tailings management system does not imply the need for separate documentation specific to a management system for tailings. The tailings management system can be incorporated into broader site management systems. It is up to the Owner to decide how best to organize and integrate relevant information.

Tailings are a byproduct of mining, consisting of the processed rock or soil left over from the separation of the commodities of value from the rock or soil within which they occur.

Tailings and any associated water must be responsibly managed. Responsible management includes the prevention of impacts to human health and safety, the environment, and infrastructure. Tailings are managed in engineered facilities that are planned, designed, constructed, operated, closed and maintained in the long-term post-closure period (i.e., throughout the facility **life cycle**) in a manner consistent with the need for responsible management. Responsible management is defined by comprehensive assessments of the **risks** associated with a tailings facility, both physical and chemical, that evaluate the potential health, safety, environmental, societal, business, economic and regulatory impacts, and the implementation of appropriate controls to effectively manage those risks.

Tailings facility: The collective engineered structures, components and equipment involved in the management of tailings solids, other mine waste managed with tailings (e.g., waste rock, water treatment residues), and any water managed in tailings facilities, including pore fluid, any pond(s), and surface water and runoff. This may include structures, components and equipment for:

- classification of tailings through water content management (e.g., cyclones, thickeners, filter presses);
- transport tailings to the tailings facility (e.g., pipelines, flumes, conveyors, trucks);
- containment of tailings and associated water (e.g., dams, dykes, stacks, liner systems, cover systems);
- management of seepage (e.g., underdrains, collection ponds, pumping wells);
- water reclaim systems (e.g., pumping to the ore processing facility); and
- management of surface water releases from the tailings facility (e.g., diversions, decant structures, spillways, outlets, flumes, water treatment);

This also includes:

- structures, components and equipment for the surveillance and maintenance of tailings facilities; and
- mechanical and electrical controls, and power supply associated with the above.

Owner is the company, partnership, or individual who has legal possession or is the legal holder of a tailings facility under law in the applicable jurisdiction where the facility is located. For example, the company, partnership or individual that owns the mine or ore processing facility from which tailings and water are generated is the Owner of those tailings and can be considered the Owner of the tailings facility.

Each tailings facility is unique, reflecting site-specific environmental and physical characteristics that contribute to shaping the most appropriate approach to performance and risk management for that facility. The mining industry has the technology, experience and resources to locate, plan, design, construct, operate, decommission and close tailings facilities in a safe and environmentally responsible manner, and there remain opportunities to continually review and improve all aspects of tailings management.

The mining industry is accountable and responsible for managing tailings. This responsibility requires the development and implementation of a management system for effective decision making to integrate technical, regulatory, societal, and business requirements. An essential component of effective tailings management is the implementation of a tailings management system – one that embodies the elements of responsible tailings management. This Tailings Guide details a tailings management framework which provides the basis for Owners to implement a site-specific tailings management system. Elements of this framework are:

- Policy and commitment;
- Planning;
- Implementing the tailings management framework;
- Performance evaluation; and
- Management review for continual improvement.

A management system describes the set of procedures an organization needs to follow in order to meet its objectives. (International Standards Organization)

The intent of this Tailings Guide is to facilitate the development and implementation of facility-specific tailings management systems that address the specific needs of individual Owners and tailings facilities. Development and implementation of the tailings management system takes into account regulatory requirements and community expectations. The tailings management framework provides a foundation for managing tailings in a safe, and environmentally and socially responsible manner throughout the full life cycle of a tailings facility.

This third edition of the Tailings Guide is the result of a review of the current state of science regarding tailings management, incorporating current international best practice. The review has led to the strengthening of key concepts that were described in the previous editions, and introduces others, including:

Risk-Based Approach: an integral component of a tailings management system, with the goal of managing **tailings** facilities in a manner commensurate with the presence and magnitude of the physical and chemical risks that they may pose across the entire life cycle, including **closure**, and **post-closure**. Managing and mitigating risk includes:

- identification of potential risks at the **project conception and planning** phase of the life cycle, and rigorous risk assessment early in the life cycle, and updated periodically throughout the life cycle;

- the application of the most appropriate technology to manage risks on a site-specific basis (**Best Available Technology – BAT**);
- the application of industry best practices to manage risk and achieve performance objectives in a technically and economically efficient manner (**Best Available/Applicable Practices – BAP**); and
- the use of rigorous, transparent decision-making tools to select a site-specific combination of BAT and location for a tailings facility.

Critical Controls: identification and implementation of site-specific and governance-level controls to manage high-consequence risks relating to a tailings facility.

Engineer-of-Record: The Owner, in assuring that a tailings facility is safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the Owner. The EoR verifies whether the tailings facility (or components thereof) has been:

- Designed in accordance with performance objectives and indicators, applicable guidelines, standards and regulatory requirements; and
- Constructed, and is performing, throughout the life cycle, in accordance with the design intent, performance objectives and indicators, applicable guidelines, standards and regulatory requirements.

Independent Review: systematic evaluation of all technical, management and governance aspects of a tailings facility across the life cycle by competent, objective, third-party reviewer(s). Provides assurance that the tailings facility's management system is effective across the life cycle.

Mining companies and their associated projects and operations typically have management systems and frameworks in place. Integrating tailings management into these systems is part of the continual review and improvement of the system. The relevant procedures, activities and controls for managing tailings facilities should be appropriately assigned across personnel, departments, and business units and be scalable, depending on the nature of both the facility and its Owner. Periodic review of the efficiency and effectiveness of management systems will assist in meeting the objectives of responsible planning, design, construction, operation and eventual closure of tailings facilities.

Potential **consequences** of unwanted events associated with tailings facilities may include impacts on the environment, human health and safety, infrastructure, financial and legal implications, and reputational impacts. Thus, the scope of potential consequences to be managed is broader than those typically defined in consequence classification systems, such as that of the *Canadian Dam Association*.

Continual improvement is the process of implementing incremental improvements and standardization to achieve better environmental and management system performance.

From the initial phases of project conception and planning through to post-closure, a tailings management system should be in place to address and integrate risk management, regulatory requirements, technical, management, and governance aspects of tailings facilities. The integration of the technical and management components associated with tailings facilities is core to responsible management of tailings facilities and maintaining social acceptance in the mining industry. Owners of tailings facilities may adapt and implement the tailings management framework to meet their site-specific needs. Implementation of a tailings management system using this framework is intended to help Owners integrate environmental and safety considerations in a manner that is consistent with continual improvement in their tailings management and, in doing so, meet societal expectations.

Implementation of the Tailings Guide is supported by checklists that provide a starting point for developing a site-specific tailings management system. The checklists also assist Owners in exposing gaps within existing procedures, identifying training requirements, obtaining permits, conducting internal audits, and aiding conformance and due diligence, at any phase of the life cycle. It is expected that at each facility the Owner will augment and/or modify these checklists to meet the specific requirements for each specific tailings facility.

Also important to effective implementation of a site-specific tailings management system is engagement with Communities of Interest (COI). Such engagement is two-way, providing the COI with opportunity to ask questions about tailings management, provide information, and express their concerns. It is also an opportunity for the Owner to respond to proactively provide information, and address concerns and questions as they arise.

Communities of Interest (COI) include all individuals and groups who have an interest in, or believe they may be affected by, decisions respecting the management of operations. They include, but are not restricted to:

- employees;
- Aboriginal or Indigenous peoples;
- mining community members;
- suppliers;
- neighbours;
- customers;
- contractors;
- environmental organizations and other non-governmental organizations;
- governments;
- the financial community; and
- shareholders.

Definition from MAC's TSM *Aboriginal and Community Outreach Protocol*

The Tailings Guide should be used in concert with MAC's *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities* (the OMS Guide).

Implementing the Tailings Guide and the OMS Guide will help Owners of tailings facilities achieve and demonstrate:

- a commitment to develop, implement, review and maintain a tailings policy;
- objective setting for planning and strategic activities related to performance and risk management of tailings facilities;
- continual improvement of a tailings management system;
- that internal controls and procedures are in place, maintained, implemented, and verified for the preparation, proper analysis, consideration and disclosure of technical, scientific, environmental and social information;
- that effective, transparent and appropriate level of authority and competency for decision-making is in place to evaluate, recommend and approve technical, management, environmental, social and economic aspects related to tailings and water management; and
- that verifiable, clearly defined and updated **critical controls** and procedures are in place to manage risks.

The objective of the Tailings Guide, together with the OMS Guide, is to continually work towards minimizing harm through the application of BAT and BAP in design, engineering, training, monitoring and maintenance of tailings facilities. This is achieved through the application of risk assessment and management practices, and through the application of "continual improvement" principles. There are complementary guidance documents available and these should be integrated as appropriate provided they embody the principles described in this Tailings Guide.

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.

MAC developed the *TSM Tailings Management Protocol* as a tool to measure progress in implementing this Tailings Guide and the OMS Guide. This Protocol contains a series of measurable indicators related to tailings management to complement these two Guides.

In 2016, the *International Council on Mining and Metals* (ICMM) released its *Position statement on preventing catastrophic failure of tailings storage facilities*, which describes a tailings governance framework. This Tailings Guide is aligned with and complementary to the ICMM position statement.

Tailings and water facilities are complex engineered facilities that must be managed appropriately over long periods of time, some in perpetuity. Detailed technical guidance should be sought elsewhere as a complement to this Tailings Guide. Particularly for mines in Canada, implementation of the Tailings Guide is complemented by guidelines published by the *Canadian Dam Association (CDA)*:

- CDA Dam Safety Guidelines 2007 (2013 Edition); and
- Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams.

Other organizations that have produced high-quality, applicable technical guidance, including guidance on risk assessment and management, include, but are not limited to:

- *International Commission on Large Dams* (ICOLD);
- *Australian National Committee on Large Dams* (ANCOLD);
- *International Standards Organization* (ISO);
  - *ISO 9000 – Quality Management*;
  - *ISO 14000 – Environmental Management*; and
  - *ISO 31000 – Risk Management*;
- *International Code for Cyanide Management*;
- *Environment and Climate Change Canada*;
- *Western Australia Department of Mines and Petroleum*;
- *Australian Government Leading Practice Sustainable Development Program for the Mining Industry*;
- South African National Standards SANS 10286 1998;
- US Bureau of Reclamation;

- US Army Corps of Engineers;
- *US Federal Emergency Management Agency*;
- United Nations Environment Programme; and
- *European Union directive* and *BAT reference document* on mine waste management.

The Tailings Guide does not replace professional expertise or regulatory requirements. Owners of tailings facilities should obtain qualified professional advice, including legal, to be sure that each facility's specific conditions are understood and addressed.

It is important to note that this Tailings Guide discusses a wide range of information that should be documented as part of the development and implementation of a tailings management system. It is up to the Owner's discretion to decide how best to organize this information.

2 Tailings Management Framework

2.1 Overview

This chapter presents the key elements of the framework to manage **tailings facilities** in a safe, sustainable, and environmentally responsible manner.

Figure 1 provides an overview of the essential elements of the tailings management framework as applied through all phases of the life cycle of a tailings facility: project conception and planning, design, initial construction, operations and ongoing construction, temporary or permanent closure, post-closure, and reopening of closed tailings facilities. The elements of the tailings management framework are:

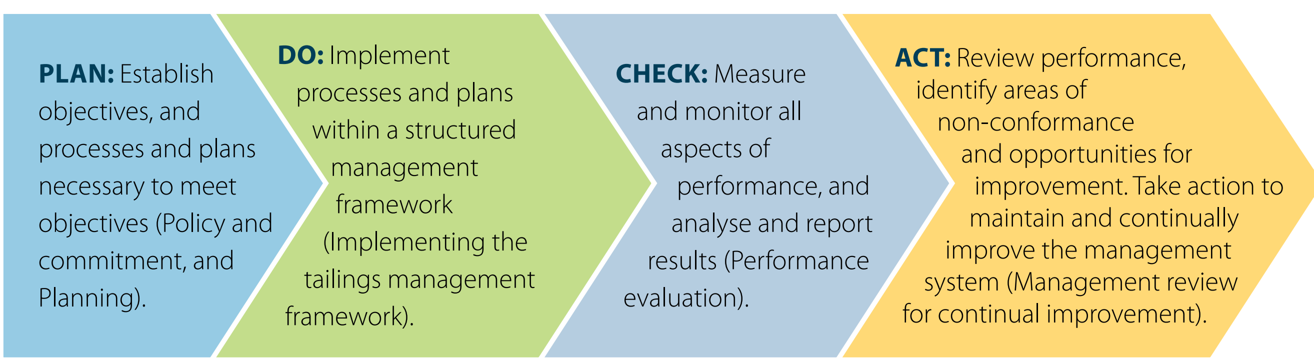
- Policy and commitment (*see Section 3*);
- Planning (*see Section 4*);
- Implementing the tailings management framework (*see Section 5*);
- Performance evaluation (*see Section 6*); and
- Management review for continual improvement (*see Section 7*).

Also integral to the development and implementation of an effective tailings management system is oversight provided through an assurance program. Assurance, which cross-cuts all elements of the **tailings** management framework, is further discussed in *Section 8*.

Environmental Management System (EMS): The part of an overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy and reducing environmental impacts (adapted from ISO 14001)

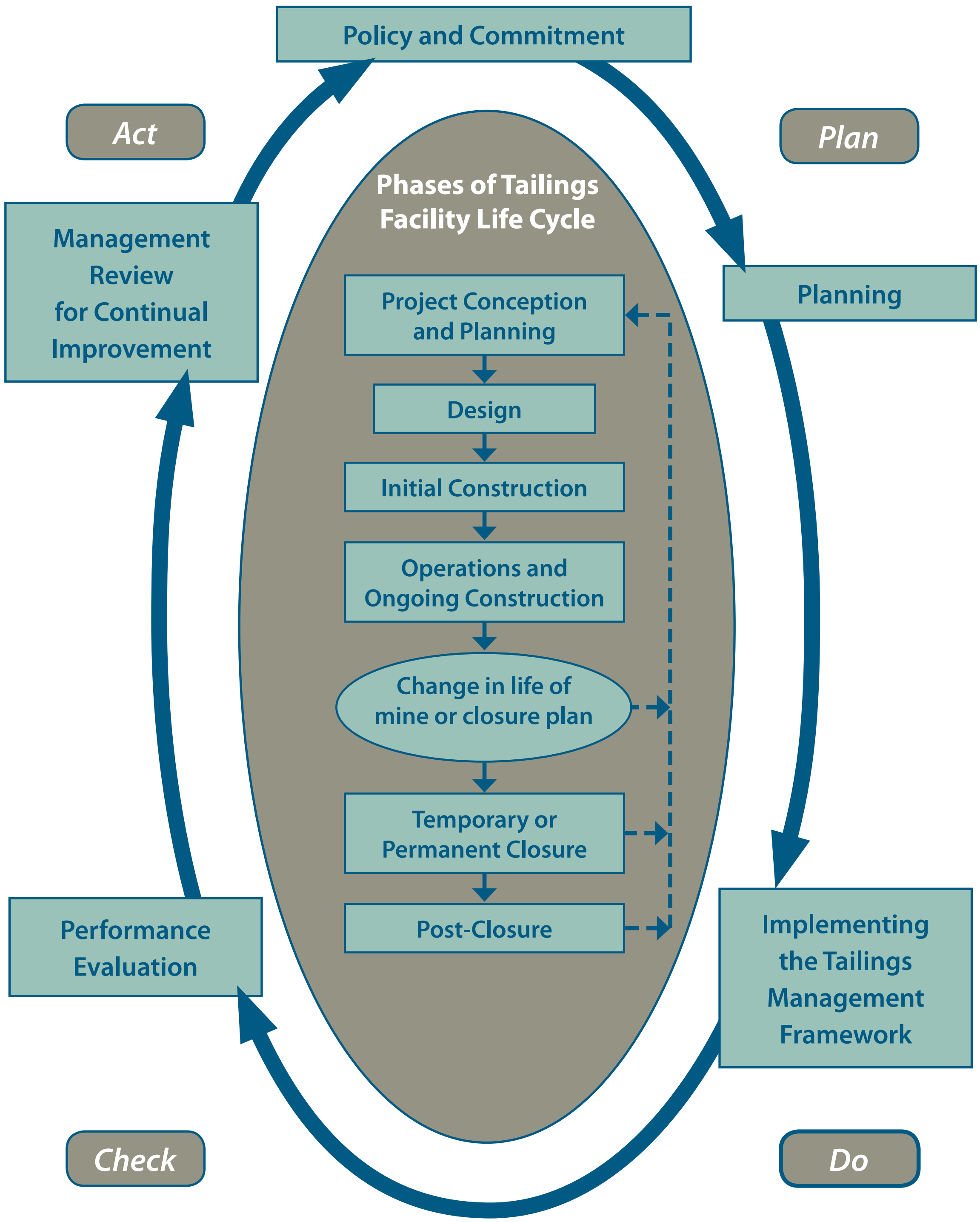
The tailings management framework is based on the *ISO 14001* definition of an environmental management system which includes: an organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining policies.

Consistent with other models for environmental management systems, the tailings management framework follows a cycle of Plan-Do-Check-Act; a management model for control and continual improvement.



The cycle is then repeated, with objectives re-visited and revised as appropriate, and processes and plans adjusted (see Figure 2). This helps to drive continual improvement, leading to improved environmental protection and reduced risk.

Figure 1: Elements of the Tailings Management Framework



Phases of the Life Cycle of a Tailings Facility:

Project Conception and Planning: begins at the outset of planning of a proposed mine, and is integrated with conception and planning for the overall site, including the mine plan and plans for ore processing. The phase includes the use of rigorous decision-making tools to support selection of the location for the tailings facility, and the BAT to be used for tailings management.

Design: begins once the location and BAT for the tailings facility have been selected, and occurs in concert with detailed planning of all aspects of the proposed mine. Detailed engineering designs are prepared for all aspects of the tailings facility and associated infrastructure.

Initial Construction: construction of structures and infrastructure that need to be in place before tailings deposition commences. This includes, for example, removal of vegetation and overburden, and construction of starter dams, tailings pipelines, access roads, and associated water management infrastructure.

Operations and Ongoing Construction: tailings are transported to, and deposited in, the tailings facility. Tailings dams may be raised, or new tailings cells added as per the design. Depending on the overall mine plan, the operations and ongoing construction phase of a tailings facility may or may not coincide with the period of commercial operations of the mine.

Standby Care and Maintenance: the mine has ceased commercial operations and the deposition of tailings into the facility is not occurring. The Owner expects to resume commercial operations at some point in the future, so surveillance and monitoring of the tailings facility continue, but the facility and associated infrastructure are not decommissioned and the closure plan is not implemented.

