Guidance Document

Health, Safety and Reclamation Code for Mines in British Columbia

Version 1.0

Updated July 2016

Contents

Introduction

A revision of Part 10 of the Health Safety and Reclamation Code for Mines in British Columbia, 2016 (Code) was published on July 20, 2016. The Code revision was the product of work directed by the Ministry of Energy and Mines (MEM) and supported by the Tailings Technical Review Sub-committee to address seven recommendations made by the Independent Expert Engineering Review Panel following their review of the Mount Polley Tailings Facility Breach (January 30, 2015 final report on the Mount Polley tailings dam[1]), and contains new requirements for both existing mines that include tailings storage facilities under their Mines Act permit and for mine owners who plan to include tailings storage facilities in new Mines Act Permit applications.

This guideline has been established to provide specific guidance and context to owners, engineers of records, regulators, consultants and auditors on the Ministry of Energy and Mines' (MEM) expectations for the application of the Code, and to assist operations in understanding and complying with the Code when it comes to tailings management. Variances from the Code must be supported with appropriate engineering justification, and submitted for approval by the Chief Inspector.

An overview of the elements of a tailings management system is provided in this guideline. Although detailed instructions on developing and implementing specific elements are beyond the scope of this document, references are provided throughout. It is intended that periodic improvements will be made to this guideline as standards of practice advance and as MEM receives feedback from users.

The responsibility and authority for interpretation of this guideline rests with the Chief Inspector.

[1] https://www.mountpolleyreviewpanel.ca/final-report

1 Scope

This scope of this guideline is to:

- Provide guidance and context to owners, engineers of record, regulators, consultants and auditors on applying Part 10 of the Code;
- Provide references to existing provincial and national guidelines and acceptable standards of practice; and,
- Provide minimum expectations for compliance reporting required by the Code.

2 General

This guideline is intended to be general and not prescriptive in nature and provide context to clarify the Code requirements. Every site presents its own unique set of needs and challenges, and more conservative approaches than those outlined herein may be required in some cases.

2.1 Roles and Responsibilities

There are several key roles required under the Mines Act (the Act) and the Code to manage, design, build, operate and close a tailings storage facility (TSF).

Prior to conducting any work on a mine site, a mine owner must designate a Mine Manager under Section 21 of the Act, who must be present onsite daily and who is ultimately responsible for application of all requirements of the Code on the site. As such the Mine Manager is ultimately responsible for the safety of all TSFs on the site. The Code also requires the Mine Manager to designate a person to fulfill the role of a TSF Qualified Person, ensure each TSF has an Engineer of Record, ensure an Independent Tailings Review Board has been convened and fulfills its mandate, and is answers to the Chief Inspector on all issues of compliance with the Code on the mine site.

Aspects of the roles and responsibilities of individuals in those roles may vary according to the needs of the site, but defining the terms of reference should include consideration of the following:

Mine Manager (*Mines Act*)	- Manager is ultimately responsible for the mine as per Act/Code - Designated under Section 21 of the Mines Act - Accountable for all aspects of the performance and management of Tailings and Water Retaining Structures. - Responsible for compliance with regulatory requirements and relevant guidelines. - Responsible to submit all compliance reports to the required regulatory agencies by the due dates. - Defines site roles and responsibilities, authority and accountability. - Allocates required human and financial resources. - Reports dangerous occurrences including significant TSF or dam safety incidents to the Chief Inspector.
TSF Qualified Person (Code *10.4.2*)	- Develops and implements the tailings and water management plans for the TSFs under their supervision. - Coordinates the design, construction and overall management of tailings storage facilities on the site with the EoR as well as internal and external resources. - Develops succession plan for EoR. - Implements training programs for tailings and water management activities. - Implements the surveillance, inspection, monitoring and maintenance plan outlined in the Operations, Monitoring and Surveillance Manual (OMS). - Provides QPOs for operational and maintenance activities for inclusion in the OMS. - Reports to the Mine Manager regarding the status and performance of the Tailings Management System. NOTE: this role may be designated as a portion of an employee's or the Mine Manager's duties and may not necessarily be a separate position for all sites depending on the complexity of the TSFs.

Engineer of Record (EoR) -(Code *10.1.5*)

- Is a qualified and competent engineer with experience commensurate with the consequence classification and complexity of the facility.
- The responsibilities of the EoR must be assigned to an individual and not a firm. While there are benefits to retaining a third party engineer for this position, the position may be filled by an employee of the mine.
- Hold the professional responsibility for the facility design, and is responsible for evaluating the adequacy of the as-built facility relative to the design as well as applicable standards, criteria, and guidelines.
- Report on annual Dam Safety Inspections.
- Participates in Dam Safety Reviews.
- Participates in risk assessments.
- Provides Quantitative Performance Objectives and monitoring frequencies required to ensure the facility is functioning as designed for inclusion in the OMS.
- In the event of a change of the EoR, participates in implementing the succession plan, including understanding the risks and liabilities associated with such changes and employing appropriate change management procedures.

NOTE: An Engineer of Record is required to be designated once construction of a facility is underway. A TSF that is still in the planning and design phases does not require an Engineer of Record.