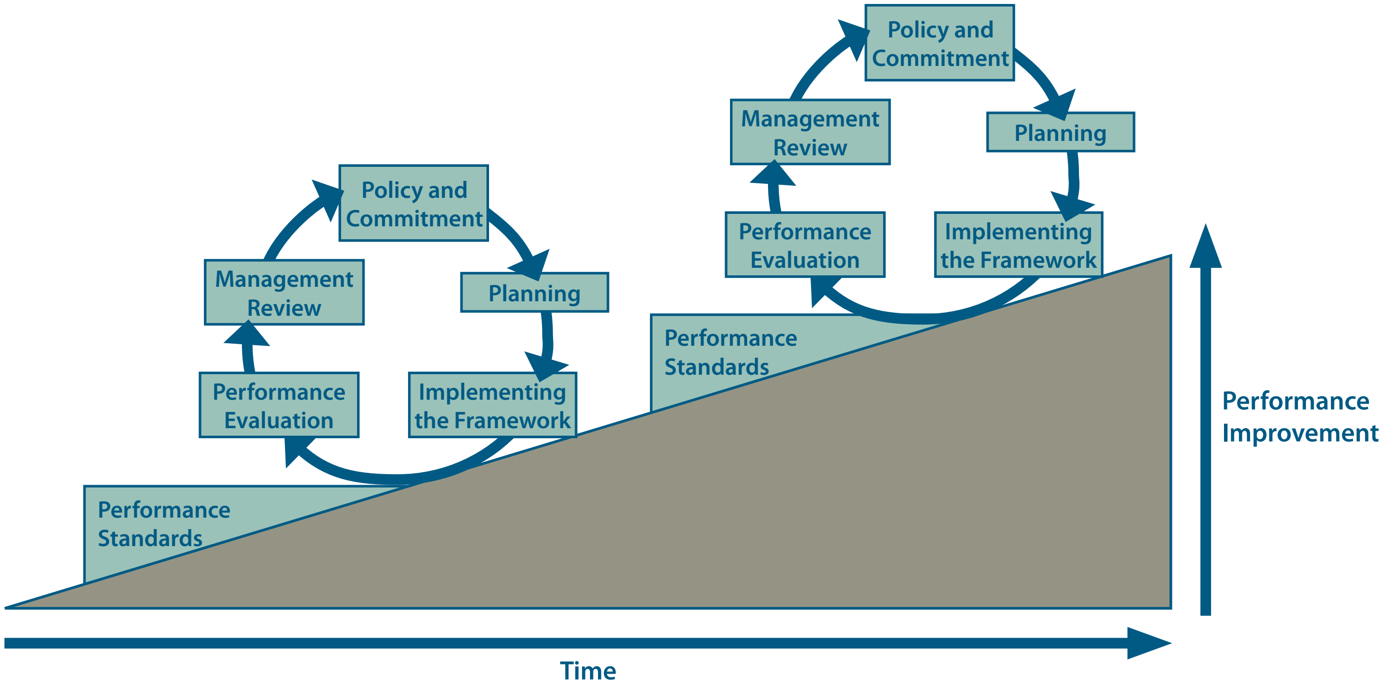
Closure: begins when deposition of tailings into the facility ceases permanently. The facility and associated infrastructure are decommissioned, and key aspects of the closure plan are implemented, including:

- transitioning for operations to permanent closure;
- removal of key infrastructure such as pipelines;
- changes to water management or treatment; and
- recontouring or revegetation of tailings and any containment structures or other structural elements.

Post-closure: begins when decommissioning work is complete, key aspects of the closure plan have been implemented, and the tailings facility has transitioned to long-term maintenance and surveillance. During post-closure, responsibility for a tailings facility could transfer from the Owner to jurisdictional control.

NOTE: particularly with respect to closure and post-closure, there are various legal definitions in different jurisdictions. These definitions are intended strictly as function definitions, characterizing key activities that differentiate these phases.

Figure 2: Continual Improvement through Implementation of the Tailings Management Framework



2.2 Overarching Principles

2.2.1 Risk Assessment and Management

The assessment and management of risk is essential to the effective management of tailings facilities, and is integral across all elements of the tailings management framework, and across the entire life cycle. Potential risks associated with tailings facilities, including the physical and chemical, as well as operational, organizational, financial and management risks, should be identified. Facilities should be conceived, designed, constructed, operated and closed in a manner that effectively manages risks to achieve the objective of minimizing harm.

Risks should be re-assessed throughout the life cycle, and as part of any material changes in the tailings facility, such as a mine life extension or a temporary suspension of operations. As the risk profile of the facility changes, the risk management measures should be updated accordingly.

Risk denotes a potential negative impact, detrimental to operations, the environment, public health or safety that may arise from some present process or future event. The potential severity or consequence of the impact and its probability or likelihood of occurrence are both considered when evaluating risk.

For new and existing facilities, risk assessment should consider potential impacts of climate change, including extreme weather events (extended drought or high precipitation events), and potential impacts on permafrost in areas of high latitude or altitude. Risk management should include measures to ensure tailings facilities are resilient enough that risks continue to be appropriately managed under changing climate conditions, particularly in the long-term, through closure, and post-closure.

Additional guidance on risk assessment and management is provided in *Appendix 1*.

One aspect of risk management is the identification, development, and implementation of critical controls, which are controls related to tailings facility management that should be implemented effectively to either prevent a serious incident from occurring, or to limit the consequences if a serious incident were to occur. The key steps in the identification, development, and implementation of critical controls are to implement a tailings management system, and to identify and evaluate:

- potential events with unwanted consequences;
- plausible failure modes and other associated risks;
- critical controls associated with each plausible failure mode;
- performance indicators associated with these controls;
- defined, systematic actions to implement the controls;
- activities to maintain, verify, and report on the effectiveness of the controls; and
- pre-defined actions for adaptive management.

The implementation of appropriate corporate governance, including the implementation of a tailings management system, is a form of critical control. However, most other critical controls are more specific to the risks associated with a given tailings facility. Thus, some critical controls can be implemented and monitored at a corporate level, while others are implemented and monitored at the site-specific level. Critical controls are further discussed in *Section 4.3*.

2.2.2 BAT and BAP for Tailings Management

The identification and implementation of tailings management technology, including the application of site-appropriate BAT, together with the application of BAP, are the cornerstones of achieving performance objectives and managing risk. Selection of BAT requires consideration of a range of potential technologies, to select the most appropriate technology to manage risks on a site-specific basis. There are many factors to consider when choosing BAT for a tailings facility, examples of which include:

- Are the likelihood or consequences of a failure of a tailings facility reduced?
- Is material separation required to manage a potential geochemical concern?
- How much water will be retained in the tailings during their transport and deposition?
- Is there potential to place any tailings in mined-out areas?
- Is the post-mining land use best served by a given technology?

BAP are accepted practices across the full spectrum of tailings management to manage risk and achieve the best outcome in a technically sound and economically efficient manner. Elements of BAP can be applied widely, including:

- confirming geochemical and physical design parameters during operations, closure, and post-closure, and adjusting;
- structural monitoring of tailings facilities to detect movement or change;
- implementing a tailings management system;
- monitoring to assess performance against water balance requirements; and
- conducting Independent Review.

Best Available Technology (BAT) is the site-specific combination of technologies and techniques that is economically achievable and that most effectively reduces the physical, geochemical, ecological, social, financial, and reputational risks associated with tailings management to an acceptable level during all phases of the life cycle, and supports an environmentally and economically viable mining operation.

Best Available/Applicable Practice (BAP) encompasses management systems, operational procedures, techniques and methodologies that, through experience and demonstrated application, have proven to reliably manage risk and achieve performance objectives in a technically sound and economically efficient manner. BAP is an operating philosophy that embraces continual improvement and operational excellence, and which is applied consistently throughout the life of a facility, including the post-closure period.

For new facilities, and for facilities undergoing mine life extensions, performance objectives and the management of potential risks are key drivers at the conceptual planning and design phases. The selection of the most appropriate tailings management technology and facility location, using rigorous decision-making tools to assess alternatives, provides the foundation for future risk management and achieving performance objectives. At the design phase, consideration should also be given to BAP that could be applied throughout the life cycle of the facility.

For existing facilities, it may not be technically or financially possible to fundamentally change the technology used for tailings management. However, other aspects of technology associated with tailings management should be re-evaluated based on the results of updated risk assessments and evolving technology that could be applied to further reduce current and future risk. BAP should be re-evaluated throughout the life cycle, with the goal of continual improvement in tailings management. Management measures also need to be re-evaluated throughout the life cycle to ensure that they remain appropriate as the risk profile, or environmental or operating conditions of the tailings facility change.

Additional guidance on the integration of BAT and BAP is provided in *Appendix 2.* Assessment of alternatives for the selection of the tailings facility location and BAT is further discussed in *Appendix 3*.

2.2.3 Independent Review

Regular, systematic Independent Review (IR) is recognized as a BAP for responsible tailings facility management.

IR provides **Owners** with independent, objective, expert commentary, advice, and, potentially, recommendations to assist in identifying, understanding, and managing risks associated with tailings facilities. The primary purpose of IR is to provide an opinion to the Owner's Accountable Executive Officer (*see Section 4.3*) regarding:

- completeness/appropriateness of the risk assessment and understanding;
- effectiveness of tailings governance and the tailings management system;
- whether the tailings facility is being effectively managed based on sound engineering practices;
- whether the risk assessment and the acceptable level of risk should be reviewed and updated;
- whether concepts and design criteria for the facility are consistent with regulatory requirements, industry guidelines and best practices, and current theory, methodologies and experience; and
- areas for improvement in the management of the tailings facility.

The objectives are to:

- Facilitate informed management decisions regarding a tailings facility so that tailings-related risks are managed responsibly and in accordance with an acceptable standard of care; and
- Ensure that the Accountable Executive Officer has a third-party opinion regarding the risks and the state of the tailings facility and the implementation of the tailings management system, independent of the teams (employees, consultants, and contractors) responsible for planning, designing, constructing, operating, and maintaining the facility.

As an overarching principle of the tailings management framework, IR is applicable across all elements of the framework. It is also applicable across the entire life cycle of a tailings facility. The input of IR should be sought from the initial conceptual planning and design phases, through to reviewing post-closure performance. However, over the life cycle of a tailings facility, and as the risk profile of a facility changes, the scope and focus of IR should be re-adjusted to ensure it remains relevant and effective.

IR is conducted by one or more appropriately qualified and experienced individuals, who have not been directly involved with the design or operation of the particular tailings facility. Qualifications and experience of reviewers should be aligned with the tailings facility's complexity and risk profile.

Additional guidance on IR is provided in *Appendix 4.*

2.2.4 Designing and Operating for Closure

Some of the potential impacts and risks posed by mining remain long after mining operations cease. In particular, tailings facilities may pose physical and chemical risks in perpetuity. Thus, tailings facilities may represent a long-term risk and liability that must be responsibly managed for many decades after mining operations cease. Designing and operating for closure is a BAP for mitigating these long-term risks and reducing liability.

> A **closed tailings facility** is one that is no longer being used for the deposition of tailings, with the expectation that the facility will not be used for deposition of tailings in the future. The mine or ore processing facility with which the tailings facility is associated may or may not also be closed.

Designing and operating for closure requires a long-term view. Tailings facilities are seldom for temporary storage. While some may eventually be re-mined to recover additional commodities of value, they should be conceived, designed, constructed, operated and closed on the assumption that they will be permanent facilities. Tailings facilities, designed for closure, are true future engineered landforms, intended to remain physically and chemically stable for the long-term. It is important to ensure that short-term financial or operational priorities do not prevail over better design and operational practices that would have lower long-term impacts, complexity or risks.[1]

Designing and operating for closure is holistic, and takes all aspects of the mine into account, not just the tailings facility itself. For example, design and operational decisions related to mining and ore processing can impact both the quantity, and physical and chemical characteristics of tailings and associated water, and can have long-term implications for the management of tailings: management of tailings begins upstream in the operation – in the mine planning and in the ore processing plant.

The earlier that tailings hazards and associated unknowns are reduced, the greater the potential for meeting long-term closure objectives. Thus, planning and designing for closure should be initiated at the project conception and planning phase of the life cycle. Figure 3 illustrates the importance of planning for closure, and the application of BAT and BAP throughout the life cycle. For example, selecting the most appropriate combination of technology and the tailings facility location for a given site at the very outset will reduce risks and minimize closure liability.

1. The Australian Government (2016: *Leading Practice Sustainable Development Program for the Mining Industry: Tailings Management*) states that: "Conventional economic analysis can lead to minimising initial capital expenditure and deferring rehabilitation costs. Net present value analysis discounts the current cost of future expenditures on closure, rehabilitation and post-closure management. Therefore, if this short-term economic perspective is taken, without taking into account the longer term social and environmental costs, there is little motivation to invest more substantially at the development phase to avoid or reduce expenditures at the closure phase. There are a number of reasons, however, for applying leading practice at the earliest stage of development and for designing and operating the TSF to achieve optimal closure outcomes."

Figure 3: Risk Management Practice over the Life of the Mine[2]

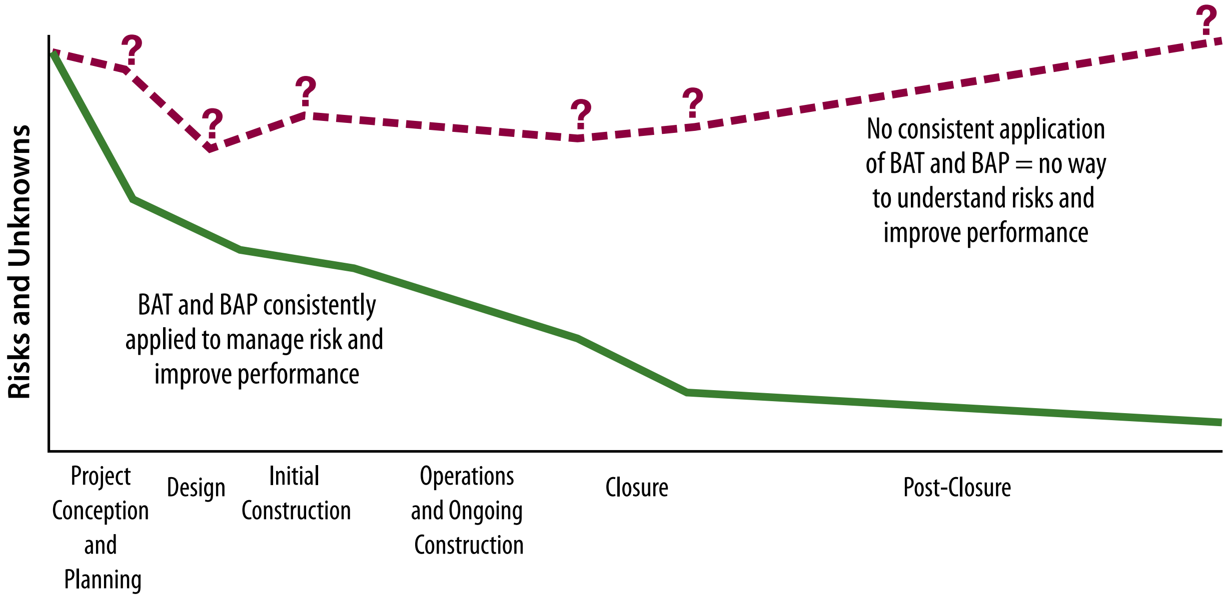


Figure 3 captures the importance of good decisions early in the life cycle of a tailings facility, but does not consider the financial accounting practices used in mine planning, particularly the application of discount rates to longer-term costs. Use of such practices can minimize, from a financial planning perspective, the importance of upfront investment in longer-term management of impacts and risks. At the same time, if every potential project became so risk adverse that financial considerations had no role in management practices, the benefits of mining to society would not be realized. Balance is required and a transparent decision process with input through IR will assist in achieving, demonstrating, and communicating this balance.

After key design decisions are made about the selection of tailings management technology and a location for a tailings management facility, closure plans should continue to evolve and be refined in greater detail, considering changes in the mine plan, regulatory changes, a changing risk profile of the tailings facility, status of progressive reclamation activities, and changes in **COI's** expectations.

Tailings facilities not originally designed with closure objectives in mind, such as facilities that have already been in operation for several decades, may be able to adjust their tailings management practices or adopt newer technologies (e.g., segregation if tailings with high potential for impacting water quality) to reduce risk and better position the tailings facility for closure. Regular review of such opportunities is central to continual improvement.

2. Figure adapted from International Council of Mining and Metals (2008): *Planning for Integrated Mine Closure: Toolkit*

2.3 Managing Throughout the Life Cycle of a Tailings Facility

Mining companies face the challenge of effectively and efficiently managing tailings facilities throughout their life cycle, from project conception and planning, to design[3], through initial construction, operations and ongoing construction, to eventual closure, and post-closure[4] (Figure 1).

Tailings facilities continue to change and evolve over their life, and the life cycle of a tailings facility is rarely a simple linear progression from one phase to the next. For example, while construction is a discrete life cycle phase for most aspects of a mine, construction activities at a typical tailings facility continue throughout the operating life of the mine as dams or other containment structures are raised, or as facilities are enlarged to accommodate increasing volumes of tailings. This is unlike other types of containment structures, such as hydroelectricity dams or water resource management dams, which are typically built to final configuration at the outset. In addition, within the operational phase there can be changes that were not anticipated at the beginning of mine life, such as enlargements of the footprint of tailings facilities, care and maintenance suspensions (and subsequent re-starts), process and technology changes, and so forth, reinforcing the criticality of effective risk management and change management.

The life cycle timescale can extend for many decades to reach the end of the operations and ongoing construction phase, and centuries beyond for closure and post-closure. In some cases, tailings might be re-processed in the future as technology improves and commodity prices increase. Thus, many aspects of tailings management are not predictable at the mine's conception.

Change itself is a key source of risk for tailings facilities, and needs to be effectively managed. Systematic, risk-based management approaches provide a means of navigating these aspects of the mining life cycle.

At each phase in the tailings facility's life cycle, implementation of a tailings management system requires that actions be planned and implemented within the context of policies and commitments, with performance measurement and reporting mechanisms in place.

Typically, responsibility for the management of a tailings facility will come under different roles during different phases of its life cycle. For example, one team may lead the design, another the initial construction, another during the operations and ongoing construction phase, and another team for the closure phase. During post-closure, the facility may transition from active care and management to a more passive mode, but some level of surveillance and maintenance may still be required. Transfer of ownership of the facility may occur, but continuity of some degree of ongoing surveillance and maintenance may be necessary to ensure risks continue to be appropriately managed.

Consequently, having an established management system that ensures that design fundamentals/ elements, operating principles and constraints, the risk assessment and risk management processes, and the associated critical controls are consistently carried forward to the subsequent management teams is essential to ensuring that risks are effectively managed and that new, unknown risks are not introduced by losing the original design data and intent.

Additional information on managing through the life cycle of a tailings facility is provided in *Appendix 5*.

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3. The project conception and planning, and the design phases encompass key steps in the mine planning process: Pre-Scoping Study, Scoping Study, Pre-Feasibility Study, and Feasibility. Thus, just as conceptual mine planning begins at the pre-scoping and scoping steps, planning for tailings management should also begin at these steps.

4. The closure and post-closure phases correspond to the overall closure phase, as described in the Canadian Dam Association's (CDA) *Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams*. The closure phase, as defined in this Tailings Guide, corresponds to the transition phase as defined by the CDA. The post-closure phase, as defined in this Tailings Guide, corresponds to the active and passive closure phases as defined by the CDA.

3 Policy and Commitment

Every Owner of a tailings facility should establish a tailings management policy and/or commitments that meet the specific requirements applicable to their portfolio of **tailings facilities**. Each **Owner** should develop their commitments in the manner that best meets their needs and corporate management approach while addressing their commitments to regulators and their **COI**.

Each Owner should demonstrate commitment to:

- protection of public health and safety;
- responsible management of tailings with the objective of minimizing harm;
- allocation of appropriate resources to support tailings management activities; and
- implementing a tailings management system through the actions of its employees, contractors and consultants.

On a facility-specific basis, the Owner should also make more specific commitments. These additional commitments will likely take the form of the following:

- Plan, design, construct and operate tailings facilities in a manner that reduces long-term impacts, **risks** and liability;
- Ensure tailings management complies with regulatory requirements, and conforms with reasonable and prudent engineering practice, set design criteria, company standards/guidelines, and the Owner's tailings management system;
- Engage with COI, taking into account their considerations in relation to the design (including location), operation, and management of the tailings facility;
- Manage tailings facilities commensurate with the risks they pose through implementation of BAT and BAP, with the objective of minimizing harm, and meeting performance, corporate governance, environmental and social requirements;
- Manage all solids and water within designated areas;
- Establish an ongoing program of review, including Independent Review, and continual improvement of health, safety and environmental performance through the management of risks associated with each tailings facility; and
- Implement the level of accountability, authority and competency for decision making appropriate to the level of risk that the decision entails.

The policy and/or commitments should be:

- reviewed and endorsed by the Board of Directors or Governance Level (*see Section 4.3*);
- communicated to employees;
- understood by employees and contractors whose duties, directly or indirectly, may affect the safety of tailings facilities;
- communicated to COI; and
- implemented with budget allocation.

A tailings management policy does not need to be a stand-alone document, and can be part of an overarching company operation, environmental or sustainable development policy, if that policy contains specific reference to tailings management, and includes the policies and commitments as outlined here.

Some owners may have multiple policies to address different needs.

The key is that all necessary information be documented. It is up to the Owner to decide how best to organize that documentation.

4 Planning

4.1 Risk Management

The identification and mitigation of **risk** are fundamental tenets of good management, and this applies to the management of tailings (*Section 2.2.1*). Risk assessments should be completed as frequently as required to meet the tailings management objectives established for any given facility. The acceptable level of risk should be defined in the context of the facility and for its specific **life** phase, taking into account the likelihood and consequence of catastrophic failure, and perspectives of the **Owner**, regulators and **COI**.

Risk assessment and management should take into account:

- physical and chemicals risk of the **tailings facility**;
- environmental risks such as earthquakes, landslides or avalanches, which could impact the facility; and
- other risks external to the Owner and the facility, including regulatory and permitting risks (e.g., not obtaining permits in a timely manner, or permits that are not aligned with the design intent of the tailings facility).

A risk management plan should be prepared and documented so that it describes the outcomes of the risk assessment, and mitigation measures to:

- eliminate or avoid risk to the extent practicable;
- reduce risk by minimizing the likelihood or potential consequence of an unwanted event or condition that poses a risk; and
- detect, respond to, and minimize the consequences if an unwanted event or condition occurs that poses a risk.

Development of a conceptual risk management plan should begin at the **project conception and planning phase** of the life cycle for new facilities and expansions of existing facilities, and be refined and developed in greater detail during the **design phase**.

For all operations, the risk assessment and the risk management plan should be reviewed and updated regularly as appropriate through the life cycle of the tailings facility. The plan should also be reviewed and updated in the event of changes that were not anticipated at the beginning of mine life, such as mine life extensions, care and maintenance suspensions (and subsequent re-starts), changes in the ore being processed, process and technology changes, etc.

4.2 Performance Objectives

Establish and document performance objectives, indicators, and associated performance measures for the tailings facility based on:

- environmental requirements;
- risk assessment and the level of acceptable impact and risk; and
- risk management plan.

Performance objectives and indicators should be aligned with the Owner's tailings management system and policy and/or commitments, standards/guidelines, regulatory requirements, commitments to COI, and sound engineering and environmental practices.

Performance objectives are overall goals, arising from the Owner's policy and commitment, which are quantified where practicable.

Performance indicators are detailed performance requirements that arise from the performance objectives and that need to be set and met in order to achieve those objectives. Performance indicators must be measurable and quantifiable.

(Both definitions adapted from *ISO 14001*)

Performance objectives and indicators should be developed for the entire life cycle of the tailings facility, including planning for both potential temporary and eventual permanent closure, and should address:

- protection of employee and public health and safety;
- design objectives and criteria, including geotechnical, geochemical, operational, community, and environmental performance objectives that the tailings facility is expected to achieve;
- mitigation of negative environmental impacts by ensuring continued physical and chemical stability of all components/structures; and
- acceptable post-closure use within a feasible technical and economic framework.

For new facilities or facilities undergoing expansion, performance objectives should be established early in the conceptual planning and design phases. Assessments of alternatives for facility location and tailings management technology should take these performance objectives into account.

4.3 Accountability and Responsibility

A wide range of employees, contractors and consultants are typically engaged to implement a tailings management system and apply a duty of care in ensuring that tailings facilities are managed in a responsible manner. Given the number of people involved, and the range of roles related to tailings management, it is important that accountability and responsibility be clearly defined and in place for all decisions related to tailings management. Decisions should be made by persons who have clear accountability or responsibility, and who are appropriately qualified and experienced.

It is essential that persons with accountability and responsibility for tailings management have an understanding—appropriate to their accountability, responsibility, and authority level—of how the tailings facility is planned, designed, constructed, and operated. This includes the risks posed by the facility, the risk management process, **critical controls** management, and operational constraints.

The circumstances of each Owner and tailings facility vary and, therefore, governance and organizational structure should be appropriately tailored to the needs of each Owner and facility. At a minimum; however, accountabilities, responsibilities, authority, and roles should be clearly defined and documented for:

- Owner's Board of Directors or Governance Level;
- Accountable Executive Officer;
- Responsible Person(s);
- Engineer-of-Record (EoR); and
- Independent Reviewer(s).

It is also essential that the Owner understand the roles and mandate of all relevant regulatory agencies, and have a clear understanding of the regulatory framework within which the tailings facility is planned, designed, constructed, operated, and closed.

Board of Directors or Governance Level

Ultimately, the accountability for decisions related to tailings management rests with the Owner's Board of Directors or Governance Level. This will depend on the size and structure of the Owner company.

The role and accountability of the Board of Directors or Governance Level versus the Accountable Executive Officer is determined by the Owner, and should be documented.

> For large, multi-national companies headquartered outside of the country in which the tailings facility is located, the governance level could be equivalent to the highest-level committee or board within that country, providing oversight and review of tailings management activities.

Accountable Executive Officer

The Board of Directors or Governance Level designates an Accountable Executive Officer for tailings management. This Officer:

- needs to be aware of key outcomes of tailings facility risk assessments and how these risks are being managed;
- has accountability and responsibility for putting in place an appropriate management structure;
- assigns responsibility and appropriate budgetary authority for tailings management and defines the personnel duties, responsibilities and reporting relationships, supported by job descriptions and organizational charts, to implement the tailings management system through all phases in the facility life cycle; and
- provides assurance to the Owner and its COI that tailings facilities are managed responsibly.

Responsible Person(s)

As a minimum, the Owner should designate one Responsible Person for each tailings facility. During initial construction, and operations and ongoing construction, there should be a Responsible Person immediately available at all times. The Responsible Person(s) has clearly defined, delegated responsibility for tailings management and appropriate qualifications. There may also be a designated Responsible Person at the corporate level. The Responsible Person(s) identifies the scope of work and budget requirements (subject to final approval) for all aspects of tailings management, including the EoR, and will delegate specific tasks and responsibilities for aspects of tailings management to qualified personnel.

Engineer-of-Record

The Owner, in assuring that a tailings facility is safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the Owner. The EoR verifies whether the tailings facility (or components thereof) has been:

- Designed in accordance with performance objectives and indicators, applicable guidelines, standards and regulatory requirements; and
- Constructed, and is performing, throughout the life cycle, in accordance with the design intent, performance objectives and indicators, applicable guidelines, standards and regulatory requirements.

For tailings facilities that include retention structures/dams, the EoR is responsible for Dam Safety Inspections and associated reports. The EoR should also participate in the facility's risk assessments and be accessible to independent reviewers, and, for facilities with retention structures, dam safety reviews. The EoR provides these activities as part of the Owner's broader assurance process, as described in *Section 8*.

The EoR must have experience and knowledge commensurate with the risk management requirements for the facility. The EoR must have the appropriate qualifications, which includes professional certifications relevant to the jurisdiction in which the tailings facility is located (e.g., Professional Engineer registration in the appropriate province or territory in Canada).

Independent Reviewer(s)

The Independent Reviewer(s) provides Owner with independent, objective, expert commentary, advice, and potentially recommendations, to assist in identifying, understanding, and managing risks associated with tailings facilities, as well as the implementation of the Owner's tailings management system. The Independent Reviewer(s) does not have decision-making authority. Accountability and responsibility for decisions rests with the Owner.

Independent Reviewers are third-parties who are not, and have not been directly involved with the design or operation of the particular tailings facility.

4.4 Management Process

4.4.1 Conformance Management

The Owner should document and implement conformance management processes to ensure that:

- applicable regulations, permits and commitments (including commitments/conditions coming from environmental assessment and permitting) are identified, documented, understood and effectively communicated;
- owner's policies, guidelines, standards, practices are identified, documented, implemented, and reviewed;
- those accountable and responsible for conformance understand the conformance management plan and have the necessary training and competence; and,
- procedures to assess state of conformance have been established, implemented, documented and communicated as required for responsible management of the facility.

In cases of non-conformance, the Owner should:

- report the non-conformance, internally and externally, as appropriate;
- determine the causes of the non-conformance, and identify and implement corrective measures;
- address consequences of the non-conformance, including mitigating environmental impacts;
- review the effectiveness of measures to correct the non-conformance; and
- make necessary changes to the tailings management system to prevent future non-conformance.

The nature of non-conformance events should be documented, together with corrective actions taken, and the results of the corrective actions.

4.4.2 Change Management

The Owner should document and implement change management processes to maintain the integrity of the tailings facility and the management system, including changes to:

- approved designs and plans, including temporary changes, and expansions to tailings facilities;
- facility ownership;
- persons involved, or roles of, employees, contractors and consultants with key duties related to the tailings facility, including the Accountable Executive Officer, Responsible Person(s), EoR, and Independent Reviewer(s);
- conditions that may impact the ongoing operation/maintenance of the tailings facility, including temporary suspension of mining operations;
- the closure plan;
- regulatory requirements; and
- other changes that are potentially material to the risks associated with the tailings facility and its management (i.e., changes that have the potential to change, in the current or future phases of the life cycle, the performance or risk profile of the tailings facility or its component parts).

Change management processes should include succession planning for key roles related to tailings management, including the Responsible Person(s), EoR, and Independent Reviewer(s). For external roles such as the EoR and Independent Reviewer(s), this could include having documented terms of reference, descriptions of required qualifications, and a documented process for filling external roles in the event of change.

Changes that could impact the risk profile of a tailings facility should be reviewed and potential impacts should be evaluated. Changes should be approved by all the relevant persons (e.g., EoR, Responsible Person(s), personnel involved in tailings management and related activities, and the Accountable Executive Officer, as appropriate). In particular, if changes are proposed to the original or current design of the tailings facility (e.g., changes in dam construction specifications), these proposed changes should be carefully documented and risks of the change in the current and future phases of the life cycle should be evaluated. Depending on the nature of the change and the potential impact, Independent Review (IR) of the proposed change is recommended (see also *Appendix 4*). Before implementing, the proposed change should be approved at a level commensurate with the potential impact of the change.

If other changes are proposed, such as changes to plans and procedures, the potential impacts of these changes should also be evaluated, and changes should be approved at the appropriate level prior to implementation. Changes should be documented.

4.4.3 Controls

Critical Controls

Critical controls are site-specific and governance-level risk controls, and associated performance measures, that define actions intended to assist the management of high-consequence risks related to a tailings facility. Critical controls may be technical, operational or governance in nature. Critical control management is a governance approach to managing high-consequence risks relating to an operation or business. It is designed to provide a high level of assurance against the occurrence of high-consequence events, as defined by the Owner and its EoR, with input from IR.

In the context of tailings management, critical controls are a subset of risk controls that prevent high-consequence events.

Risk controls are measures put in place to either:

- prevent or reduce the likelihood of the occurrence of an unwanted event; or
- minimize or mitigate the negative consequences if the unwanted event does occur.

The designation of critical controls is an Owner and tailings facility-specific exercise. Risk controls are typically designated as critical controls if:

- Implementation of the control would significantly reduce the likelihood or consequence of an unwanted event or condition that poses unacceptable risk (see also *Appendix 1*);
- Conversely, removal or failure of the control would significantly increase the likelihood or consequences of an unwanted event or condition that poses an unacceptable risk, despite the presence of other controls;

- The control would prevent more than one failure mode, or would mitigate more than one consequence; and
- Other controls are dependent upon the control in question.

Processes for management of critical controls should be implemented, key elements of which are as follows:

- Identify potential failure modes and causes using risk assessment techniques (see *Appendix 1*);
- Identify risk controls associated with potential failure modes and causes;
- Identify those risk controls deemed to be critical on an Owner or facility-specific basis;
- Appoint a "risk owner" and "critical control owner" for that risk;
- Define the critical controls and their performance criteria, measurable performance indicators, and surveillance requirements;
- Identify pre-defined actions to be executed if control is lost;
- Verify execution of critical controls by the critical control owner or designate, at a frequency commensurate with the frequency of control execution;
- Report deficiencies in critical controls to the Responsible Person(s) and, where appropriate, the Accountable Executive Officer, and identify actions to address those deficiencies;
- Track implementation of actions to address critical control deficiencies, and report to the Responsible Person(s) and, where appropriate, the Accountable Executive Officer; and
- Periodically review and update risk controls and critical controls, based on updated risk assessments, risk management plans, and past performance.

Quality Management

There are two key components to quality management: quality assurance (QA) and quality control (QC). These two components are closely related, but they are different.

To illustrate, a QA plan for the construction of a tailings dam or other containment structure would prescribe the specifications (determined at the design phase) for all aspects of construction, such as the specifications for materials to be used in the construction of the dam. A QC plan would describe procedures to ensure that these specifications are met, and procedures to address cases where specifications are not met. The overall goal is to ensure that the dam is constructed in a manner that is consistent with the design principles, and to eliminate risks associated with sub-standard construction of the dam.

Quality is defined in the *ISO 9000* standard as the "degree to which a set of inherent characteristics fulfils requirement".

Quality assurance (QA): The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled. QA ensures that you are doing the right things, the right way.

Quality control (QC): The observation techniques and activities used to fulfill requirement for quality. QC ensures that your results are what you expected.

Definitions for QA and QC from the *American Society for Quality.*

QA and QC plans can be separate, or combined in a quality management plan, but it is important that both components be described and documented.

Quality management should address a wide range of aspects related to the tailings facility, including construction, operation, maintenance and surveillance practices through the life of the facility.

Control of documented information is addressed below, but one specific aspect of this form of control is linked to quality management. It is important that both design records and as-built records be retained for all aspects of construction of tailings facilities. These records should be retained throughout the life cycle of the facility. This should include revisions to construction drawings, test results, meeting minutes, construction photographs, monitoring records, and any other pertinent information.

Operational Controls

Operational controls are described in an Operation, Maintenance and Surveillance (OMS) manual. An OMS manual should be prepared for each tailings facility, and should describe requirements for the ongoing operation, maintenance and surveillance of the facility, based on the current engineering design and site considerations. The OMS manual documents and clearly communicates responsible operating practices to operators and staff responsible for the tailings facility.

As a key component of operation, the OMS manual includes or refers to other plans specific to various aspects of the operation of the tailings facility. These plans also need to be developed and documented (see also *Appendix 6*):

- tailings transport and deposition plan;
- water management plan; and
- closure plan.

Risk controls and critical controls are documented in the OMS manual, together with associated performance criteria and indicators, and descriptions of actions to be taken if control is lost.

Operation: the operation plan for a tailings facility addresses the transport and containment of tailings, and, where applicable, process water, effluents and residues, and the recycling of process water.

Maintenance: the maintenance program for a tailings facility addresses identification and description of critical parts, routine, predictive and event-driven maintenance, and operating and surveillance observations for all civil, mechanical, electrical and instrumentation components of a facility.

Surveillance: surveillance involves inspection and monitoring of the operation, structural integrity, and safety of a facility. It consists of both qualitative and quantitative comparison of actual to expected behaviour. It must be a designed program, fully integrated with operation and maintenance activities, and consistent with life cycle and regulatory requirements.

As a key component of surveillance, the OMS manual documents facility-specific performance measures as indicators of progress on management actions and objectives. These measures include technical performance indicators as well as indicators tied to management actions, including maintenance activities.

For further guidance on the development of an OMS manual, see MAC's *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities*.

4.4.4 Resources

For effective and efficient implementation of a tailings management system, including eventual decommissioning and closure, and sustained post-closure management, the Owner should identify, secure and regularly review adequacy of:

- human resources and external contractors and consultants;
- condition, function and suitability of equipment;
- financial resources; and
- schedules of activities that integrate the required resources related to tailings management. Examples of activities to be scheduled include timing of construction, access to construction material, reviews, inspections, and any other item critical to successfully implementing the tailings management system.

Measures should also be in place for financial control, control of documented information, training and competence, and communications, as further described below.

Financial Control

Establish and document a budget for tailings management, considering both short-term and long-term needs for responsible and effective tailings management throughout the life cycle.

Establish and document associated financial controls, obtain budget approval, and track capital and operating costs against the budget. In addition, at a frequency documented and appropriate to the facility and its life cycle phase, re-evaluate the decommissioning and reclamation provision for each facility commensurate with all applicable regulations and commitments.

Control of Documented Information

Current Documents:

Access to, and use of, current and accurate documented information is a critical component to enable the safe management of a tailings facility. Information that is determined by the organization as being necessary to the effectiveness of the tailings management system, throughout the life cycle, should be controlled. Owners should establish and implement a process to ensure that documented information is created, maintained, retained, and archived.

When creating and maintaining documented information, the Owner should ensure appropriate:

- identification and description (e.g., title, date, author, reference number); and
- review and approval.

Documented information should be accessible, and adequately protected. Obsolete versions of current documents should be removed and archived.

Records Retention:

Owners should develop and implement a process to identify records that are potentially useful to the future management of the tailings facility. These records should be retained and not destroyed. These records could include records related to planning, design, construction, operation and closure of tailings facilities, including surveillance and monitoring records. Records that are retained should be adequately protected and archived so that they are preserved and retrievable in the future.

Training and Competence

Tailings management requires the Owner and personnel involved in the tailings facility to have a level of competence consistent with the requirements of the facility and its risks. Key elements of developing and maintaining competence are qualifications, training, and experience.

Providing appropriate training to those who are involved with the tailings facility, including contractors, consultants, and suppliers, will require different training at different levels. For example, senior management should receive higher level, conceptual training about the risks of tailings management, while mine managers and others working directly on specific aspects of tailings facilities, including their design, construction, and operations, should receive detailed and relevant training that corresponds to their work.

A training program should be developed and implemented. Records related to training for employees, contractors and consultants, which was funded by or provided by the Owner, should be maintained.