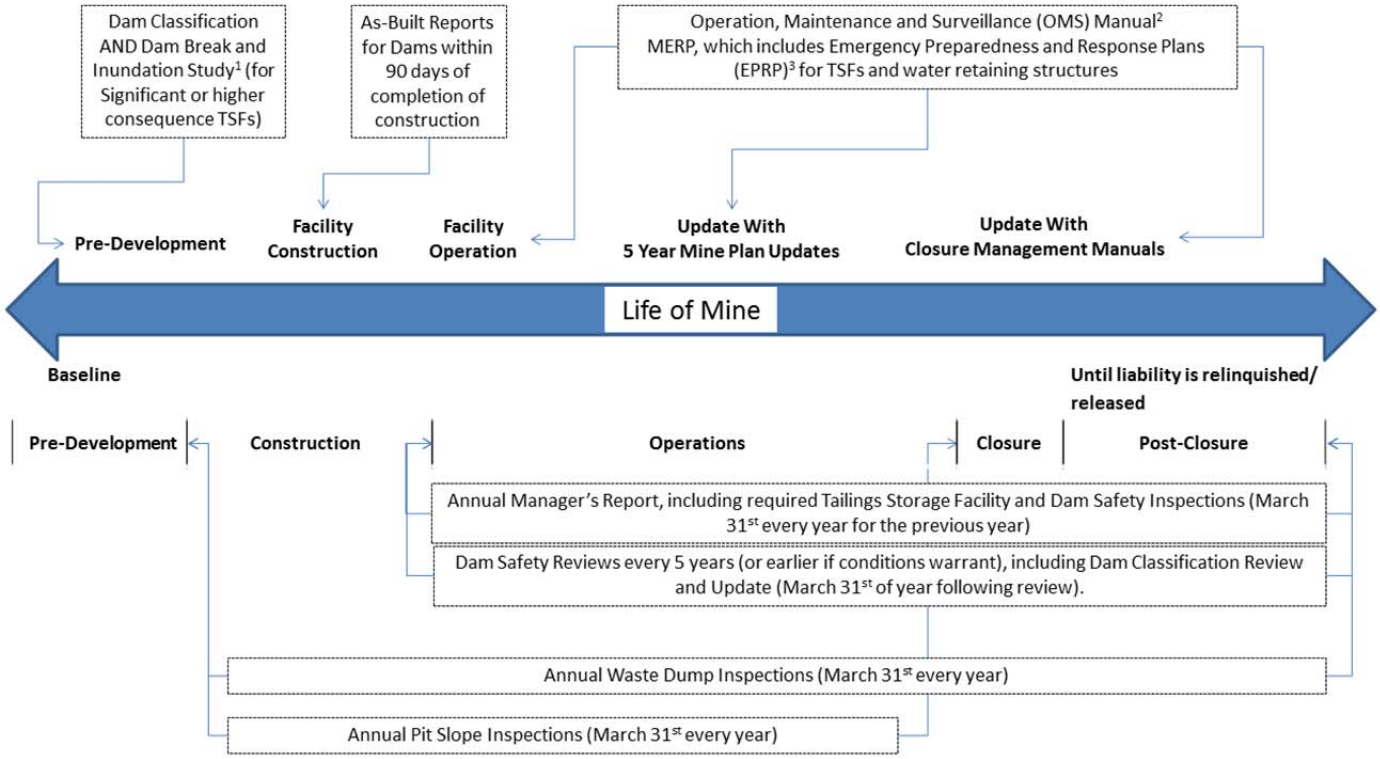
Independent Tailings Review Board (ITRB)-(Code *10.4.2*)

- Made up of independent subject matter experts not currently involved in or responsible for the design, operation or construction of the facility.
- Provides an independent assessment to senior mine management and regulators whether the tailings storage facility is designed, constructed and operated appropriately, safely and effectively.
- Provides the site team with practical guidance, perspective, experiences and standard/best practices from other operations.
- Reviews and comments on the planning and design process, monitoring programs, data analysis methodology and work performed by site team and/or contract consultants.
- Provides non-binding advice and guidance, but does not direct the work or perform the role of the Engineer of Record.
- Size and make-up of the ITRB based on complexity of the tailings system, in terms of risk, consequence and disciplines of substance.

Inspectorate	- Designated by MEM and the Chief Inspector of Mines to review applications and compliance reporting for completeness and technical reasonableness. - Conducts inspections of mine sites to assess and enforce compliance with the Code.

2.2 Life of Mine Reporting Requirements

Geotechnical Reporting Requirements – Life of Mine

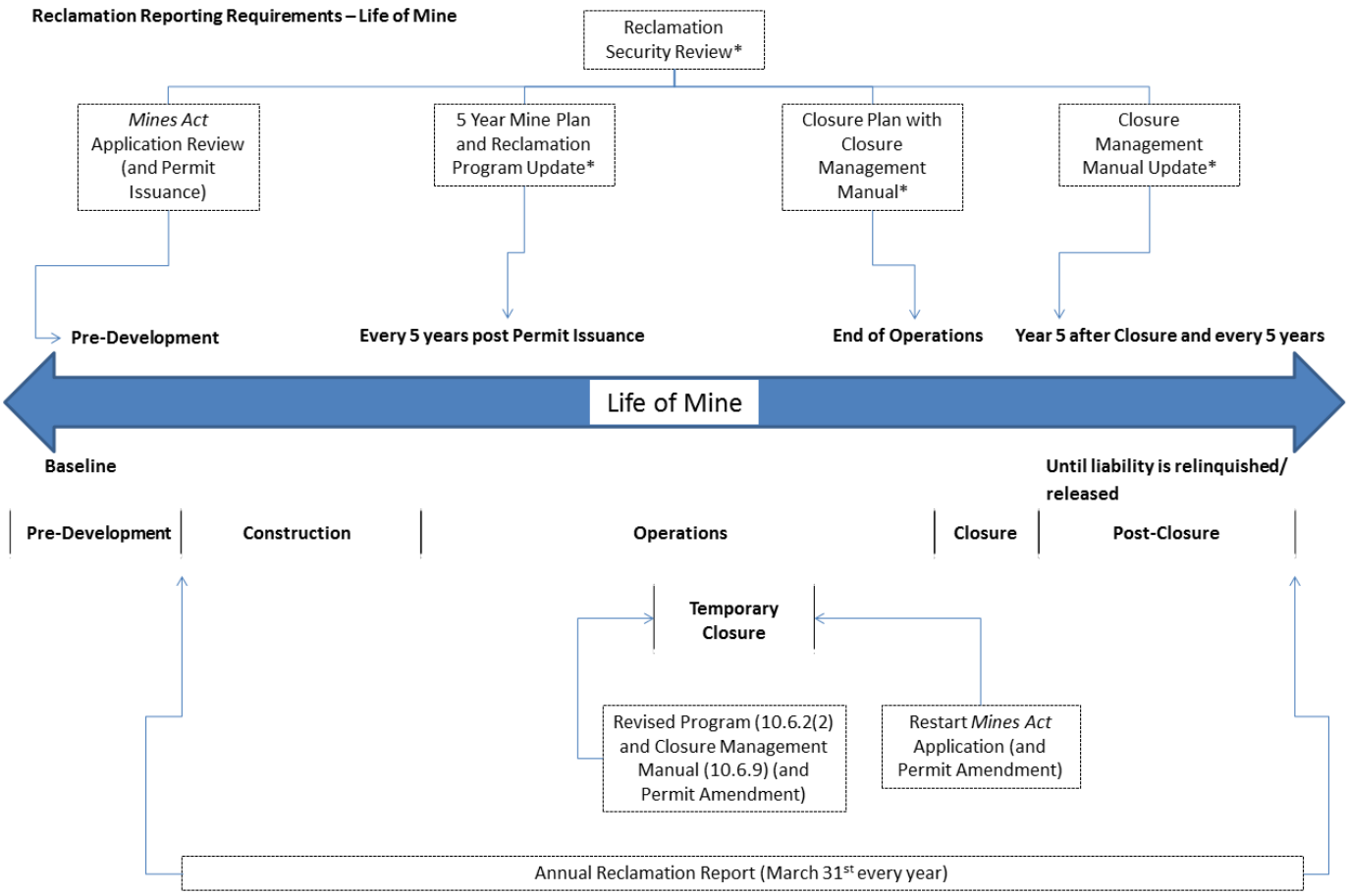


Note: Years on the Life of Mine Timeline are for illustration only. Mining phases vary for actual Mine Plans.

[1] Inundation Study requires update if Dam Classification changes.

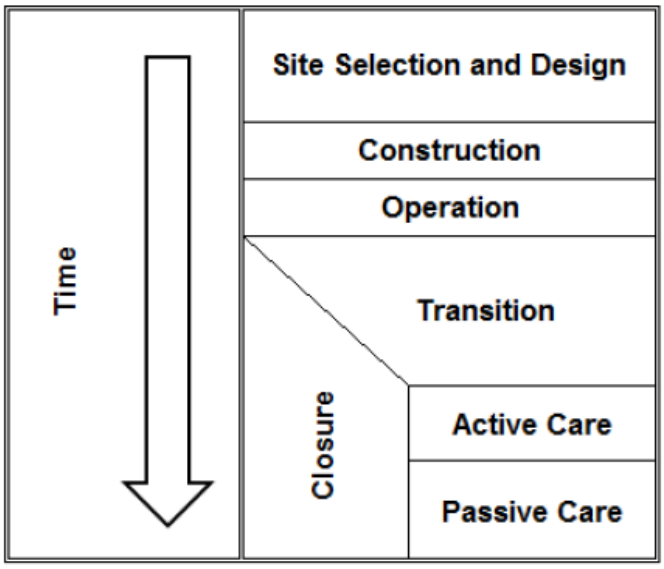
[2] Requires annual updates.

[3] Required annual updates and testing.



Note: Years on the Life of Mine Timeline are for illustration only. Mining phases vary for actual Mine Plans.
* Denotes may trigger a permit amendment.

Phases of a Mining TSF or dam.[2]



[2] Canadian Dam Association, Dam Safety Guidelines, Technical Bulletin – Mining Dams (DRAFT), Figure 2.1. September 2013.

3 Mines Act Permit Applications *(HSRC, 2016. 10.1.2-10.1.3)*

3.1 Alternatives Assessment

In order to demonstrate the selection of Best Available Technology (BAT), inclusion of an alternatives assessment is required in Mines Act Permit Applications that include one or more tailings storage facilities.