Typical aspects to be covered in training:

- Tailings management system;
- Tailings facility management plans, permits, approvals, and commitments;
- Individual duties, responsibilities, and reporting relationships;
- The importance of conformance to design, operational controls, financial controls, and change management procedures;
- Risk assessment;
- Risk management and critical controls;
- Significance of change, and change management process;
- Emergency preparedness and response plans;
- Operation, maintenance and surveillance plans and processes described in the OMS manual; and
- Importance of communications and document management.

Communications

Establish and implement two-way communication processes for personnel who have accountability or responsibility for implementing the tailings management system, including reporting of significant information (e.g., results of Performance Evaluation) and decisions to senior management, the EoR, regulators, and COI, as appropriate.

As described below in *Section 5.2*, an **emergency** preparedness and response plan is an essential component of a tailings management system. This plan should be developed in collaboration with local first responders, COI, and relevant regulators, and is an important component of an effective communications strategy.

5 Implementing the Tailings Management Framework

When fully implemented at a specific site, a tailings management system based on this framework will encourage continual improvement in the safe and environmentally responsible management of **tailings facilities**.

As described in *Section 2*, the tailings management framework has been designed for application through the full **life cycle** of a tailings facility, beginning at any phase. **Owners** of tailings facilities should implement the framework at the earliest practicable opportunity.

Implementing the tailings management framework requires the full implementation of all plans described in *Section 4*. In addition, there are two key components to implementing the tailings management framework:

- implementing an OMS manual; and
- preparing and, if necessary, implementing **emergency** preparedness and response plans.

5.1 Operation, Maintenance and Surveillance Manual

Implementing a facility-specific OMS manual, developed as described in *Section 4.4.3*, is a key component of implementing the tailings management framework.

An OMS manual is a "living" document that will be regularly reviewed and likely revised several times during the **operations and ongoing construction** phase of the facility's life cycle, as well as beyond. It is a critical component of meeting performance objectives, and managing current and future risks associated with any tailings facility. It should be reviewed on a regular basis—with the frequency tied to the **risk** associated with the tailings facility at its respective point in the life cycle, and annually at a minimum—by the team tasked with responsibility for each facility and by the current design team for each tailings facility.

For further guidance on implementing an OMS manual, see MAC's *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities*.

5.2 Emergency Preparedness and Response Plans

Emergency preparedness and response plans (EPRPs):

- identify possible emergency situations that could occur during the **initial construction**, operations and ongoing construction, **closure,** and **post-closure** phases of the life cycle of a tailings facility, and which could pose a risk to populations, infrastructure, and the environment; and
- describe measures to respond to emergency situations and to prevent and mitigate on and off-site environmental and safety impacts associated with emergency situations.

EPRPs should be developed and documented for each tailings facility, and should be integrated with the overall site-level EPRP, although the EPRP for the tailings facility may be a separate document.

Examples of possible emergencies that should be addressed in EPRPs include: structural failures of the facility; rising water levels within a facility; cracking of a dam; a sudden loss of environmental containment of the facility; or other events typically linked to the loss of one or more **critical controls**.

EPRPs for tailings facilities should incorporate considerations from the risk management plan. For those tailings facilities that impound water, which could lead to an inundation risk in the event of a dam breach, the risk management plan and the EPRP both need to include inundation considerations. Each emergency scenario for a tailings facility that impounds water should have the potential inundation area for that emergency clearly defined.

For potential emergencies with large inundation areas, such as a facility failure with loss of containment and flows extending beyond the mine project boundaries, these plans should consider, and be communicated to, **COI** (in addition to the regulators and other parties who are required to be notified of any emergency) so that they can also prepare an effective plan for such an emergency.

EPRPs are further described in MAC's *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities*. The OMS manual primarily addresses conditions related to normal operation and control of the tailings facility, while the EPRP functions when there is a loss of control (emergency) at the facility. It is essential that the OMS manual and the EPRP be aligned, such that there are no functional gaps between normal operations and emergency response, and that procedures are in place to transition from normal conditions to an emergency situation that may arise.

Procedures should be established and implemented for periodic review and testing of the EPRPs, to ensure that the plans are current and that they are adequate in the event that an emergency occurs. Review and testing should involve potentially affected COI, such as local first responders and relevant government agencies. Copies of EPRPs should be provided to potentially affected COI.

Inundation studies identify:

- predicted consequences associated with failure modes for a tailings facility;
- downstream areas that could be directly impacted by the release of tailings solids and water;
- timing and size of overall area of impact following a loss of containment; and
- potential impacts of a failure on: human health and safety, the environment, cultural and archeological resources, and infrastructure.

Inundation studies inform the analysis of potential consequences of a failure, including costs.

In accordance with the *CDA's Dam Safety Guidelines* (Section 2.5), such analyses should be conducted for two scenarios:

Flood-induced event: Impoundment breach from a natural flood of a magnitude that is greater than what the tailings facility can safely pass.

Sunny-day event: This is a sudden event that occurs during normal operations. It may be caused by various factors, including internal erosion, piping, earthquakes, and operational events or errors leading to overtopping, or similar events.

Additional guidance is also available from the Association of Professional Engineers and Geoscientists of British Columbia, which released *"Flood Mapping in BC - APEGBC Professional Practice Guidelines"*

It is also important that EPRPs be augmented with crisis planning. A crisis is defined as an event or set of circumstances that could significantly affect an Owner's ability to carry out their business, damages an Owner's reputation and/or threatens the environment, the health and safety and well-being of its employees, neighbouring communities or the public at large. Any tailings-related emergency that constitutes a crisis should be managed as such. The EPRP is intended to guide the initial physical response to the emergency, whereas the crisis plan is intended to guide communications internally and externally. Further information on crisis planning is available, for example:

- MAC's *Crisis Management and Communications Planning Reference Guide*
- United Nations Environment Programme *Awareness and Preparedness for Emergencies at Local Level* (2nd Edition, 2015)

5.3 Checklists

The tailings management framework is intended to be flexible in how it is applied to suit the requirements of specific sites, Owner policies, regulatory requirements, and commitments to COI. To aid in the implementation of the tailings management framework, MAC has developed a checklist tool which is available for download from the MAC website at *www.mining.ca/tailings-management*.

The checklist provides a basis for developing customized, site-specific tailings management systems. Completing the checklist can help identify gaps and/or deficiencies in tailings management. It is intended to be a tool to help in the implementation of the tailings management framework. Use of the checklist is not a "box-checking" or audit exercise – it is a tool to help ensure that the Owner has addressed all relevant aspects of the framework. By completing the checklist, the Owner is provided with a snapshot of the state of implementation of the tailings management framework for their tailings facilities, recognizing that the state of implementation continues to evolve through the life cycle of the facility.

The master checklist is provided in Microsoft Excel, allowing users flexibility in adapting the checklist to their specific circumstances. The master checklist encompasses all aspects of the tailings management framework across all phases of the life cycle. Users can tailor the checklist to the specific life cycle phase of the facility to which the checklist is being applied, ignoring or deleting those items on the checklist not relevant to that life cycle phase.

The master checklist is provided in *Appendix 5* to illustrate, but users are encouraged to download and use the Excel version.

6 Performance Evaluation

Performance evaluation is essential to:

- assess whether performance objectives are being met;
- assess the effectiveness of risk management measures, including **critical controls**;
- inform updates to the **risk** management process for the **tailings facility**; and
- inform the Management Review for Continual Improvement.

Performance evaluation builds upon the results of surveillance conducted in accordance with the requirements contained in the OMS manual by analyzing and interpreting the results to evaluate performance. The evaluation includes results of inspections and reviews, both internal and independent, to evaluate:

- operating performance against performance objectives and indicators, and critical controls;
- compliance with regulatory requirements, and conformance with plans and commitments;
- the risk management process, including the need to update the risk assessment; and
- the need for changes or updates to the OMS manual, the EPRP, or other site-specific **tailings** management system-related documents. This includes evaluating the effectiveness of surveillance processes and the utility of the information being collected, and identifying any gaps in information collection.

Performance evaluation should include the identification of gaps, deficiencies or areas of non-conformance with the tailings management system, including performance objectives and plans to address those objectives. Action plans to make necessary changes or updates should be documented, approved and implemented, and implementation of action plans should be documented and tracked to completion. Deviations from the approved corrective actions should be documented to describe if and why action different from those originally approved were undertaken. The status of action plans should be communicated internally and to **COI**, as appropriate.

Performance evaluation occurs at various timescales, from hourly or daily, to annual or more, depending on the aspect of performance being evaluated. For example, evaluation of conformance for some parameters related to tailings deposition or water management may require daily oversight, while broader, more comprehensive performance evaluation, such as evaluating the need for changes to the OMS manual, may be done on a less frequent basis.

Results and recommendations arising from individual performance evaluations should be documented and reported. Frequency of reporting depends on the nature of the performance evaluation and the results.

It is necessary to report the results and recommendations of performance evaluations to the Responsible Person(s), the Accountable Executive Officer and, as appropriate, the Board of Directors or Governance Level, at a frequency and level of detail documented in the **Owner's** policies and procedures.

Assurance is a critical component of performance evaluation. *Section 8* provides the essential elements of an assurance program.

7 Management Review for Continual Improvement

Management should perform regular reviews to ensure continual improvement, based on Performance Evaluation and Assurance. The management review process should evaluate the:

- status of actions from the previous management review;
- overall performance of the tailings management system to ensure its continuing suitability, adequacy and effectiveness, and the need for changes to components of the system:
    - policy and commitment;
    - accountability and responsibilities;
    - conformance management;
    - change management;
    - controls (**critical controls** and quality management); and
    - resources (financial controls, control of documented information, training and competence, and communications).
- performance of the **tailings facility**;
- effectiveness of **risk** management; and
- adequacy of resources (human and financial) committed to tailings management.

The management review process should also identify opportunities for improvement and describe associated action plans.

The frequency of management reviews varies, but is typically annual during the **initial construction**, and **operations and ongoing construction** phases, and the **closure phase**.

The management review for continual improvement is reported to the Accountable Executive Officer to ensure that the **Owner** is satisfied that the tailings management system is effective and continues to meet the needs of the facility. The management review for continual improvement goes beyond technical performance to address all aspects of the management of the tailings facility.

The management review process also provides an opportunity for the Responsible Person(s), the EoR and other employees and contractors involved in tailings management to: reconfirm alignment between design requirements and operational practices; discuss realized or anticipated changes and their implications/management; and identify opportunities for improvement.

The management review should identify and evaluate the potential significance of changes since the previous management review that are relevant to the tailings management system, including:

- changes to regulatory requirements, standards and guidance, industry best practice, and commitments to **COI**;
- changes in mine operating conditions (e.g., production rate) or site environmental conditions;
- changes outside the mine property that may influence the nature and significance of potential impacts resulting from the tailings facility on the external environment or vice versa; and
- changes in the risk profile of the tailings facility.

The management review should also provide a summary of significant issues related to the overall performance of the tailings facility and tailings management system, updated since the previous management review, including:

- regulatory compliance, conformance with standards, policies and commitments, and status of corrective actions;
- facility maintenance;
- facility surveillance; and
- inspections, internal or external audits, evaluations of effectiveness, and IR.

The management review outcomes should be documented, including:

- conclusions regarding the performance of the tailings facility and the tailings management system;
- action plans to address findings contained in the conclusions, including:
  - actions to ensure performance objectives are met;
  - actions to address non-conformity with requirements, standards, policy, or commitments; and
  - opportunities for continual improvement.
- modifications required in the tailings management system; and
- enhancements to human and financial resources to help ensure effective tailings management.

8 Assurance

Assurance, defined as the oversight process to ensure that tailings management is being effectively executed, is distinct from Performance Evaluation. Developing and implementing assurance measures is an essential element of a tailings management system. Effective assurance demonstrates to the **Owner** (including the Responsible Person(s), Accountable Executive Officer and the Board of Directors or Governance Level), regulators, and **COI** that a **tailings facility** is being managed responsibly.

Assurance providers, both internal and external, need to have appropriate qualifications relevant to their assurance activities to ensure that assurance is effective.

The outcomes of assurance processes, together with the results of Performance Evaluation, provide the basis for Management Review for Continual Improvement.

Assurance can come in several forms, including:

Audits (both internal and external): The formal, systematic and documented examination of a tailings facility's conformance with explicit, agreed, prescribed criteria, often requirements stipulated in law or regulation, or in the Owner's tailings management system. Audits evaluate and report on the degree of conformance with stipulated criteria, based on the systematic collection and documentation of relevant evidence. Audits involve some degree of judgment but are not designed to determine root cause of deficiencies, or to evaluate management system effectiveness.

External audits are conducted by auditors who are external to the company being audited. Auditors maintain an objective viewpoint throughout the audit process to ensure that findings and conclusions are based only on the evidence (Adapted from *ISO 19011*).

Evaluation of Effectiveness: An evaluation of effectiveness goes beyond determining whether a condition has been met, and includes an assessment of whether the tailings management system (or components thereof) is achieving the intended results. It considers both the extent to which planned activities have been realized, and the extent to which desired results, outcomes and targets are being achieved.

Criteria to be examined will depend on the scope of the evaluation. Typical sources of information that should be considered when evaluating tailings management system effectiveness include:

- changes in external conditions that could affect the system and achievement of established objectives; and
- changes in internal conditions that could affect the system and achievement of established objectives.

Performance results and trends that should be evaluated to determine the effectiveness of the management system and its implementation include:

- the extent to which performance objectives and indicators are being achieved;
- the extent to which planned activities have been implemented as intended;
- fulfilment of conformance obligations;
- non-conformities and corrective actions based on inspection and audit results;

- monitoring and measurement results;
- adequacy of resources to support achievement of objectives;
- feedback from practitioners and end users; and
- any additional relevant information or feedback from COI.

Independent Review (IR): one of the overarching principles of the framework, IR is described in *Section 2.1* and further discussed in *Appendix 4.*

Glossary

Acceptable risk: The level of risk deemed acceptable to an Owner, considering legal requirements, internal policy, business factors and societal acceptance.

Best Available/Applicable Practice (BAP): Management systems, operational procedures, techniques and methodologies that, through experience and demonstrated application, have proven to reliably manage risk and achieve performance objectives in a technically sound and economically efficient manner. BAP is an operating philosophy that embraces continual improvement and operational excellence, and which is applied consistently throughout the life of a facility, including the post-closure period.

Best Available Technology (BAT): The site-specific combination of technologies and techniques that is economically achievable and that most effectively reduces the physical, geochemical, ecological, social, financial, and reputational risks associated with tailings management to an acceptable level during all phases of the life cycle, and supports an environmentally and economically viable mining operation.

Communities of Interest (COI): All individuals and groups who have an interest in, or believe they may be affected by, decisions respecting the management of operations. They include, but are not restricted to:

- employees;
- Aboriginal or Indigenous peoples;
- mining community members;
- suppliers;
- neighbours;
- customers;
- contractors;
- environmental organizations and other non-governmental organizations;
- governments;
- the financial community; and
- shareholders.

Continual improvement: The process of continual, incremental improvements and standardization to achieve enhanced performance.

Critical controls: Risk controls and associated performance measures that define actions designed to assist the management of high-consequence risks relating to a tailings facility. Critical controls may be technical, operational or governance in nature. Critical control management is a governance approach to managing high-consequence risks relating to an operation or business.

Documented information: Information of importance that is required to be controlled and maintained by the organization. Documented information can refer to the tailings management system and its processes, documentation, and records.

Emergency: A situation that poses an impending or immediate risk to health, life, property, the environment and which requires urgent intervention to prevent or limit the expected adverse outcomes.

Engineer-of-Record: The Owner, in assuring that a tailings facility is safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the Owner. The EoR verifies whether the tailings facility (or components thereof) has been:

- Designed in accordance with performance objectives and indicators, applicable guidelines, standards and regulatory requirements; and
- Constructed, and is performing, throughout the life cycle, in accordance with the design intent, performance objectives and indicators, applicable guidelines, standards and regulatory requirements.

For tailings facilities that include retention structures/dams, the EoR is responsible for Dam Safety Inspections and associated reports. The EoR should also participate in the facility's risk assessments and be accessible to independent reviewers, and, for facilities with retention structures, dam safety reviews. The EoR provides these activities as part of the Owner's broader assurance process.

Life cycle: The succession of phases in the life of a tailings facility, consisting of: project conception and planning, design, initial construction, operation and ongoing construction, closure, and post-closure. At some sites, the life cycle may also include temporary closure. In the case of tailings facilities, the life cycle, including the closure, and post-closure phases, can extend to decades or centuries, unless the facility is removed at some point in the future if tailings are reprocessed or relocated.

Project Conception and Planning: begins at the outset of planning of a proposed mine, and is integrated with conception and planning for the overall site, including the mine plan and plans for ore processing. The phase includes the use of rigorous decision-making tools to support selection of the location for the tailings facility, and the BAT to be used for tailings management.

Design: begins once the location and BAT for the tailings facility have been selected, and occurs in concert with detailed planning of all aspects of the proposed mine. Detailed engineering designs are prepared for all aspects of the tailings facility and associated infrastructure.

Initial Construction: construction of structures and infrastructure that need to be in place before tailings deposition commences. This includes, for example, removal of vegetation and overburden, and construction of starter dams, tailings pipelines, access roads, and associated water management infrastructure.

Operations and Ongoing Construction: tailings are transported to, and deposited in, the tailings facility. Tailings dams may be raised, or new tailings cells added as per the design. Depending on the overall mine plan, the operations and ongoing construction phase of a tailings facility may or may not coincide with the period of commercial operations of the mine.

Standby Care and Maintenance: the mine has ceased commercial operations and the deposition of tailings into the facility is not occurring. The Owner expects to resume commercial operations at some point in the future, so surveillance and monitoring of the tailings facility continue, but the facility and associated infrastructure are not decommissioned and the closure plan is not implemented.

Closure: begins when deposition of tailings into the facility ceases permanently. The facility and associated infrastructure are decommissioned, and key aspects of the closure plan are implemented, including:

- transitioning for operations to permanent closure;
- removal of key infrastructure such as pipelines;
- changes to water management or treatment; and
- recontouring or revegetation of tailings and any containment structures or other structural elements.

Post-closure: begins when decommissioning work is complete, key aspects of the closure plan have been implemented, and the tailings facility has transitioned to long-term maintenance and surveillance. During post-closure, responsibility for a tailings facility could transfer from the Owner to jurisdictional control.

Owner: The company, partnership, or individual who has legal possession or is the legal holder of a tailings facility under law in the applicable jurisdiction where the facility is located. For example, the company, partnership or individual that owns the mine from which the tailings and wastewater are generated is the Owner of those tailings and can be considered the Owner of the tailings facility.

Risk: A potential negative impact, detrimental to operations, a facility, the environment, public health or safety, that may arise from some present process or future event. When evaluating risk, both the potential severity and consequence of the impact and its probability of occurrence are considered.

Risk controls are measures put in place to either:

- prevent or reduce the likelihood of the occurrence of an unwanted event; or
- minimize or mitigate the negative consequences if the unwanted event does occur.

Risks need to be managed via controls, and risk controls should have designated owners and defined accountabilities. Some risk controls are designated as critical controls.

Tailings: A byproduct of mining, consisting of the processed rock or soil left over from the separation of the commodities of value from the rock or soil within which they occur.

Tailings facility: The collective engineered structures, components and equipment involved in the management of tailings solids, other mine waste managed with tailings (e.g., waste rock, water treatment residues), and any water managed in tailings facilities, including pore fluid, any pond(s), and surface water and runoff. This may include structures, components and equipment for:

- classification of tailings through water content management (e.g., cyclones, thickeners, filter presses);
- transport tailings to the tailings facility (e.g., pipelines, flumes, conveyors, trucks);
- containment of tailings and associated water (e.g., dams, dykes, stacks, liner systems, cover systems);
- management of seepage (e.g., underdrains, collection ponds, pumping wells);
- water reclaim systems (e.g., pumping to the ore processing facility); and
- management of surface water releases from the tailings facility (e.g., diversions, decant structures, spillways, outlets, flumes, water treatment);

This also includes:

- structures, components and equipment for the surveillance and maintenance of tailings facilities; and
- mechanical and electrical controls, and power supply associated with the above.

Appendix 1: Risk Management Framework and Approach

The mining industry operates within a risk management culture aimed at responsible management of risks. A risk management framework should be embedded within each organization's overall strategic and operational policies and practices. In general, risk management entails identification, assessment, and treatment of risks. In the tailings management context, a risk management approach facilitates continual review and improvement of risk management strategies across the life cycle of a tailings facility. It should, therefore, be flexible, iterative and responsive to change. In addition, effective and transparent management of risks requires an appropriate level of competency for decision-making to evaluate, recommend and approve technical, management, environmental, social and economic risks related to tailings management.

Implementation of a risk-based approach requires an Owner of a tailings facility to first define their facility's risk profile, taking into consideration the internal and external operating environment, and quantitative and qualitative factors. Once this context has been established, a risk assessment for the tailings facility can be performed.

As part of this, Owners should consider the "business risk" in the context of a tailings facility breach or other significant unwanted event. Most major mining companies employ comprehensive risk management systems that could be used to characterize potential business impacts such as those to workforce health and safety, lost production, corporate reputation, and market capitalization. In fact, an Owner's business risk may potentially be of more consequence and warrant more stringent design, construction and operating requirements than would otherwise be determined on the basis of other industry standards and/or regulations.

There are two basic approaches to risk assessment:

- identify the potential risks and determine the likelihood of a range of potential consequences of those risks; and
- determine credible failure modes and assess what potential conditions (hazards), and their likelihood, could result in those failure modes.

Applying both of these approaches provides for a robust assessment of risks.

Generally, a risk assessment attempts to answer the following fundamental questions:

1) What can happen (unwanted event) and how (failure mode)?
2) If it does happen, what are the consequences?
3) What is the likelihood (probability) that such an unwanted event will happen?
4) Can the risk be practically eliminated?
5) What can be done to reduce the likelihood?
6) What can be done to reduce the consequences?
7) Is the level of risk tolerable or acceptable and does it require further treatment?

Relationship between failure modes and hazards: a single failure mode (e.g., overtopping of a dam) could be triggered by multiple hazards (e.g., landslide, extreme precipitation, etc.); conversely, one hazard (e.g., downstream inundation) could be triggered by more than one failure mode (e.g., overtopping, foundation failure, piping of water through a dam, etc.).

Risk management strategies typically involve developing and implementing risk controls aimed to control or mitigate risks identified during risk assessment. Through application of risk management strategies, organizations take the necessary steps to reduce identified risks within acceptable levels that are As Low As Reasonably Practicable (ALARP). These strategies mitigate and control risks by one or a combination of the following:

- eliminating or avoiding specific risks to minimize overall risk to the extent practicable;
- minimizing the likelihood that the risk will occur by early identification and implementation of appropriate controls; and
- developing contingency and mitigation plans for the potential consequences of the identified risks.

There may be some risks which, even when reduced to ALARP, remain unacceptable and hence require a re-evaluation of alternatives.

As Low As Reasonably Practical (ALARP): The point at which the cost (in time, money and effort) of further risk reduction is significantly disproportionate to the risk reduction achieved.

Additional guidance and information is available in the public domain on the topic of risk and its management with respect to tailings facilities and other similar infrastructure, including documents prepared by the *Canadian Dam Association (CDA),* the US Bureau of Reclamation, the *Australian Leading Practice Sustainable Development Program (LPSDP)*, the *Australian National Committee on Large Dams (ANCOLD),* and the *International Commission on Large Dams (ICOLD),* among other government groups and industry associations. Also, refer to *International Organization for Standardization (ISO)* standards or its country equivalents such as the Australian/New Zealand Standards and the *Canadian Standards Association* for more guidance on risk management and risk assessment concepts and tools.

Application of risk assessment tools:

According to ICOLD Bulletin 139, hazard rating is defined as "the consequential damage from a tailings dam failure (is) generally assessed in terms of its potential effect on the four categories of:

1) Loss of life
2) Environmental damage
3) Cost of physical damage
4) Social impact including public perception"

These four categories could be used as the basis to perform a risk assessment at any phase of the life cycle of a tailings facility. While trying to keep these categories as generic as possible, the above listed four categories could be expanded as follows:

1) Health and safety (including potential injury, health degradation of people, and loss of life);
2) Environmental (including potential environmental damage and/or environmental degradation);
3) Financial (including increased costs to the operation/corporation and/or cost of potential physical damage);
4) Social (including potential cultural degradation and/or public perception);

5) Legal (including non-compliance and insufficient permits);

6) Operational management and control (including inadequate management tools, qualified resources, and/or funding); and

7) Reputation for the Owner, including market capitalization and share loss.

Note: Consequence and risk assessments can be performed with or without the Owner's financial considerations. Either method may be appropriate depending upon context and should be clearly declared.

Risks that are encountered during the different phases of the mine, or during extreme events affecting the tailings facility, can be evaluated against the categories listed above using a failure mode and effects analysis (FMEA) model and a typical likelihood–consequences matrix similar to the one shown in Figure A.1.1. Risks may be identified as extreme, high, moderate or low. As a starting point, all management concepts presented in *Appendix 2* should be assessed following such a risk-based approach and considering all life cycle phases of the tailings facility.

In addition to FMEA, there are several other risk assessment techniques that can assist in the evaluation of the likelihood of occurrence of an undesired event and its consequences to the operation, society, and the environment. Some other commonly-used techniques include preliminary hazard analysis, Monte Carlo simulation, cause and consequence analysis, and decision/event trees analyses. Some of these other techniques can be used in conjunction with a likelihood-consequences matrix. For example, the bow-tie method (see Figure A.1.2) could be used to gain a better understanding of the extent and effectiveness of risk controls, including critical controls, which are in place or could be implemented for the management of high or extreme consequence events, as identified in a likelihood-consequences matrix model. Refer to the Australian Government's *LPSDP document on Risk Management* for further details on the application of bow-tie analysis.

The Independent Reviewer(s) should be provided risk assessments and management plans for the tailings facility in question, and include the results of those assessments and plans in the scope of the IR. Summary results of risk assessments should be reported to the Accountable Executive Officer.

Figure A.1.1. Sample of a typical qualitative risk assessment matrix. The likelihood, consequence and overall risk level descriptors (e.g., possible, major, high risk, etc.) are for illustrative purposes only, and many other descriptors are acceptable provided they are defined, understood, and used consistently.

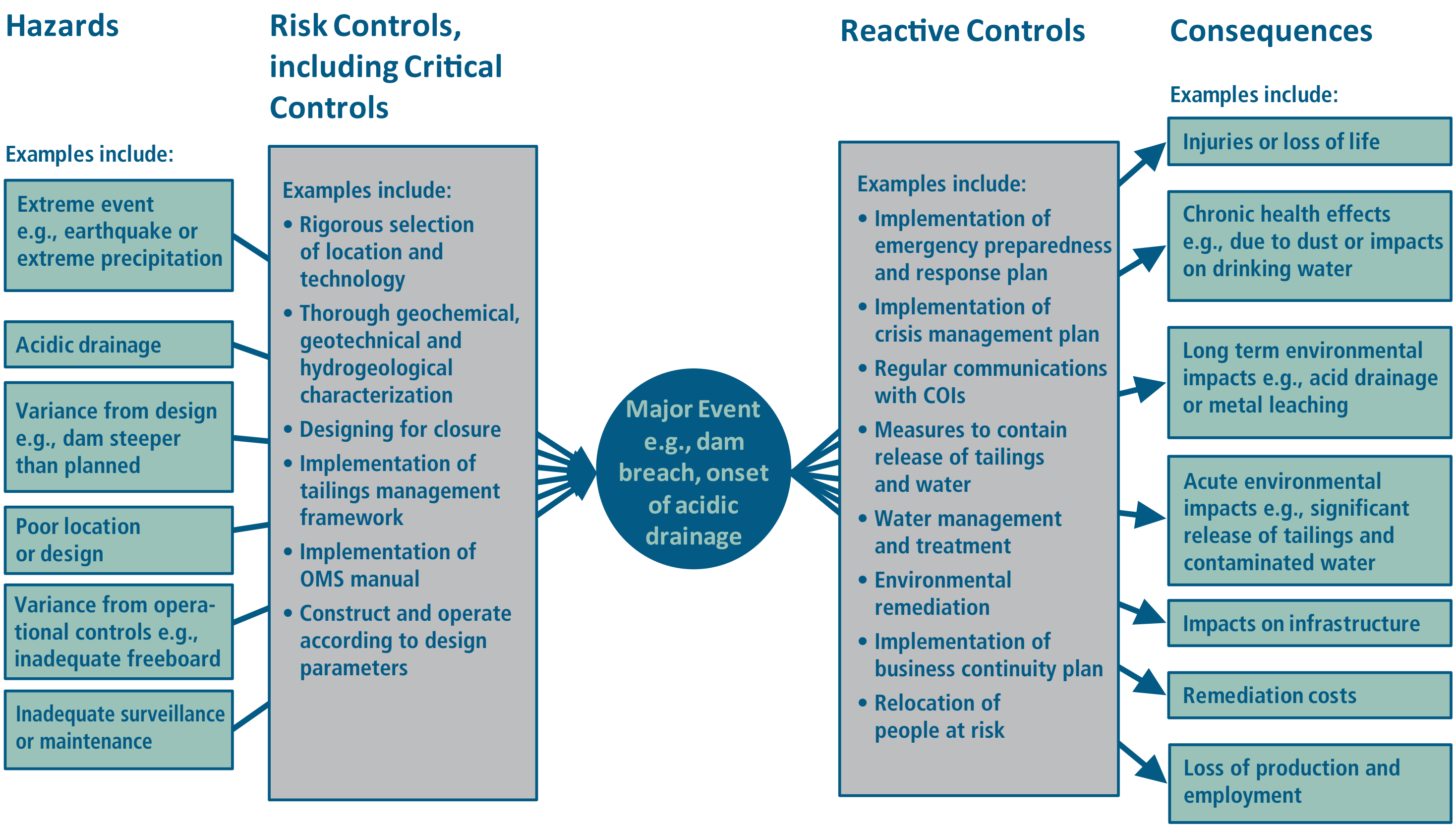
Increasing likelihood

	Negligible	Minor	Moderate	Major	Catastrophic
Very Likely	M	H	H	E	E
Likely	M	M	H	H	E
Possible	L	M	M	H	H
Unlikely	L	L	M	M	H
Rare	L	L	L	M	M

Increasing consequence

L: low risk
M: moderate risk
H: high risk
E: extreme risk

Figure A.1.2: Illustration of a typical bow-tie analysis, providing examples of possible hazards and risk controls to reduce the likelihood or consequence of a major event, and reactive controls and potential consequences if a major event occurs.



Appendix 2: Best Available Technology and Best Available/ Applicable Practice

Best Available Technology, or BAT, is the site-specific combination of technologies and techniques that is economically achievable and that most effectively reduces the physical, geochemical, ecological, social, financial and reputational risks associated with tailings management to an acceptable level during all phases of the life cycle, and supports an environmentally and economically viable mining operation.

Best Available/Applicable Practice, or BAP, encompasses management systems, operational procedures, techniques and methodologies that, through experience and demonstrated application, have proven to reliably manage risk and achieve performance objectives in a technically sound and economically efficient manner. BAP is an operating philosophy that embraces continual improvement and operational excellence, and which is applied consistently throughout the life of a facility, including the post-closure period.

BAT

The incorporation of BAT into tailings management is designed to ensure that the selected tailings technology or methodology effectively achieves performances objectives, manages the identified risks, and is technically and economically feasible. When considering BAT for tailings management, it is important to understand that no single technology or technique, or combination thereof will be the best risk management alternative for every tailings facility. The variability of topography, climate, seismicity, ecosystem, mineralogical and chemical composition of soil and bedrock, project economics, and other site-specific considerations dictates that the BAT should be determined for each tailings facility on an individual basis.

The full spectrum of tailings management alternatives should be assessed for each potential facility location at the project conception and planning phase of the life cycle (see also *Appendix 3*). This rigorous, transparent process for assessing alternatives provides a methodology to identify the optimum combination of tailings management alternatives and facility location, considering the site-specific risk profile and conditions, and taking closure and post-closure risks and liabilities into account. Typically, the criteria to use when selecting BAT are summarized in *Appendix 3.1* and include:

- tailings facility risks;
- closure plan and end land use;
- tailings characteristics (physical and chemical);
- water balance and management;
- COI expectations;
- regulatory requirements and considerations; and
- project economics.

The goal of applying BAT as part of the tailings management strategy for a site is to determine the tailings management methodology, which will provide a safe, stable facility with an acceptable level of impact and risk for the full life cycle of the facility.

BAT should be reassessed at discrete times throughout the life of the facility when operating data, new technology or other reasons to contemplate a significant change to the facility life cycle plan arise.

BAP

A commitment to using BAP is a commitment to using relevant knowledge and technology to help ensure success. In fact, implementing this Tailings Guide is an example of employing BAP.

For tailings management, BAP encompasses the management systems and operational procedures developed and implemented, in consideration of current engineering and governance practices, so that tailings facilities are designed, constructed, operated, maintained, monitored and closed to achieve performance objectives.

There are several key concepts that help define BAP:

- Tailings management practice is constantly evolving and improving as the collective knowledge base expands. As a result, the management system should include specific processes to ensure that practices stay current, effectively manage facility impacts and risks, and incorporate continual improvement;
- The management practices and processes need to be auditable and verifiable; and
- Successful implementation requires effective, timely communication inside and outside the company.

BAP is used to assess, monitor, verify and continually improve the Owner's management systems and practices. BAP is also used to help ensure that mechanisms are in place to:

- confirm that controls are effective at managing the evolving risks associated with tailings facilities;
- stay current with changes in technology, practice, and industry knowledge, including triggering re-assessments of BAT when warranted; and
- evaluate and incorporate applicable changes into the Owner's tailings management system and operating practices.

Relationship between BAT and BAP

Since technologies and practices evolve over time, it is important to recognize the interplay of BAT and BAP. Selection of BAT does not include the ongoing management, governance, and continual improvement processes throughout the life of the tailings facility – these, however, are components of BAP. Managing a facility with BAP principles may generate the need to reassess BAT if facility performance or available and applicable technology changes, or if some other factor is identified through the continual improvement process that potentially warrants a change to the facility design. The assessment of BAT facilitates a thorough and transparent identification and understanding of the potential impacts, risks, and costs associated with a tailings technology selection and provides a sound framework to manage these risks and costs through BAP.

Appendix 3: Assessment of Alternatives

Overview

A process to assess alternatives for the location of a potential tailings facility, and the site-specific BAT for tailings management, should be implemented at the project conception and planning phase of the life cycle. Selection of BAT and facility location lay the foundation for all subsequent decisions and activities related to the tailings facility, including risk management. Decisions at this phase of the life cycle have profound and often irreversible implications throughout the life cycle.

Alternatives for closure and long-term closure objectives and post-closure land use are essential considerations in the initial selection of location and technology, and may also need to be reassessed at other phases throughout the life cycle. Alternatives may also need to be assessed at other phases throughout the life cycle in the event of a mine-life extension and the need for a new or expanded tailings facility.

Alternatives assessment is typically conducted as a multi-step process:

1) Identify performance objectives, describing how the tailings facility is expected to perform throughout the entire life cycle, including the long-term closure objectives and post-closure land use.
2) Identify possible (i.e., reasonable, conceivable, and realistic) alternatives, avoiding *a priori* judgments about the alternatives.
3) Pre-screen possible alternatives to eliminate from further consideration any that would not meet the performance objectives or otherwise have characteristics that would be "show-stoppers". This step is also referred to as fatal-flaw analysis.
4) Assess remaining alternatives using multiple accounts analysis or a similar decision-making tool.
5) Conduct a sensitivity analysis to test the robustness and validity of the outcomes of the detailed assessment of alternatives against various biases and assumptions. Despite efforts to make the assessment of alternatives as objective as possible, there will be biases and perceived biases in the process. For example, the assessment could be re-done without consideration of project costs, to see the impact of removing consideration of costs on the final outcome.
6) Document the results in a comprehensive technical report.

There are a number of aspects that are important for an effective alternatives assessment:

- The alternatives assessment should consider a wide range of factors, and be conducted by a multi-disciplinary team consistent with the unique conditions for the proposed facility. This team typically includes geotechnical engineers and geologists, fisheries biologists, hydrologists, archaeologists, specialists in community and Indigenous relations, specialists in traditional ecological knowledge, social scientists, and economists.
- Team members should be open minded, both to each other, and to the outcome of the process. Having a pre-conceived notion of the "right" answer can bias results. The team members need to respect the alternatives assessment process.
- Team members should collect and consider a broad range of information, examples of which are provided in *Appendix 3.1*.

- External input is required through the steps described above. Input of COI, including regulators, informs the process, and Independent Reviewers should also be engaged.
- Alternatives should be assessed and documented using a rigorous, transparent decision-making tool, such as multiple accounts analysis, further described below.
- Given the need to select both a location and BAT, the process may require more than one iteration.

Figure A.3.1 illustrates an overall framework for the planning and design of tailings facilities, and the role of alternatives assessment within that framework.

Multiple Accounts Analysis

Multiple accounts analysis (MAA) is a tool that is used to support decision-making, including for tailings management. There are a number of good, structured decision-making tools available to assist the tailings planning and design process. Since the federal regulator in Canada mandates the use of MAA, it is given additional focus here. This approach was described in *A Multiple Accounts Analysis for Tailings Site Selection*.[5] It was expanded upon by Environment and Climate Change Canada in its *Guidelines for the Assessment of Alternatives for Mine Waste Disposal* (2011). This discussion is based on the approach as described in these documents.

MAA and similar tools are effective methods to help make complex decisions, and to help communicate to others how those decisions were made and what factors were considered. These tools are widely applicable to a range of potential decisions. In the context of decisions about tailings management, they are applicable regardless of tailings characteristics, geography, environmental and societal context of a site, and other factors that may influence such decisions.