In an alternatives assessment, various design concepts, technical options and sites are weighted against each other to support a site selection and technology selection. Alternatives Assessments are of the most value when conducted early in the development or expansion process. The level of sophistication for the alternatives assessment should be commensurate with the scope and stage of the project, and this determination should be made in consultation with the design engineer.

The alternatives assessment provides a comparative analysis of options considering the following sustainability factors:

- Environment
- Society
- Economics

The assessment typically utilizes a multiple-accounts analysis procedure by which each alternative is rated using qualitative and quantitative indicators of the above factors. Selection of the number and scope of qualitative and quantitative indicators is typically commensurate with the scope and level of the project and available information, and is typically performed by a specialist consultant engaged for the project.

Selection indicators for large projects should be conducted in consultation with local communities, First Nations, and stakeholders in order to maintain a transparent, defensible evaluation.

The following guidance on setting objectives and targets are provided for consideration in design and operations:

- Physical stability is of paramount importance, and options that require a compromise to physical stability should be discarded,
- Facilities should be chemically and biologically stable, or be designed to mitigate transport of contaminants into the receiving environment,
- Footprint areas of the facility should be minimized,
- In-pit or underground backfill should be maximized,
- Impacts to receiving environments should be minimized,
- Post-closure land use objectives should be defined, including ecosystems support and productive uses for future generations where possible,
- All available technologies should be considered,

- Effort to reduce and remove water from containment within tailings facilities should be made,
- Alternatives to water covers should be considered in planning stages.

Constraints should be clearly stated, incorporated into the project design criteria or operating or closure performance criteria, and documented in the project design report or site OMS manual. Examples of constraints include, but are not limited to, the following:

- Topography
- Climate (precipitation and temperature significantly affect water balance)
- Geology
    - Geochemistry of tailings
    - Tailings rheology
    - Foundation conditions (faults, strength, etc.)
    - Groundwater seepage
    - Construction material availability
- Water supply and reclaim
- Power supply
- Property ownership/boundaries
- Proximity of downstream receptors
- Upstream and downstream activities
- Cumulative effects with other operations in region
- Transportation corridors
- Ore body location and configuration relative to potential TWRS locations
- Community perspectives
- Economics and financial feasibility

Procedural guidance can be found in Government of Canada guideline: *Guidelines for the Assessment of Alternatives for Mine Waste Disposal.* September 2013. (http://ec.gc.ca/Publications/default.asp?lang=En&xml=5ECBCE8B-7E50-49E3-B7AD-8C21A575E873)

3.2 Risk Assessment

No matter the size, construction and operation of a TSF introduces risks to the mine environment and any surrounding communities. It is critical that the risks associated with a TSF are appropriately characterized to inform design and operational objectives. As such risks should be identified, documented and managed to a level appropriate to the structure's consequence classification.

While risk assessments are required for all TSFs under the Code, MEM expects that facilities with a consequence classification of "High" or above will be subjected to a formal risk assessment performed by a suitably qualified, independent facilitator experienced with such facilities. The objectives of the risk assessment include, but may not be limited to:

- To identify all risks associated with the structure;
- To assess the impacts associated with those risks;
- To inform selection of design alternatives for assessment to select best available technology;
- To develop design objectives;
- To determine monitoring objectives

The International Organization for Standardization (ISO) provides the general process in *ISO 31000, Risk Management – Principles and Guidelines* (which can be purchased through the ISO website: http://www.iso.org/iso/home/standards/iso31000.htm). The process generally includes the following steps:

- Establish basis: define scope, objectives and acceptance criteria;
- Risk identification: establish the sources of the risk identification and identify potential impacts;
- Risk Analysis: Identify consequences and estimate likelihood for comparison with acceptance criteria;
- Risk Evaluation: Define consequences in terms of scale and cost, quantify uncertainties, identify gaps, and update a Risk Register;
- Risk Reduction: Employ Best Available Technology to mitigate or eliminate the risks and conduct additional work to reduce uncertainly and fill gaps.

Elements for consideration should be selected as appropriate for the scope and complexity of the structure and the site, and may include the following consequence categories:

- Facility or technical integrity
- Production Loss / Project schedule
- Labour
- Safety and health
- Environment and cultural values
- Infrastructure and economics (off site)
- Legal and regulatory
- Reputation
- Financial Impacts

Risk assessments incorporate elements of uncertainty (typically by increasing the assigned probability), and consider inherent risk (natural state), current risk (with existing controls in place) and mitigated risk (with proposed management plan in place).

3.3 Design Standards for Tailings Storage Facilities (TMF) and Associated Infrastructure

The Code requires designs and assessments be performed and documented to demonstrate that TSFs, dams, foundations and abutments are designed, constructed, operated and maintained to accepted industry standard of practice to give confidence that they will remain stable under all credible hazards, failure modes, loading conditions and combinations thereof. To meet this, engineering designs and assessments must be performed under the direction of suitably qualified and experienced professionals. For tailings storage facilities and water storage dams, this means the facility must be designed by a Professional Engineer and that an Engineer of Record must be designated for all facilities which are operating or under construction. Designs and the associated assessments are the responsibility of the Engineer of Record.

In situations where the Best Available Technology for a site involves a dam, there are many professional groups that supply guidance around the design process for these critical structures. This guidance is updated regularly and generally reflects the standard of practice of the day, and the Code requires these standards be considered during the design process. This guidance includes:

- Canadian Dam Association (CDA) Dam Safety Guidelines[3], and 2014 technical bulletin: "Application of Dam Safety Guidelines to Mining Dams"[4], ICOLD, BCMLARD, BC Dam Safety Guidelines (FLNRO), GARD guideline for acid rock drainage (provide link to)

These guidance documents present the minimum design standards and principles for aspects related to mining dams, including, but not limited to:

- Risk based design principles,
- Inflow Design Flood,
- Earthquake Design Ground Motion,
- Freeboard,
- Factors of safety,
- Consequence classification

These design guidelines and principles for risk management should be applied to both operating and closure conditions. It is worth noting that the Code lays out required minimum design criteria for seismic and flood design (*HSRC, 2016. 10.1.7),* criteria for design slopes (*HSRC, 2016. 10.1.8)*, and minimum static factor of safety (*HSRC, 2016. 10.1.9).*

Where tailings storage facilities do not require dams, such as in the case of dry-stack TSFs, other standards and guidelines may be applicable.

Performance of designs and assessments is the responsibility of the Engineer of Record.

[3] http://www.cda.ca/
[4] Ibid.

3.3.1 Design Criteria

There are some differences in Code requirements between water dams and dams that impound tailings. Water dam designs are expected to consider the minimum recommended criteria laid out in CDA guidance, based on the consequence classification of the dam. Dams impounding tailings are required to meet minimum design criteria laid out in the Code. These minimum requirements are summarized in Table 3-1 and Table 3-2.

Table 3-1 Minimum Design Criteria for Water Dams

Dam Class	Annual Exceedance Probability - Floods	Annual Exceedance Probability - Earthquakes	Minimum Static Factor of Safety			Downstream Slope No Steeper Than
			End of Construction	Long term	Full or Partial Drawdown	
Low	1/100	1/100	1.3	1.5	1.2 - 1.3	Not Specified
Significant	Between 1/100 and 1/1000	Between 1/100 and 1/1000				
High	1/3 between 1/1000 and PMF	1/2475				
Very High	2/3 between 1/1000 and PMF	½ between 1/2475 and 1/10,000 or MCE				
Extreme	PMF	1/10,000 or MCE				

Note: Adapted from CDA Dam Safety Guidelines, 2013. Further context and guidance provided there

Table 3-2 Minimum Design Criteria for Tailings Dams[1]

Dam Class	Annual Exceedance Probability – Floods[2]	Annual Exceedance Probability - Earthquakes	Minimum Static Factor of Safety			Downstream Slope No Steeper Than
			End of Construction	Long term	Full or Partial Drawdown	
Low	1/3 between 1/975 and PMF	1/2475	1.5	1.5	1.5	2H:1V
Significant	1/3 between 1/975 and PMF	1/2475				
High	1/3 between 1/1000	1/2475				

	and PMF					
Very High	2/3 between 1/1000 and PMF	½ between 1/2475 and 1/10,000 or MCE				
Extreme	PMF	1/10,000 or MCE				

Note: 1) Adapted from CDA Dam Safety Guidelines, 2013. Further context and guidance provided there.

2) The Code required that a facility that stores the inflow design flood use a minimum event duration of 72 hours.

Failure modes that are to be assessed with specific analyses for both operating and closed facilities include, but are not limited to:

Geotechnical:

- Slope Stability
- Seepage
- Internal erosion and piping
- Static and dynamic liquefaction
- Characterization of the footprint area as well as upstream areas,
- Site-specific seismic hazards,
- Minimum acceptable factors of safety,
- Long-term consolidation settlements,
- Short-term and long-term deformations.

Hydrotechnical:

- Flow capacity
- Surface erosion
- Water balance

Hydrogeological:

- Hydraulic fracturing
- Seepage through the foundation and abutments

Geochemical:

- Acid generation from tailings or dam construction materials
- Metal leaching from tailings or dam construction materials
- Water treatment effectiveness and capacity

Mechanical:

- Tailings transport pressure and flow capacity
- Water conveyance pressure and flow capacity

Loading conditions that should be considered in stability analyses include:

- Initial and interim and long-term construction stages,
- Impounding of water,
- Impoundment of tailings,
- Rapid drawdown (if possible for the facility),
- Earthquake impact on dam,
- Earthquake induced liquefaction of retained tailings,
- Extreme climatic events (precipitation, temperature and wind).

3.3.2 Site Characterization Guidelines (*HSRC, 2016. 10.1.4(3)*)

The Professional Practice Guidelines – Site Characterization Assessments for Dam Foundations in BC has been developed by the Association of Professional Engineers and Geoscientists of BC (APEG BC) in response to Recommendation 6 in the Report on Mount Polley Tailings Storage Facility Breach prepared by the Independent Expert Engineering Investigation and Review Panel (Panel Report).

For non-dam infrastructure, the objectives and the decision-making process for determining the extent and scope of the associated site characterization assessment described in the APEG BC Professional Practice Guideline should still be considered in the development of the investigation program.

The Site Characterization Guidelines will be available on the APEG BC website

3.4 Consequence Classification (*HSRC, 2016. 10.1.6)*

Consequence classifications of each structure are to be maintained in the site inventory of dams and water retaining structures, reviewed as part of the annual inspection, and updated in the event of a change in downstream conditions. Embankments containing solids (e.g. sludge ponds) are considered dams if the contents are liquefiable and if the retaining structure meets the definition of a dam.