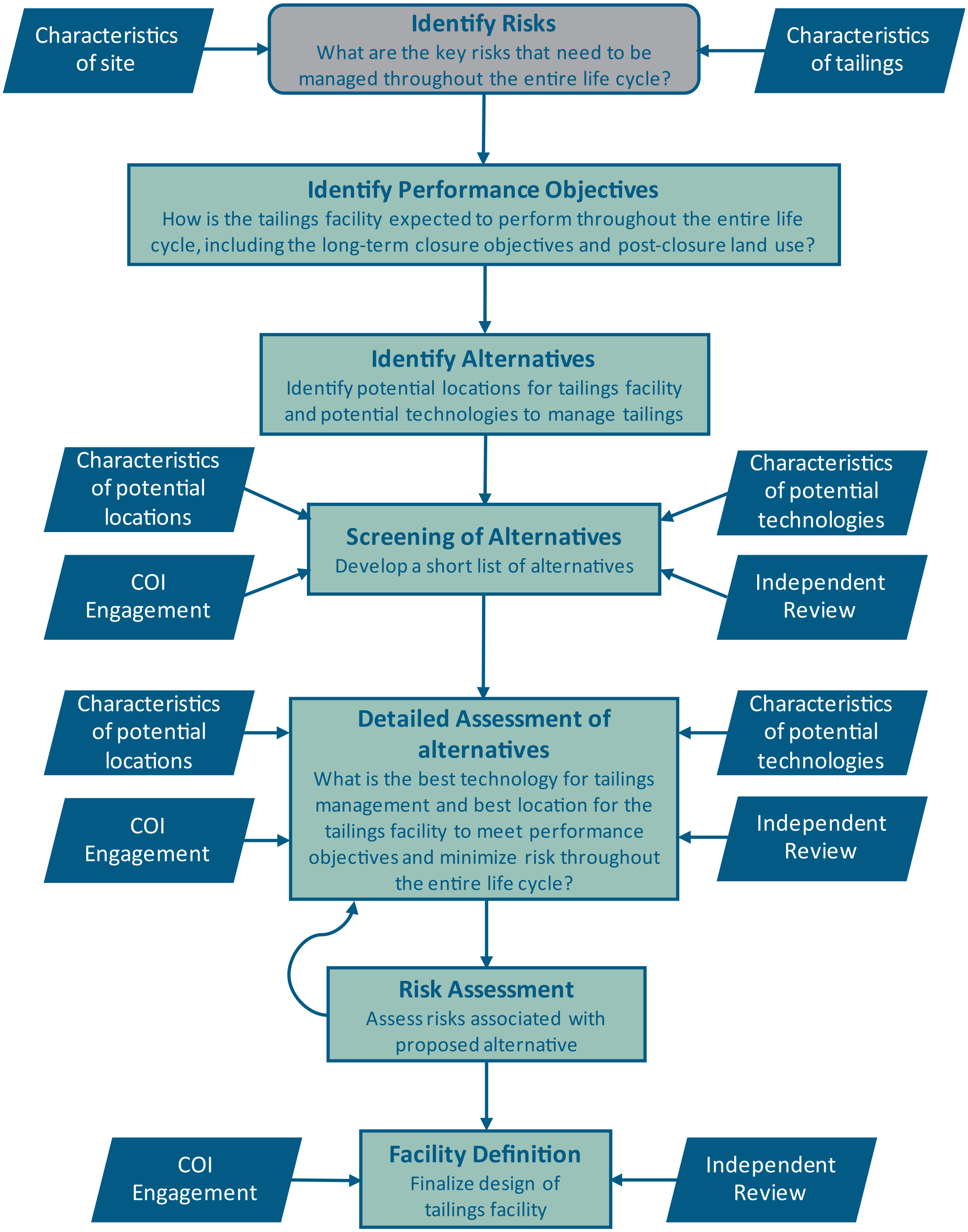
MAA is part of a broader toolbox of methods referred to as multiple criteria decision analysis. The strength of such tools is that they provide a method of integrated assessment of different characteristics of alternatives, for example, for comparing potential impacts on wildlife with capital costs. In effect, these tools provide a rigorous, semi-quantitative means of comparing apples and oranges. The methodology also provides a means to make inherent subjectivity and biases more transparent, and then testable using sensitivity analysis.

MAA is a two-stage process. The first stage consists of the development of a multiple accounts ledger: a list of accounts and various sub-accounts that describe the alternative and its potential impacts. For example, an account for "Environment" could include a wide range of sub-accounts, from impacts on aquatic and terrestrial wildlife, to post-closure land use. Measurable indicators are described for each sub-account. For example, a sub-account describing the surface area of the facility would provide an indicator measured in square kilometres.

The second stage is referred to as a Value-Based Decision Process. It involves "ranking, scaling and weighting the indicator values in the sub-accounts in a systematic, transparent manner such that the value basis for the combination or accumulation of effects is readily apparent" (Robertson and Shaw, 1999).

5. Robertson, A.MacG., Shaw, S.C. (1999): Multiple Account Analysis for Tailings Site Selection. In Sudbury 99 conference proceedings, Mining and the Environment II, vol. 3, pp. 883-891.

Figure A.3.1: Framework for Planning and Design of Tailings Facilities



Appendix 3.1: Typical Information Considered for Assessment of Alternatives and Tailings Facility Design

Examples of the types of information typically considered for assessment of alternatives and designing of a tailings facility are provided below. This information listing is not exhaustive, and is intended to be illustrative rather than prescriptive. Information listed below may not be applicable in all cases, and additional types of information or detail may be needed on a site-specific basis.

1) Basic Characteristics

Characteristics of the Proposed Mine

Ore and host rock:

- Reserves and projected mine life
- Mineralogy
- Chemical composition
- Oxidation processes, including acid-generating potential
- Potential for leaching of metals and other contaminants

Mine plan and mine openings:

- Potential for sequential mine development and use of mined out openings for tailings management
- Potential for use of tailings as backfill during operations

Ore processing parameters related to tailings:

- Process and reagents to be used
- Treatment processes (e.g., cyanide destruction)

Characteristics of Tailings and other Materials

Tailings — characteristics independent of tailings management technology selected:

- Daily/annual throughput
- Total quantity of tailings and other materials to be managed in the tailings facility
- Mineralogy
- Size distribution
- Chemical composition
- Oxidation potential, including acid-generating potential
- Suitability for separating sulphides if potentially acid-generating
- Potential for leaching of metals and other contaminants
- Variability in all of the above

Tailings — characteristics dependent on tailings management technology selected - should be evaluated for each technology alternative assessed:

- Rheology
- Consolidation properties
- Solids content
- Plasticity
- Liquid phase chemistry
- Hydraulic conductivity and anisotropy of fresh and compacted tailings
- Variability in all of the above

Materials to be co-managed with tailings (e.g., waste rock, treatment sludge):

- Daily/annual amount placed and total quantity to be managed in the tailings facility
- Timeframe for placement (could be after the end of operations in the case of treatment sludge)
- Chemical composition
- Oxidation potential, including acid-generating potential
- Potential for leaching of metals and other contaminants
- Stability considerations

Availability and Characteristics of Impoundment Construction Materials (if applicable)

Waste rock and tailings:

- Quantities suitable for construction
- Availability at appropriate time for construction
- Chemical composition
- Oxidation potential, including acid-generating potential
- Potential for leaching of metals and other contaminants
- Physical and engineering properties (e.g., strength, gradation, slaking potential)
- Hydraulic conductivity in the dam structure

Glacial till and other earthfill/rockfill materials:

- Availability and transport distances
- Quantity available
- Environmental impacts of excavating borrow material
- Environmental impacts of quarry development and operation
- Size distribution
- Suitability for low permeability applications
- Chemical composition

- Oxidation potential, including acid-generating potential
- Potential for leaching of metals and other contaminants
- Durability and integrity
- Internal erosion potential
- Freeze/thaw resistance

Air and Water Management

Site climate (seasonal variations, means and extremes):

- Temperature
- Prevailing wind direction and speed, including dust generation potential
- Precipitation, including 1/100-year flood, 1/1000-year flood and Probable Maximum Flood
- Seasonal precipitation patterns, including snowfall, rainy season, etc.
- Evaporation
- Climate change projections (e.g., temperature, precipitation and extreme events)

Overall site water balance — independent of tailings management technology selected:

- Water use in ore processing
- Mine water production
- Evaporation
- Other water flows to be managed on site
- Clean water interceptors and diversions
- Availability of make-up water
- Water discharge to the environment

2) Additional Characteristics – Screening Level Assessment

These characteristics should be considered for each potential alternative included in the initial step of screening alternatives to develop a short list of alternatives for more detailed assessment. The objective at this stage is to identify "fatal flaws" in potential alternatives, to eliminate those alternatives from further consideration.

Basic information about each potential location:

- Distance from ore processing facility – transport of tailings
- Distance from mine – transport of waste rock for construction
- Topography, based on regional and detailed topographic maps, aerial photos or satellite images
- Surface area of potential tailings facility
- Potential locations of dams, and estimated dam heights, if applicable
- Estimated total capacity of potential tailings facility
- Identification of any sensitive downstream areas (e.g., communities) that could be impacted in the event of a failure of the facility

Existing and planned infrastructure:

- Mine-related infrastructure, including roads, buildings, open pits and waste rock facilities
- Non-mine related infrastructure, including roads, utility corridors, proximity to communities or other land owners

Flora and fauna that could preclude a tailings facility at that location:

- Presence of fish-frequented water bodies within the footprint of the possible tailings facility that would have permitting implications
- Presence of endangered or threatened species, migratory species
- Other ecological values (e.g., calving or rutting grounds)

Hazards or other features that could preclude a tailings facility at that location:

- Risk of landslides or avalanche
- Geologic faults or other features
- Geotechnical conditions
- Hydrologic conditions

Social or cultural features that could preclude a tailings facility at that location:

- Significant archeological features, such as burial grounds
- Areas of spiritual significance
- Areas used for traditional harvesting for food, medicinal or spiritual purposes

Closure considerations:

- Ease of closure and related factors that could preclude a tailings facility at that location

Cost:

- Rough but defensible estimate of costs of a tailings facility at each location, across the entire life cycle, from planning and design, through closure and post-closure

3) Additional Characteristics – Detailed Assessment

These characteristics should be considered in a sufficient level of detail to be able to rigorously assess each potential alternative on the short list of alternatives for more detailed assessment. Level of detail is less than that required for detailed engineering design and construction, but should be detailed enough to understand the key factors that influence the selection of the location, and how a tailings facility at that location would be designed, constructed, operated and closed.

Tailings management plan (see also *Appendix 6*):

- Potential tailings technology (e.g., conventional, cycloned, thickened, paste or filtered)
- Management of acid-generating potential (e.g., wet cover, elevated water table, dry cover, segregation of sulphides)
- Management of neutral pH leaching of metals, metalloids and non-metals
- Surface area of potential facility, locations and heights of any dams or other containment structures

- Capacity of facility as designed
- Design of any dams or other containment structures (e.g., permeable vs. water retaining, centreline or downstream, keyed to bedrock vs. constructed on surficial materials)
- Construction materials for any dams or other containment structures (e.g., glacial till core, waste rock, cycloned tailings, other materials)
- Any materials to be co-managed with tailings, and method of co-management

Closure plan (see also *Appendix 6*):

- Planned post-closure land-use
- Closure strategy for tailings facility
- Overview of long-term maintenance and monitoring
- Progressive reclamation plan

Basic information about each potential location:

- Detailed topography, based on LIDAR (Light Detection and Ranging) or other sources

Bedrock and hydrogeology:

- Rock units present in footprint of possible tailings facility and adjacent areas
- Presence of faults, aquifers, aquitards or other features that influence the direction and rate of groundwater flow
- Estimated hydraulic conductivity of relevant rock units, based on geological characteristics

Surficial geology and hydrogeology:

- Depth to bedrock in footprint of possible tailings facility
- Stratigraphy of surficial units
- Presence and extent of clay deposits and their potential to cause stability concerns if a tailings facility is constructed on top of the clay
- Presence and extent of other factors that influence stability and foundation conditions, such as organic material, high water table, loose sands, old tailings/filled ground, fractured bedrock, etc.
- Estimated hydraulic conductivity of surficial units, based on geological characteristics
- Presence and extent of high or low permeability units (e.g., sand or clay)

Hydrology within the footprint of the possible tailings facility, and in upstream and downstream areas:

- Watershed delineation and flow patterns
- Size and flow of streams
- Presence of wetland areas
- Runoff
- Return period of floods and potential severity
- Bathymetry of any lakes or ponds

Water management:

- Inflows and outflows to possible tailings facility
- Design parameters for extreme weather events
- Seepage management measures (e.g., control and collection measures)
- Estimated rate of seepage from possible tailings facility
- Estimated quality of seepage groundwater
- Clean water interceptors and diversions

Natural hazards within the footprint of the possible tailings facility, and in adjacent areas that could impact the facility:

- Risk of landslides or debris flows
- Risk of avalanche
- Seismic risk

Terrestrial environment within the footprint of the possible tailings facility, and in adjacent areas that could be impacted by the facility:

- Key animal and plant species present
- Habitat features such as denning areas or natural pastures
- Presence of species of commercial, recreational or Indigenous significance, such as species that are trapped, hunted or gathered for food, sale, medicine or traditional/spiritual use

Aquatic environment within the footprint of the possible tailings facility, and in upstream and downstream areas that could be impacted by the facility:

- Water and sediment quality
- Any upstream or close downstream sources of impacts on water quality or disturbance to the aquatic environment
- Fish species present, including any endangered and threatened species
- Presence of species of commercial, recreational or Indigenous significance

Archeology within the footprint of the possible tailings facility and in immediately adjacent areas:

- Presence of archeological sites of Indigenous or non-Indigenous significance such as burial sites, camp sites, historic sites, etc.

Indigenous considerations associated within the footprint of the possible tailings facility, and in adjacent areas:

- Status of land claims
- Traditional use of the area for hunting or gathering
- Sites of spiritual significance
- Agreements with Indigenous communities

Other considerations:

- Presence of permafrost
- Presence of areas impacted by past mining or other industrial or commercial activity

Socio-economic considerations – may be the same for all alternatives considered, but should be assessed on a location-by-location basis:

- Other current and historical land or water use, including recreation, parks, drinking water sources
- Other commercial uses in the area, such as mining, logging or farming

Cost:

- Estimate of costs of a tailings facility at each location, across the entire life cycle, from planning and design, through closure and post-closure

4) Additional Characteristics – Detailed Design

Bedrock and hydrogeology:

- As above under item (3), but more detailed as appropriate
- Measured hydraulic conductivity of relevant rock units

Surficial geology and hydrogeology[6]

- Detailed information on depth to bedrock in footprint of planned tailings facility
- Detailed stratigraphy of surficial units
- Detailed information on presence and extent of clay deposits and other factors that may influence stability and foundation conditions
- Measured hydraulic conductivity of surficial units
- Relevant physical characteristics of surficial units, particularly in areas of planned dam foundations

Hydrology within the footprint of the planned tailings facility, and in upstream and downstream areas:

- As above under item (3), but more detailed as appropriate

Natural hazards within the footprint of the planned tailings facility, and in adjacent areas that could impact the facility:

- As above under item (3), but more detailed as appropriate
- Description of mitigation measures
- Other characteristics listed under item (3), but more detailed as appropriate

Cost:

- Sufficiently detailed estimate of costs of the selected tailings facility, across the remaining life cycle of the facility.

6. See for example: Association of Professional Engineers and Geoscientists of BC (2016): Site Characterization for Dam Foundations in BC

Appendix 4: Independent Review

Introduction

Tailings facilities are complex structures, and all aspects of their management are subject to human error. Tailings governance structures that support effective risk management decisions are critical for maintaining and increasing the resilience of tailings facilities throughout their life. A key aspect of effective Owner governance is regular Independent Review (IR) of tailings facilities and their governance, which is recognized as an essential BAP for responsible tailings facility management, and is required in some jurisdictions. In addition, many financial institutions require IR processes to demonstrate responsible risk management. Insurance companies may offer premium reductions if IR is part of a facility's risk management program.

There is no specific method or formula for conducting effective IR. This appendix describes principles and elements that would be common to any effective IR process; however, how these principles and elements are applied for a given facility will be as unique as that facility's characteristics. The following material and examples are intended to provide guidance, and are not intended to be prescriptive.

Owners of tailings facilities employing BAP typically use IR to provide, in a systematic, ongoing manner, an independent, qualified opinion about:

- the risks and the state of the tailings facility;
- whether the tailings facility is being managed based on sound engineering practices; and
- whether concepts and design criteria are consistent with regulatory requirements, industry standards, and current theory, methodologies and experience.

IR may also provide recommendations to improve tailings facility management, although IR processes do not confer decision-making authority on the reviewers. Accountability and responsibility for decisions whether to implement recommendations rests solely with the Owner.

The objective of IR is to allow those accountable and responsible for tailings facility management to make more informed decisions regarding a tailings facility so that tailings-related risks are managed responsibly and in accordance with acceptable standards of care.

IR is not a substitute for appropriate design, or the role of the EoR, and it is essential that an Owner employ an appropriately qualified and experienced team and/or retains consultants to provide the necessary specialized services throughout the life cycle of the facility. It is important that an Owner designate a person responsible for coordinating IR efforts with designers, operations staff and senior management.

Benefits

IR pools the experience and knowledge of experts in tailings facility design and management to respond to the technical challenges that an Owner is likely to encounter or may be currently facing.

IR is most effective if it begins at the project conception and planning phase of the life cycle, and continues through design, construction, operation, closure, and post-closure. As such, the intent of IR is to identify and address potential deficiencies before they occur and is fundamentally a preventative risk control measure. The preventative focus of IR fosters continual improvement and mitigates complacency.

The IR process requires that the Owner provides comprehensive, high-quality information to Independent Reviewers. Compiling such information helps strengthen documentation of the Owner's institutional memory and can reduce reliance on the memory of individuals involved in tailings management.

IR may be used to support Performance Evaluation and Management Reviews for Continual Improvement.

Spirit of "Independent"

The intention, or spirit, of "independent" is that the reviewer(s) should not be directly involved with the design or operation of the particular tailings facility. Where potential conflict of interest exists, such conflicts should be identified and declared so the Owner understands when 'independence' is theoretically compromised and agrees. For example, it is acceptable to have an Independent Reviewer who is employed by the same company as the EoR for the tailings facility, provided the intent of 'independent' is met. This is further reinforced by maintaining a clear understanding between the Owner and their consultant(s) (e.g., designer, EoR) that an Independent Reviewer may need to abstain from a discussion or withhold an opinion when a conflict of interest may apply. This flexibility allows the IR process to maximize the use of appropriately qualified reviewers; understanding that there may be a limited pool of such qualified individuals available.

Guidance for Independent Review

Guidance provided is for IR intended for internal purposes, to inform the facility Owner. It is not intended to address other types of IR, such as that required by some regulators.

Detail Level of IR

The level and detail of IR should be established clearly and prior to any review proceeding. An example of the level and detail required is consistent with that described for "Review Level" by Robertson and Shaw (2003)[7], as follows:

> *At this level the reviewer generally reviews all key documents and does at least "reasonableness of results" checks on key analyses, design values, and conclusions. Design, construction and operational procedures are reviewed at a level sufficient to develop an independent opinion of the adequacy and efficiency of the designs, construction and operations. The reviewer generally relies on the representations made to the reviewer by key project personnel, provided the results and representations appear reasonable and consistent with what the reviewer would expect. A review report is produced which documents the reviewer's observations as to the adequacy of the design, construction and operations and indicates any recommendations that flow from these.*

7. Robertson, Andy and Shaw, Shannon (2003): *Risk Management for Major Geotechnical Structures on Mines*

Risk-Based Approach

IR is a component of an effective risk management system. As such, the degree of IR involvement over the life cycle of the facility should be risk-based, with particular emphasis on the potential impacts of a significant tailings facility event on the business overall, to worker and community health and safety and to the environment.