In-situ "pillars" of natural ground being used to retain water or tailings as a part of the mine operations are considered the same as a constructed embankment and should be classified as a dam, unless it can be demonstrated that there is no potential for the pillar to fail due to overtopping, piping, slope failure or other failure mode that results in an unexpected or undesirable release of contents.

The Code requires that tailings storage facilities that store water or saturated tailings use more conservative design criteria than those provided by CDA, as outlined in HSRC, 2016. 10.1.7.

Information for water dams in B.C. can be found on the Ministry of Forests, Lands and Natural Resource Operations page for Dam Safety.

Table 3-3 Dam Classification (from CDA Dam Safety Guidelines 2013)

Dam Class	**Population at risk**	**Incremental losses**		
		Loss of life	Environmental and cultural values	Infrastructure and economics
Low	None	0	Minimal short-term loss or No long term loss	Low economic losses; area contains limited infrastructure or services.

Dam Class	Population at risk	Incremental losses		
		Loss of life	Environmental and cultural values	Infrastructure and economics
Significant	Temporary only (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities)	The appropriate level of safety required depends on the number of people, the exposure time, the nature of their activity, and other considerations.	No significant loss or deterioration of fish or wildlife habitat, OR Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent - Ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	10 or fewer	Significant loss or deterioration of important fish and wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent - Ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	100 or fewer	Significant loss or deterioration of critical fish and wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent - Ordinarily located in the dam-breach inundation zone (e.g., as permanent residents)	More than 100	Major loss of critical fish and wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

The Code requires that a dam breach and inundation study or a run-out analysis conformant to CDA requirements be conducted to support the dam classification (HSRC, 2016. 10.1.10).

TSFs that do not include dams should still be classified according to their consequence, and with consideration of the losses outlined in **Error! Reference source not found.**, though the modes of failure and the methods for determining impacts of failure will be different. The methods for determining the impact of failure for TSFs that do not include dams should be determined by the Engineer of Record.

3.5 Mines Act Permit Application Information Requirements

Mines Act Permit Application Information Requirements can be found in the MEM/MOE document *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits*. Feb. 2016 (http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/permitting/minesact-ema_application_information_requirements_feb2016.pdf).

With regards to tailings storage facilities a Mines Act application should:

- provide TMF plans and sections at appropriate scales, showing the proposed tailings impoundment facility (dam heights, dam slopes, foundation slopes, construction materials, etc.) and dam profiles projected over the life of the mine;
- provide descriptions of the main construction materials, method of construction, and characteristics of the foundation materials;
- provide results of the geotechnical site investigation program, confirming primary design features and foundation conditions at the dam locations;
- identify any findings that are significantly different from what was predicted during the Environmental Assessment—if there are significant differences, explain whether or not design modification(s) or other forms of mitigation are proposed to address this;
- provide supporting data from the geotechnical field investigations, associated laboratory work, and stability/sensitivity analyses demonstrating input parameters and associated factors of safety in an appendix;
- provide descriptions of
    - any water diversion structures and spillways,
    - tailings properties,
    - seepage rates and seepage management, addressing any potential for groundwater contamination and plans to monitor and mitigate, and
    - geohazards that could influence the TMF and how these have been accommodated in the design;
- provide a monitoring plan for all embankments, including number and type of instrumentation, movement and piezometric thresholds and response; and

3.5.1 First Nations Established and Asserted Treaty Rights

A description of the First Nations established and asserted rights is required when preparing a Mines Act permit application or permit amendment application as noted in part 10 requirements 10.1.3 (c). This includes a description of information on recognized First Nations within the requested permit application and area and their established or asserted treaty rights.

Information is available from a variety of public sources including the CAD (consultative areas database) on the government of B.C. website or by contacting the First Nations directly.

3.5.2 Sediment Ponds and Diversion Structures

A memorandum of understanding[5] between the MEM and the Ministry of Forests, Lands and Natural Resource Operations exists regarding the regulation of impoundments and diversion structures at mine sites. This document provides clarification about which agency is responsible for the various types of impoundments, ponds and diversion structures that may be required on a mine site and when a licence under the *Water Act* may be required.

Applications should provide:

- descriptions of embankment heights/excavation depths, slope angles, storage capacity and method of construction for all dams and impoundments;
- results of geotechnical and other site investigation including foundation conditions and soil properties;
- descriptions of embankment construction materials and borrow source locations;
- stability assessment(s), including factors of safety and associated strength parameters;
- a plan for any proposed instrumentation or monitoring;
- reference to the Canadian Dam Association, Dam Safety Guidelines where appropriate, including consequence classification, seismic design criteria, inflow design flood, etc.;
- sediment pond design consistent with the "Guidance for Assessing the Design, Size and Operation of Sedimentation Ponds Used in Mining"[6];
- descriptions of the depth, width, slope angles and materials for any diversion ditches and channels;
- hydraulic capacity and confirmation that all ditches/channels can safety convey the design flood in accordance with CDA Dam guidelines[7] (minimum 1:200 years) without overtopping, side slope failure or significant erosion;
- descriptions of any required lining or armouring of ditches or channels; and

[5] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/developing-a-mine/mou_impoundments_diversions.pdf
[6] http://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/settling_ponds.pdf
[7] http://www.cda.ca/

- an assessment of geohazards that could influence the diversion ditches or channels and proposed mitigation measures.

3.5.3 Waste Rock Storage Facilities

Applications should also:

- provide plans and sections detailing proposed waste rock dumps, projected over the life of mine (information on lift heights, maximum dump heights, storage capacity, slope angles, and foundation angles should be provided);
- describe final post-mine waste rock dump configurations following resloping;
- summarize results of geotechnical and other site investigations, including foundation conditions and laboratory testing;
- provide geotechnical stability assessment and sensitivity analyses, including factors of safety and associated strength parameters;
- provide failure modes effects assessments for each facility, including potential for generation of debris flows or flow slides if dumping in or near channels, and assessment of run-out potential with consideration of Part 6.10.1(7) of the Code;
- describe how waste rock dumps will be designed and constructed, including method(s) of disposal and any proposed cover and/or drainage collection system(s) to address potential ML/ARD with cross references to the relevant ML/ARD subsections of the application that address this in greater detail;
- describe operating practices, including any proposed special handling, with cross-references to relevant ML/ARD subsections if applicable;
- ensure that all waste dumps are designed for geotechnical stability with reference to the "Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee"[8], and provide the risk classification (these guidelines are dated and should be considered minimum criteria);
- address potential for groundwater contamination, and present and discuss plans to monitor and mitigate groundwater contamination;
- describe stripping requirements of topsoil and organics to enhance spoil stability and to accommodate reclamation efforts—if topsoil or organics must be left in the footprint of the spoil, this decision must be rationalized, and stability analyses must account for potential sliding on the topsoil layer (if applicable); and
- provide a preliminary monitoring plan for all waste rock storage facilities, including proposed instrumentation, movement thresholds and response.

4 Construction and Operations

4.1 Annual Manager's Report (*HSRC, 2016 .10.4.4)*

The additional information required by the Chief Inspector under HSRC, 2016, Clause 10.4.4 (g), includes the following for TSFs:

- Summary of design and construction works from the year
- Planned design and construction works for the following year
- Schedule for the following year
- Update on Life of Mine operation and construction plans and schedule
- Summary of OMS/EPRP updates
- Summary of open engineering recommendations, regulatory orders and permit conditions and status of each recommendation, including schedule to address
- Summary of dangerous occurrences including significant TSF or dam safety incidents that that occurred during the year
- Updated dam inventory
- Tailings Facility and Dam Safety Inspection Report (see section 3.2)
- Update on risk management activities

4.2 Annual Tailings Facility and Dam Safety Inspection Report (*HSRC, 2016. 10.5.3)*

The purpose of a Tailings Storage Facility Inspection, Water Management or Dam Safety Inspection is to review and evaluate the adequacy of performance and operation of the overall facility, with specific attention on short-term physical condition and surveillance results. The report shall be prepared by the EoR but the inspection may be conducted by either the EoR or the EoR may designate a qualified geotechnical engineer registered as a Professional Engineer (P.Eng.) in British Columbia to perform the inspection on their behalf. These reports are submitted with the owner, agent or manager's annual reporting due on March 31 of the following year, per the Code clause 10.4.4.

All TSF and water retaining dams must have annual inspection. All inspection reports will be posted and made available publically.

Deficiencies, non-conformances and opportunities for improvement identified during the inspection shall be prioritized with recommended timelines for completion, and action plans developed.

Different types of tailings storage facilities may require different information. The Code differentiates between two general types of tailings storage facility:

1. TSFs that store water or saturated tailings.
2. TSFs that cannot retain water or saturated tailings (i.e. dry-stack).

At a minimum, the following information should be provided in the Annual Inspection Report.

INFORMATION REQUIREMENT	FACILITIES THAT IMPOUND WATER OR SATURATED TAILINGS	FACILITIES THAT CANNOT IMPOUND WATER OR SATURATED TAILINGS
1. Executive Summary	✓	✓
(a) Summary of Facility Description.	✓	✓
(b) Summary of key hazards.	✓	✓
(c) Consequence Classification.	✓	✓
(d) Summary of significant changes (e.g. construction, development downstream, etc.).	✓	✓
(e) Significant changes in instrumentation and/or visual monitoring records.	✓	✓
(f) Significant changes to stability and/or surface water control.	✓	✓
(g) Summary of review of the OMS manual.	✓	✓
(e) Summary of review of the Emergency Preparedness and Response Plan.	✓	✓
(f) Scheduled date for the next formal Dam Safety Review in accordance the Code and the CDA Dam Safety Guidelines (2013).	✓	×
(g) Summary of recommendations	✓	✓
2. Facility Description	✓	✓
(a) Description of facility components.	✓	✓
(b) History of key construction milestones.	✓	✓
(c) Summary of past years' construction (if any) with a description of any problems and stabilization.	✓	✓
(d) Summary of past years	✓	✓