While some sites conduct IR on an annual basis, the frequency of IR should be determined on a facility-specific basis, depending on the risk profile and life cycle phase of the facility. In some instances, additional, special one-off type IR sessions may be warranted; for example, where existing facilities are being upgraded to comply with current design criteria and standards or facilities that are in design, commissioning and initial operation. In these conditions, IR frequency should be determined in consultation with the IR body, Owner and EoR. As a site approaches a "steady state" of operation, IR frequency may be reduced. The IR frequency during closure may vary according to risk.

An IR body may comprise a single reviewer or several individuals. The IR body composition and experience level should be commensurate with the tailings facility's complexity and risk profile. Accordingly, an Independent Reviewer could vary from a competent person employed by a separate Owner, to an internationally-recognized subject-matter expert. At high-risk facilities, (where a breach could plausibly result in inundation of residence(s) and loss of life) a panel of three or four subject-matter experts with different but complementary areas of expertise and experience may be required to cover the various disciplines associated with management of the facility (e.g., geotechnology, hydrology, hydrogeology, and geochemistry). In other instances, temporary IR involvement for niche disciplines (e.g., paleo seismology, seismic hazard assessment) outside the expertise of the core IR body may be required. Redundancy of technical disciplines within the IR body should be considered in accordance with a facility's risk profile.

IR Program

The terms of reference for IR should be carefully considered in accordance with the facility risk profile. Recommended terms of reference are provided in Appendix 4.1. Effective IR requires that Owners maintain reliable archives of relevant documents. This becomes particularly important in the event of changes in employees, contractors, or consultants (e.g., EoR) involved in tailings management, or if a significant event or change should occur.

The IR process should involve both site-personnel (e.g., Responsible Person), the EoR, and key consultants to be most effective. The IR process requires a wide range of information, which typically includes:

- facility description, including design and as-built information;
- risk assessment and risk management plans;
- OMS manual, with a summary of key operational, maintenance and surveillance practices and procedures;
- results of Performance Evaluation and Management Review for Continual Improvement;
- for new facilities, assessment of alternatives for selection of tailings facility location and BAT;
- any changes since the last IR (if IR has been done previously);
- other relevant studies and assessments;
- summary of previous IR recommendations and status of implementation; and
- pertinent information on medium to long-range planning for the facility.

The IR should be documented to describe: the review's scope and process; details of the technical issues evaluated; and, as appropriate, recommendations, including opportunities for improvement.

For IR to best function as an effective risk management tool, the IR process should be confidential. A lack of confidentiality could undermine the IR process, because it relies on open discussions of the risks and issues related to a tailings facility, including scenarios about possible future site changes (e.g., information about potential mine life extensions that could influence current or potential shareholders or investors) that cannot legally be disclosed. In this regard, confidentiality is necessary for compliance with securities regulations as the IR typically considers future mining plans and "forward-looking information". If required, the IR process and findings can be summarized for disclosure.

In response to any recommendations from the IR process, an action plan should be developed. Progress of implementing the action plan should be tracked and, as appropriate, shared with the Independent Reviewer(s). The Owner should also identify any recommendations that will not be implemented, and document a rationale.

Suggested Reading

For facilities considering an IR program, a process summary is appended to this document. The following publications are recommended resources to provide further context and examples of IR:

Hoek, E. 2001. Geotechnical Review Boards in Mining. Geotechnical News. March 2001.

Matich, M.A.J. 1986. Design and Review Boards. Alberta Dam Safety Seminar. Edmonton. September 1986.

McKenna, G. 2001. Celebrating 25 Years – Syncrude's Geotechnical Review Board. Geotechnical News. September 1998.

Robertson, A. Shaw, S. 2003. Risk Management for Major Geotechnical Structures on Mines. http://www.infomine.com/library/publications/search.asp?action=16384&search_text=audit+review&search_dt_all=true&Search=Search

Appendix 4.1: Recommended Terms of Reference for IR

IR Mandate: To provide IR of a tailings facility's design, construction, and management to allow the Owner to make more informed decisions regarding the facility so that tailings-related risks are managed responsibly and in accordance with an acceptable standard of care. The Reviewer(s) should comment on matters that:

- affect the physical or chemical integrity of the facility;
- may impact human health and safety, the environment and, potentially affected communities;
- are beyond industry norms of current practice or evolving practice; and
- affect the future conditions of the site.

The Reviewer(s) should also consider the effectiveness of the site's tailings management system.

The Reviewer(s) are managed by an appropriate representative of the Owner. IR findings are made known to the Accountable Executive Officer, either directly or through the Owner's representative. The Reviewer(s) does not have decision-making authority and does not replace the role of the EoR or an experienced independent dam safety reviewer for assessing dam safety. Other than acts of gross negligence, wilful misconduct or fraud, the Reviewer(s) should have no exposure to professional liability and should be indemnified by the Owner to direct and third-party claims.

In circumstances where imminent risk to public health or safety are apparent, the Reviewer(s) is responsible to disclose such risks on an "as soon as possible basis" to the Accountable Executive Officer, and confirms whether those risks are appropriately managed.

Requirements for "independent": The Reviewer(s) must be independent and not be directly involved with the design or operation of the tailings facility. Where there may be some conflict of interest, for part of the review being performed, this conflict should be declared such that the Owner understands when 'independence' is theoretically compromised and agrees or takes other action.

Level of Review: The level and detail intended for IR should be consistent with that described for "Review Level" by Robertson and Shaw (2003).

Appendix 5: Considerations for Managing Throughout the Life Cycle of a Tailings Facility

Section 5.3 describes a checklist that may be customized to help implement the tailings management framework throughout the life cycle. A master checklist is available for download from the MAC website at *www.mining.ca/tailings-management*. The master checklist is illustrated in *Appendix A.5.1*.

In addition to applying the checklist, additional considerations for management for all phases of the life cycle are described below. It is important to note that different jurisdictions may have requirements that differ from what is described below, particularly with respect to the closure, and post-closure phases. In such cases, this Tailings Guide should not supersede those regulatory requirements.

Project Conception and Planning Phase

- For new facilities, or for operating facilities undergoing expansion, this phase is carried out by a multidisciplinary team of specialists such as engineers and geologists, and environmental and social scientists, all with relevant experience in the assessment of appropriate tailings management technologies, site selection, design of the tailings facility components, and construction and operation of tailings facilities. It is preferable to have the EoR engaged in this phase as part of the team. The team reports to the overall project development team assigned by the Owner to develop the mine.
- Designer-of-record should be assigned, which may be the same as the EoR.
- A long-term view is critical (including closure and post-closure), so that short-term financial priorities do not prevail over a more appropriate design that would have lower long-term impacts, complexity, and risks (including the long-term financial risks in the event of a failure).
- During the project conception and planning phase, select site and tailings management technology(ies) (see also Appendices 1, 2 and 3), and develop a conceptual design and closure plan for the tailings facility.

Design Phase

- The design team needs to have competent professional staff experienced in the disciplines required to appropriately design the tailings facility. The team will typically be managed by the project development team assigned by the Owner to develop the mine.
- The facility design needs to consider and address anticipated operating realities to design a robustly operable facility. As such, persons with operational expertise should be involved in the design process.
- During the design phase, develop the detailed facility design, construction methodology, operational controls and procedures, and a more detailed closure plan. Aspects of the tailings facility construction and operation should be planned and designed in compliance with regulatory requirements and in conformance with the approved plans, appropriate engineering and environmental practices, risk management, commitments to COIs and the Owner's tailings management system.
- Although many critical aspects of design should be completed before initial construction begins, aspects of design continue throughout the life cycle, particularly during the operations and ongoing construction phase.

Initial Construction Phase

- Facility construction up to the commissioning of a facility is usually managed by a mine project development and construction management team.
- Implementation of a quality assurance plan and quality control plan is required to ensure that construction is in accordance with design specifications.
- The EoR provides assurance that design standards are being met.
- Conformance management plan and change management plan should be implemented.

Operations and Ongoing Construction Phase

- Facility operations and continuing construction during the operating phase are usually managed by site operators who are assigned responsibility at the beginning of the commissioning of the mine development.
- This change in the personnel responsible for the tailings facility, from the initial construction phase to ongoing construction during operations, can be problematic from a continuity perspective and, therefore, needs to be appropriately planned for and managed in the tailings management system.
- A facility that was initially designed and constructed in a project environment can be compromised by decisions of the facility operations team during or following commissioning of the facility.
- The facility operations team may not fully appreciate the potential significance and risks of decisions made during the operating phase. Consequently, it is important that the tailings management system plan for and incorporate measures to mitigate such risks.
- The EoR needs to closely support the facility operations team to ensure continuity with the original design requirements, and that an appropriate engineering assessment is carried out if the original design specifications or operating parameters/constraints are to be modified.

Closure and Post-Closure Phases

- A specific project team often takes the lead in preparing for decommissioning and closure. In many cases, this team will manage the decommissioning and closure of the tailings facility.
- At this phase, it is critical that the tailings management system accommodate planning for both the shorter-term, more finite period of decommissioning and closure, as well as addressing the long-term post-closure period, particularly long-term maintenance and surveillance to ensure that tailings landforms remain physically and chemically stable.
- The Owner should provide the financial and physical resources necessary to implement the closure plan and ensure long-term maintenance and monitoring.

A.5.1: Illustrative Sample of the Master Checklist, to be Used as a Tool for Owners in Implementing the Tailings Management Framework

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
Overarching Principles					
Risk Assessment and Management					
2.2.1	Addressed below under Planning				
BAT and BAP for Tailings Management					
2.2.2	Have the following factors been considering in selecting the tailings management technology for a specific tailings facility:				
	• Are the likelihood or consequences of a failure of a tailings facility reduced?				
	• Is material separation required to manage a potential geochemical concern?				
	• How much water will be retained in the tailings during their transport and deposition?				
	• Is there potential to place any tailings in mined-out areas?				
	• Is the post-mining land use best served by a given technology?				
2.2.2	Has a rigorous decision-making tool such as multiple accounts analysis been used to select the most appropriate tailings management technology for a new facility, or to expand the capacity of an existing facility?				
2.2.2	Has a rigorous decision-making tool such as multiple accounts analysis been used to select the most appropriate location for a new tailings facility?				
2.2.2	In selecting the tailings management technology, have the potential risks of the alternatives assessed been considered across the life cycle of the facility, and have performance objectives and criteria been considered across the life cycle, including closure objectives?				
2.2.2	In selecting the tailings facility location, have the potential risks of the alternatives assessed been considered across the life cycle of the facility, and have performance objectives and criteria been considered across the life cycle, including closure objectives?				
2.2.2	Are best available/applicable practices for tailings management being implemented across the full spectrum of tailings management, including:				
	• confirming geochemical and physical design parameters during the operations and ongoing construction, closure, and post-closure phases, and adjusting accordingly;				
	• structural monitoring of tailings facilities to detect movement or change;				
	• implementing a tailings management system;				
	• implementing a system to identify and manage critical controls;				
	• monitoring to assess performance against water balance requirements; and				
	• conducting Independent Review.				
Independent Review					
2.2.3	Has a mechanism been established for conducting Independent Review on a routine basis?				
2.2.3	Is Independent Review being implemented according to the established mechanism?				
2.2.3	Is Independent Review providing advice on:				
	• completeness/appropriateness of the risk assessment and understanding;				
	• effectiveness of tailings governance and the tailings management system;				
	• whether the tailings facility is being effectively managed based on sound engineering practices;				
	• whether the risk assessment and the acceptable level of risk should be reviewed and updated;				
	• whether concepts and design criteria for the facility are consistent with regulatory requirements, industry guidelines and best practices, and current theory, methodologies and experience; and				
	• areas for improvement in the management of the tailings facility.				
2.2.3	Is Independent Review being applied across all elements of the tailings management system, and across all phases of the life cycle of a tailings facility?				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
Designing and Operating for Closure					
2.2.4	Have long-term closure objectives and potential post-closure land uses been considered in the conceptual planning and design of the tailings facility?				
2.2.4	Has the tailings facility been designed to remain physically and chemically stable for the long-term.				
2.2.4	For older facilities not designed for closure, have options to adjust their tailings management practices or adopt newer technologies been considered to reduce risk and better position the tailings facility for closure?				
2.2.4	Is the tailing facility being constructed in a manner consistent with the closure objectives?				
2.2.4	Is the tailings facility being operated in a manner consistent with the closure objectives?				
2.2.4	Is the closure plan being updated, considering changes in the mine plan, regulatory changes, a changing risk profile of the tailings facility, status of progressive reclamation activities, and changes in COI expectations?				
Policy and Commitment					
3	Does the Owner have a demonstrated commitment to:				
	• protection of public health and safety;				
	• responsible management of tailings with the objective of minimizing harm;				
	• allocation of appropriate resources to support tailings management activities; and				
	• implementing a tailings management system through the actions of its employees, contractors and consultants.				
3	On a facility-specific basis, has the Owner made more specific commitments to:				
	• design, construct and operate the tailings facility in a manner that reduces long-term impacts, risks and liability;				
	• ensure tailings management complies with regulatory requirements, and conforms with reasonable and prudent engineering practice, set design criteria, company standards/guidelines, and the Owner's tailings management system;				
	• engage with COI, taking into account their considerations in relation to the design (including location), operation, and management of the tailings facility;				
	• manage the tailings facility commensurate with the risks it poses through implementation of BAT and BAP, with the objective of minimizing harm, and meeting performance, corporate governance, environmental and social requirements;				
	• manage all solids and water within designated areas;				
	• establish an ongoing program of review, including Independent Review, and continual improvement of health, safety and environmental performance through the management of risks associated with the tailings facility; and				
	• implement the level of accountability, authority and competency for decision making appropriate to the level of risk that the decision entails.				
3	Is the policy and/or commitments:				
	• approved by senior management and endorsed at the governance level;				
	• communicated to employees;				
	• understood by employees and contractors whose duties, either directly or indirectly, may affect the safety of tailings facilities; and				
	• implemented with budget allocation?				
Planning					
Risk Management					
4.1	Is a risk management process in place for the tailings facility?				
4.1	Are risk assessments completed and/or updated at a frequency that supports the aims of the tailings management activities for that facility?				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
4.1	Have the outcomes of the risk assessment been documented?				
4.1	Do the risk assessment and management measures take into account:				
	• physical and chemicals risk of the tailings facility;				
	• environmental risks such as earthquakes, landslides or avalanches, which could impact the facility; and				
	• other risks external to the Owner and the facility, including regulatory and permitting risks (e.g., not obtaining permits in a timely manner, or permits that are not aligned with the design intent of the tailings facility).				
4.1	Has a risk management plan been prepared and documented that describes mitigation measures to:				
	• eliminate or avoid risk to the extent practicable;				
	• reduce risk by minimizing the likelihood or potential consequence of an unwanted event or condition that poses a risk; and,				
	• detect, respond to, and minimize the consequences if an unwanted event or condition occurs that poses a risk?				
4.1	For a new tailings facility or the expansion of the capacity of an existing facility, has development of a conceptual risk management plan begun at the project conception and planning phase of the life cycle?				
4.1	For a new tailings facility or the expansion of the capacity of an existing facility, has the conceptual risk management plan been refined and developed in greater detail during the design phase?				
4.1	Is the risk management documentation, including the risk assessment record, reviewed and updated as necessary in the event of any changes not anticipated at the beginning of mine life (e.g. mine life extensions, suspensions to care and maintenance, re-starts, and process and technology changes)?				
Performance Objectives					
4.2	Have performance objectives and criteria been developed that are aligned with the Owner's tailings management system, policy and/or commitments, standards/guidelines, regulatory requirements, commitments to COIs, and sound engineering and environmental practices?				
4.2	Are performance objectives, indicators, and associated performance measures for the tailings facility based on:				
	• environmental requirements;				
	• risk assessment and the level of acceptable impact and risk; and				
	• risk management plan?				
4.2	Have performance objectives and criteria been developed for the entire life cycle of the tailings facility, including planning for both potential temporary and eventual permanent closure, and including:				
	• protection of employee and public health and safety;				
	• design objectives and criteria, including geotechnical, geochemical, operational, community, and environmental performance objectives that the tailings facility is expected to achieve;				
	• mitigation of negative environmental impacts by ensuring continued physical and chemical stability of all components/structures; and,				
	• acceptable post-closure use within a feasible technical and economic framework?				
4.2	For a new tailings facility or the expansion of the capacity of an existing facility:				
	• Have performance objectives been established in the conceptual planning phase?				
	• Did the assessments of alternatives for facility location and tailings management technology take these performance objectives into account?				
Accountability and Responsibility					
4.3	Do personnel with accountability and responsibility for tailings management have an understanding, appropriate to their accountability and responsibly, of how the				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
	tailings facility is designed, constructed and operated, including risk posed by the facility, the risk management plan, critical controls management, and operational constraints?				
4.3	Are accountabilities, responsibilities, and roles defined and documented for:				
	• Owner's Board of Directors or Governance Level;				
	• Accountable Executive Officer;				
	• Responsible Person(s);				
	• Engineer of record; and				
	• Independent Reviewer?				
Management Process					
Conformance Management					
4.4.1	Do conformance management processes ensure that:				
	• applicable regulations, permits and commitments (including commitment/conditions coming from environmental assessment and permitting) are identified, documented, understood and effectively communicated;				
	• Owner's policies, guidelines, standards, practices are identified, documented, implemented, and reviewed;				
	• those accountable and responsible for conformance understand their duties and have the necessary training and competence; and				
	• processes to assess the state of conformance have been established, documented and communicated as required?				
4.4.1	In cases of non-conformance, did the Owner:				
	• report the non-conformance, internally and externally, as appropriate;				
	• determine the causes of the non-conformance, and identify and implement corrective measures;				
	• address consequences of the non-conformance, including mitigating environmental impacts;				
	• review the effectiveness of measures to correct the non-conformance; and				
	• make necessary changes to the tailings management system to prevent future non-conformance?				
Change Management					
4.4.2	Have change management processes been documented and implemented to maintain the integrity of the tailings facility and the management system, including changes to:				
	• approved designs and plans, including temporary changes, and expansions to the tailings facility;				
	• facility ownership				
	• employees, contractors and consultants with key duties related to the tailings facility, including the Accountable Executive Officer, Responsible Person, operating and maintenance personnel, roles and responsibilities, including those of the EoR and Independent Reviewers;				
	• conditions that may impact the ongoing operation/maintenance of the tailings facility, including temporary suspension of mining operations;				
	• the closure plan;				
	• regulatory requirements; and				
	• any other changes that are potentially material to the risks associated with the tailings facility and its management (i.e., any change that has the potential to change the performance or risk profile of the tailings facility or any of its component parts).				
4.4.2	Do change management processes include succession planning for key roles related to tailings management, including the Responsible Person(s), EoR, and				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
	Independent Reviewers?				
4.4.2	Are changes which could impact the risk profile of the tailings facility reviewed and are potential impacts evaluated?				
4.4.2	Are changes which could impact the risk profile of the tailings facility approved by all the relevant persons (e.g., EoR, Responsible Person(s), personnel involved in tailings management and related activities, and the Accountable Executive Officer) as appropriate?				
Controls					
Critical Controls					
4.4.3	Has the Owner implemented processes to manage critical controls, including:				
	• identifying potential failure modes and causes using risk assessment techniques;				
	• identifying risk controls associated with potential failure modes and causes;				
	• identifying those risk controls deemed to be critical on an Owner or facility-specific basis;				
	• appointing a “risk owner” and “critical control owner” for that risk;				
	• defining the critical controls and their performance criteria, measurable performance indicators, and surveillance requirements;				
	• identifying pre-defined actions to be executed if control is lost;				
	• verifying execution of critical controls by the critical control owner or designate, at a frequency commensurate with the frequency of control execution;				
	• reporting deficiencies in critical controls to the Responsible Person(s) and, where appropriate, the Accountable Executive Officer, and identifying actions to address those deficiencies;				
	• tracking implementation of actions to address critical control deficiencies, and reporting to the Responsible Person(s) and, where appropriate, the Accountable Executive Officer; and				
	• periodically reviewing and updating risk controls and critical controls, based on updated risk assessments, risk management plans, and past performance?				
Quality Management					
4.4.3	Has a quality management plan, or separate quality assurance and quality control plans, been developed and implemented?				
4.4.3	Does quality management address an appropriate range of aspects related to the tailings facility, including construction, operation, maintenance and surveillance practices through the life of the facility?				
Operational Controls					
4.4.3	Has an operation, maintenance and surveillance (OMS) manual been developed?				
4.4.3	Does the OMS manual document and clearly communicate responsible operating practices to operators and staff responsible for the tailings facility?				
4.4.3	Does the OMS manual include or refer to plans specific to key aspects of the operation of the tailings facility, including:				
	• tailings transport and deposition plan;				
	• water management plan; and				
	• closure plan.				
4.4.3	Does the OMS manual describe risk controls and critical controls, together with associated performance criteria and indicators, and descriptions of actions to be taken if control is lost?				
4.4.3	Does the OMS manual document facility-specific performance measures as indicators of progress on management actions and objectives?				
Resources					
4.4.4	Has the Owner identified, secured and regularly reviewed the adequacy of:				
	• human resources and external contractors;				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
	• condition, function and suitability of equipment;				
	• financial resources; and				
	• schedules of activities that integrate the required resources related to tailings management?				
Financial Control					
4.4.4	Has a budget for tailings management been established and documented that considers both short-term and long-term needs for effective tailings management throughout the life cycle?				
4.4.4	Has budget approval been obtained?				
Control of Documented Information					
4.4.4	Has the Owner established and implemented a process to ensure that documented information is created, maintained, retained, and archived?				
4.4.4	Has a process been developed and implemented to identify records related to the tailings facility that should be retained?				
Training and Competence					
4.4.4	Has a training program for relevant employees, contractors and/or consultants been developed and implemented?				
4.4.4	Are records for training for employees, contractors or consultants that is funded by or provided by the Owner maintained?				
Communications					
4.4.4	Have communications processes been established and implemented to report significant information and decisions to senior management, the Engineer-of-Record, regulators and COI, as appropriate?				
Implementing the Tailings Management Framework					
Operation, Maintenance and Surveillance Manual					
5.1	Has the OMS manual been implemented?				
5.1	Is the OMS manual regularly reviewed and revised, as appropriate, throughout the operations and ongoing construction phase of the tailings facility's life cycle, as well as beyond?				
Emergency Preparedness and Response Plans					
5.2	Has an emergency preparedness and response plan (EPRP) been developed and documented that:				
	• identifies possible emergency situations that could occur during the initial construction, operation and ongoing construction, closure, and post-closure phases of the life cycle of the tailings facility, and which could pose a risk to populations, infrastructure, and the environment; and				
	• describes measures to respond to emergency situations and to prevent and mitigate on and off-site environmental and safety impacts associated with emergency situations.				
5.2	Is the EPRP for the tailings facility integrated with the overall site-level EPRP?				
5.2	If the tailings facility impounds water has an inundation study been conducted, and does the EPRP include inundation considerations?				
5.2	Are the OMS manual and the EPRP be aligned, such that there are no functional gaps between normal operations and emergency response, and that procedures are in place to transition from normal conditions to an emergency situation that may arise?				
5.2	Are procedures established and implemented for periodic review and testing of the EPRP, to ensure that the plan is current and that it is adequate in the event that an emergency occurs?				
5.2	Does review and testing of the EPRP involve potentially affected COI, such as local first responders and relevant government agencies?				
5.2	Have copies of the EPRP been provided to potentially affected COI?				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
Performance Evaluation					
6	Do performance evaluations include results of inspections and reviews (both internal and independent) and address:				
	• operating performance against objectives and critical controls;				
	• compliance with regulatory requirements, and conformance with plans and commitments;				
	• the risk management process, including the need to update the risk assessment;				
	• need for changes or updates to the OMS manual, including evaluating the effectiveness of surveillance processes and the utility of the information being collected, and identifying any gaps in information collection; and				
	• need for changes or updates to emergency preparedness and response plans?				
6	Do performance evaluations include the identification of gaps, deficiencies or areas of non-conformance with the tailings management system, including performance objectives and plans to address those objectives?				
6	Are results and recommendations of performance evaluations documented and reported to the Responsible Person(s), the Accountable Executive Officer and the Board of Directors or Governance Level, at a pre-defined frequency and level of detail?				
Management Review for Continual Improvement					
7	Has an annual review of tailings management been conducted to:				
	• review the status of actions from the previous management review; and				
	• review the overall performance of the tailings management system to ensure its continuing suitability, adequacy and effectiveness, and the need for changes to components of the system:				
	○ policy and commitment;				
	○ accountability and responsibilities;				
	○ conformance management;				
	○ change management;				
	○ controls: critical controls and quality management;				
	○ resources: financial controls, control of documented information, training and competence, and communications;				
	• review performance of the tailings facility;				
	• effectiveness of risk management; and				
	• adequacy of resources (human and financial) committed to tailings management?				
7	Does the management review process include identification and evaluation of the potential significance of any changes since the previous management review that are relevant to the tailings management system, including:				
	• changes to regulatory requirements, standards and guidance, industry best practice, and commitments to COI;				
	• changes in mine operating conditions (e.g., production rate) or site environmental conditions;				
	• changes outside the mine property that may influence the nature of potential impacts to or of the tailings facility; and				
	• changes in the risk profile of the tailings facility?				
7	Does the management review provide a summary of significant issues related to the overall performance of the tailings facility and tailings management system, updated since the previous management review, that includes:				
	• regulatory compliance, conformance with standards, policies and commitments, and status of any corrective actions;				
7	• facility maintenance;				
	• tailings facility surveillance; and,				

Section in Tailings Guide	Management Action	Responsibility	Performance Measure	Schedule	References
	• inspections, internal or external audits, evaluations of effectiveness, and independent reviews?				
7	Are the outcomes of the management review documented and does it include:				
	• conclusions regarding the performance of the tailings facility and the tailings management system;				
	• action plans to address findings contained in the conclusions, including:				
	○ actions to ensure performance objectives are met;				
	○ actions to address non-conformity with requirements, standards, policy, or commitments; and				
	○ opportunities for continual improvement?				
	• modifications required in the tailings management system; and				
	• enhancements to human and financial resources to help ensure effective tailings management?				
Assurance					
8	Have assurance processes been implemented to provide an oversight process to ensure that tailings management is being effectively executed?				
8	Have the outcomes of assurance activities been considered in the Management Review for Continual Improvement?				
Audits					
8	Has an internal audit been conducted to provide a formal, systematic and documented examination of the tailings facility's conformance with prescribed criteria, legal requirements, and the Owner's tailings management system?				
8	Has an external audit been conducted?				
Evaluation of Effectiveness					
8	Has an evaluation of been conducted to assess whether the tailings management system (or components thereof) is achieving the intended results?				
8	In establishing the scope of the evaluation of effectiveness, have the following been considered:				
	• changes in external conditions that could affect the system and achievement of established objectives; and				
	• changes in internal conditions that could affect the system and achievement of established objectives?				
8	Have the following performance results and trends been evaluated to determine the effectiveness of the management system and its implementation:				
	• the extent to which objectives and targets are being achieved;				
	• the extent to which planned activities have been implemented as intended;				
	• fulfilment of conformance obligations;				
	• non-conformities and corrective actions based on inspection and audit results;				
	• monitoring and measurement results;				
	• adequacy of resources to support achievement of objectives;				
	• feedback from practitioners and end users; and				
	• any additional relevant information or feedback from COI.				
Independent Review					
8	Addressed above under Overarching Principles				

Appendix 6: Technical Considerations

The management of tailings facilities involves a wide range of technical disciplines that are applied in a coordinated and timely manner throughout the life cycle of each individual facility. There are numerous sources of technical guidance for Owners, operators, designers, regulators, and others that are readily available. References to some of the available guidance are provided in this Tailing Guide and each of those references will, in turn, point to other relevant materials. As this technical guidance is readily available, this Guide has not been developed to be exhaustive or comprehensive in terms of the technical guidance provided. However, there are three technical aspects essential to any tailings facility that are described in this Appendix, and which form the basis of the technical considerations for this Guide.

Tailings Transportation and Deposition Plan

The tailings transportation and deposition plan demonstrates both the capacity and flexibility of the tailings facility to meet the demands of the mining plan as it evolves throughout its life cycle, and is crucial to successfully operating the facility from construction to closure. BAP includes having the transportation and deposition plan integrated into the OMS manual, and executed during the operations and ongoing construction phase. Temporary suspension and closure conditions typically rely on an interim or final tailings surface topography to facilitate the closure strategy and post-closure land use, for example, a water cover, or a "dry" surface with appropriate drainage patterns. Typically updated annually during the operations and ongoing construction phase of the life cycle, the tailings transportation and deposition plan is prepared and implemented with eventual closure design and reclamation requirements as an objective.

The tailings transportation and deposition plan is predicated upon the tailings management technology used and the site-specific conditions of the tailings facility, and should address:

- Whether the tailings will be managed as slurry, or whether they will be dewatered to some degree and managed as thickened, paste or filtered tailings. Planned moisture content and physical characteristics of the tailings are essential to the transportation and deposition plan.
- What types of containment structures, if any, will be constructed, the construction method, materials to be used, and the method of raising those containment structures during the operating phase.
- Methods, if any, to control seepage from the tailings facility, such as the use of liners, water retaining dams, or underdrains.
- Whether there will be a single type of tailings, or whether there will be different types. For example, will there be separate "clean" tailings and potentially acid-generating tailings, which would be managed differently? If separate, how will these different types of tailings be managed?
- Whether any other materials, such as waste rock or treatment sludge, will be deposited with the tailings. For example, will potentially acid-generating waste rock be deposited with the tailings to prevent or control acidic drainage? What quantities of these materials will be deposited in the tailings facility, compared to the quantity of tailings?
- How will the tailings be transported from the ore processing facility to the tailings facility? Options include a pipeline in the cases of slurry, thickened or paste tailings, and truck or conveyor belt in the case of filtered tailings.

- Methods to prevent the release of tailings to the environment during transportation to the tailings facility.
- How will the tailings and any other materials be deposited within the tailings facility?
- How much water will be retained in the tailings facility? What measures are in place to deal with excess water, such as due to high intensity precipitation, extreme snow-pack/melt, extended periods of wet weather, extended periods of water retention, etc?

In developing the tailings transportation and deposition plan, a range of information about the physical and chemical characteristics of the tailings should be considered, including those listed in *Appendix 3.1*, Section 1. These characteristics should be validated and updated on a periodic basis throughout the life of mine. If characteristics to not meet design specifications or intent, then the potential impacts and risks of these deviations should be assessed, and appropriate actions taken to address them.

Depending on how water will be managed, and whether water will be stored in the tailings facility, the tailings transportation and deposition plan should be integrated with the water management plan.

Deposition plans typically allow for expansion of the tailings facility over the life of the mine to accommodate increasing amounts of tailings solids. This could include staged lifts to increase the height of containment structures to accommodate additional tailings, or planned lateral expansions into new cells of the tailings facility. Depending on the water content of the tailings, and the relationship between tailings management and water management, such expansions may also increase the capacity to store water and increase the retention time of water within the tailings facility.

The tailings transportation and deposition plan should be linked to the closure plan such that the tailings facility is in the configuration required for closure. The plan should be reviewed on an annual basis, with any changes to the plan subjected to the site's risk management and change management systems. Any changes should be documented.

Water Management Plan

An appropriate water management plan for any tailings facility will be unique to that facility. However, the following elements are essential to any water management plan.

Hydrology/Hydrogeology: Surface hydrology and hydrogeological data, including the delineation of tailings site catchment area(s) and all potential water sources, both natural and process, are used in the development of a water/contaminant balance and design of tailings facility components. Establish and document design parameters, then monitor actual experience to identify variances, validate projections, and anticipate potential problems.

Design Flood: The appropriate Environmental Design Flood and Inflow Design Flood need to be identified, with reference to current design standards and in consultation with regulatory agencies. Design flood considerations should be consistently applied throughout all phases of the life cycle, taking into account evolving BAP and any changes to regulatory requirements. Storage requirements, operating freeboard and spillway design are based on the hydrology of the watershed.

Water Balance: Complete a water balance study. Specify requirements for ongoing data collection for the ore processing facility and for tailings facility water balance calibration purposes. Water calculation to estimate fresh water needs and maximum pond storage requirements should be conducted and then updated at a frequency appropriate to the facility-specific conditions. Operational water balance should also be calculated and updated as appropriate.

Surface Water Management Plan: Complete a water management plan detailing appropriate designs and strategies, where required, for: clean water interceptors and diversions; seepage collection; reclaim/pump-back systems; treatment/discharge systems, including all water conveyance systems; and water retention and discharge strategy, including operating parameters. Revise the surface water management plan at a frequency appropriate to facility-specific conditions to consider potential design or operational changes to the facility. Updates to the surface water management plan should take into consideration the life cycle phase, and further requirements and expected conditions through the life cycle, including changes to the surface water management plan for the closure, and post-closure phases, as well as potential care and maintenance.

Contaminant Balance and Release: The contaminant balance provides estimates of contaminant release to surface and groundwater. Develop, where required, a plan to control contaminant release within acceptable levels. Monitor and plan for long-term conformance.

Effluent Criteria: Establish criteria for the quality and quantity of any effluent to be released to the environment, takings into account regulatory requirements and operating licenses and permits. The intent is to set performance criteria which are below legal requirements, to provide increased assurance of compliance with legal requirements. With respect to effluent quality, this may include criteria for dissolved and suspended solids, metals and metalloids, non-metals, thiosalts, cyanide, ammonia and other nitrogen compounds, and toxicity, and any other parameters that are subject to legal requirements, or of relevance to the Owner. With respect to effluent quantity, this may include criteria for maximum and base flow of effluent, as well as seasonal considerations for effluent release.

Closure Plan

Development of closure plans and performance objectives for closure and post-closure should begin at the project conception and planning phase. A conceptual closure plan, developed with a low level of detail at the project conception and planning phase, should become more detailed and elaborated at the design phase. The conceptual close plan should then be refined, elaborated, verified, and updated periodically during the initial construction and operating phases of the life cycle of the tailings facility, and in preparation for decommissioning, closure, and post-closure. The closure plan and objectives should be considered in the assessment of alternatives to select the tailings facility location and BAT, and should be a key consideration in the design of the facility. The closure plan and objectives should also be aligned with the OMS manual, so that activities during the operating phase are consistent with and support the closure plan and objectives.

A key aspect of closure that needs to be determined as early as possible in the life cycle, and at the project conception and planning phase for new facilities, is the closure strategy for the tailings facility, and the closure technology to be used. The selection of the strategy and closure technology should be driven by the objectives and performance objectives for closure and post-closure, and the planned post-closure land use. The potential physical and chemical impacts and risks of the tailings facility are key considerations. For example, if the tailings are predicted to be susceptible to oxidation or are potentially acid generating, then the facility needs to be designed to prevent or control oxidation to prevent acidic drainage throughout the life cycle. This implies designing and operating the facility, and implementing a closure strategy that will prevent exposure of the tailings to either water or oxygen. Options in such cases include a dry cover, a wet cover, or an elevated water table.

Flexibility is needed in closure planning, in the event that the operating phase is longer or shorter than originally anticipated.

A wide range of information should be considered in the development, updating and, ultimately, implementation of closure plans, including:

- risk assessment and risk management plan;
- design of the facility, including any deviations from the as-designed plans throughout the operations and ongoing construction phase;
- regulatory requirements, industry standards and guidance, corporate policy and objectives, and COI expectations;
- existing infrastructure, and infrastructure to be retained during closure and post-closure;
- tailings transportation and deposition plan;
- water management plan;
- OMS manual;
- physical and chemical characteristics of the tailings;
- topography;
- climate, including long-term climate change projections;
- hydrology;
- hydrogeology of surficial and bedrock units;
- soil conditions and geotechnical considerations;
- potential for revegetation, including access to seeds for native species; and
- availability of materials for reclamation.

Closure plans should address a wide range of topics related to the decommissioning of tailings-related infrastructure, measures to ensure the long-term physical and chemical stability of tailings facilities, and maintenance and surveillance plans for the long-term post-closure period, including:

- Progressive reclamation plan to address reclamation activities to be undertaken during the operations and ongoing construction phase of the life cycle;
- Decommissioning plan to address activities to be undertaken during the closure phase, including:
    - removal of infrastructure (e.g., tailings pipelines);
    - changes to water management, including construction of spillways;
    - changes to water treatment; and
    - recontouring of facilities;

- Reclamation and revegetation plan, including:
  - plan for stockpiling of overburden material for use in reclamation; and
  - revegetation requirements for tailings facility, including species to be used, and collection of plant or seed material;
- Long-term maintenance and surveillance plan, including:
  - assign accountability and responsibility;
  - commit resources (infrastructure, staff, budget) needed to implement the plan;
  - documented requirements for maintenance, including frequency of various activities;
  - detailed surveillance plan, including types of surveillance to be conducted, frequency of surveillance activities, and timeframe for continuance of surveillance (how many years/decades), and identification of types of surveillance that may be discontinued, with conditions to be met to discontinue;
  - conformance management plan, including action plans in cases of non-compliance or non-conformance with performance objectives, Owner's commitments, and regulatory requirements;
  - reporting (internal and external); and
  - COI engagement;
- Emergency preparedness and response plan for the closure, and post-closure phases; and
- Plan to ensure continuity of control of documented information.

Closure plans require a thorough re-assessment of facility and dam stability under closure and post-closure conditions. All aspects of the facility and dam stability must be reviewed. The actual performance of the dams in service, including deformation, seepage, foundation and sidewalls, should be checked against design projections as well as against projected post-closure conditions. Design loads might be different after decommissioning and closure.

A goal for closure often includes measures to lower the risk profile of a tailings facility and confining dams that will be required to function in perpetuity.

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