INFORMATION REQUIREMENT	FACILITIES THAT IMPOUND WATER OR SATURATED TAILINGS	FACILITIES THAT CANNOT IMPOUND WATER OR SATURATED TAILINGS
operation (tailings deposition, etc.)		
3. Identification of Engineer of Record and TSF qualified person.	✓	✓
4. Updated plan and representative cross sections.	✓	✓
5. Site photographs.	✓	✓
6. Review of climate data.	✓	✓
7. Water balance review and reconciliation.	✓	×
8. Freeboard and storage availability (in excess of the design flood).	✓	×
9. Water discharge system, volumes, and quality.	✓	✓
10. Seepage occurrence and water quality.	✓	✓
11. Surface water control and surface erosion.	✓	✓
12. Instrumentation review including:	✓	✓
(a) Phreatic surfaces and piezometric data.	✓	✓
(b) Settlement.	✓	✓
(c) Lateral movement.	✓	✓
13. Recommendations	✓	✓

Recommendations are expected to be specific, measurable, attainable, and time-bound. They should be prioritized by the Engineer of Record and tabulated. The table should contain the following information:

Structure	ID#	Deficiency or Non-Conformance	Applicable Regulation or OMS reference	Recommended Action	Priority	Recommended Deadline/Status
Tailings Pond #1						
Tailings Pond #2						

Note: must include status of previous DSI recommendations, unless status was “closed” in previous DSI.

Priority	Description
1	A high probability or actual dam safety issues considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected, could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that along would not be expected to result in dam safety issues.
4	Best Management Practice – further improvements are necessary to meet industry best practices or reduce potential risks.

4.3 Emergency Preparedness and Response (*HSRC, 2016. 10.4.2 (e)*)

The Code requires that an emergency preparedness and response plan (EPRP) for TSFs be documented, updated annually and tested on a frequency suitable for its consequence classification for response and recovery from specific incidents. This plan complements and functions in parallel with any other site emergency response and crisis response plans, and as such the Code requires that the tailings EPRP be merged and integrated with the Mine Emergency Response Plan (MERP).

An EPRP considers the specific credible failure modes and consequences identified in the structure-level risk assessment(s) and identify potential mitigations and responses accordingly.

Emergency Preparedness activities may include the following[9]:

- Implementing Warning Systems
- Implementing Alert Levels
- Community outreach
- Stockpiling materials (rip rap, pipe, etc.)
- Available resources
- Mutual Aid Agreements
- Maintaining access
- Tracking hazards (e.g. storm warnings)
- Training
- Contingency plans
- Return to operation plan
- COI consultation & public relations plan
- Testing of Response Plan

An EPRP may include the following:

[9] Canadian Dam Association Guidelines, Section 5.0, 2007.

- Communication systems & procedures
- Response flow chart & call-out procedures including community outreach
- Mitigation actions for different failure modes
- Flood management plan
- Incident Investigation procedure.

The current MERP template is available here:

http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/merpguidelines.pdf

4.4 OMS Manual (*HSRC, 2016. 10.5.2)*

The Code requires that mines develop and implement operational procedures, maintenance procedures and a surveillance and monitoring program to safely operate and monitor the condition and performance of TSFs, dams, structures and associated facilities in order to avoid or detect and address any changes, deterioration or hazardous conditions. It is required that these operation and maintenance procedures and surveillance and monitoring programs be formally documented in an Operations, Maintenance and Surveillance (OMS) manual. The OMS is not just a document for the engineer of record and mine manager. It is also an important tool for the individuals on the ground, who work on any operational aspect of the tailings facility within the tailings management system. All workers involved in tasks related to tailings should be trained in the contents and use of the OMS manual.

MEM expects that operational controls conform to industry standards of practice[10,11] and that the OMS manual will outline specific requirements, frequencies and procedures for the following:

- Resources – financial and staffing
- Surveillance & monitoring (see Section 4.4.1)
- Quantitative performance objectives and associated trigger-action response plans
- Routine Maintenance
- Event-Driven Maintenance
- Standard Operating Procedures
- Safe Work Plans
- Construction Quality Control
- Incident reporting procedures
- Non-compliance reporting procedures
- Developing and implementing effective operational controls are the responsibility of the superintendent responsible for tailings.

[10] Canadian Dam Association, Dam Safety Guidelines
[11] Mining Association of Canada, Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities, 2011.

Developing and implementing an effective surveillance and inspection program and OMS manual are the responsibility of the Mine Manager, should be coordinated by the Tailings Qualified Person with input from and review by the EoR.

The Code requires that the OMS Manual be reviewed annually or following a significant change in conditions or operations, and updated as required.

Reference MAC Guideline: *Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities*. 2011.

4.4.1 Surveillance and Monitoring (*HSRC, 2016. 10.1.12*)

The purpose of the surveillance and monitoring program is to provide positive confirmation of adequate performance of the facility, including containment, stability and operational function by observing, measuring and recording data relative to potential failure modes.

MEM expects that a surveillance & monitoring program, including any instrumentation, installations and procedures be developed and implemented in conformance with industry standard of practice[12] and local regulatory requirements, and documented in the OMS Manual.

Surveillance and monitoring program includes the following:

- Surveillance and monitoring quantitative performance objectives (QPOs)
- Instrumentation and installation details (e.g. location, type, etc.)
- Surveillance and monitoring frequencies, schedules and procedures (e.g. daily, weekly and monthly inspections or instrument readings)
- Instrumentation reading procedures
- QPOs related to alert levels
- Sampling and testing locations and procedures
- Sampling and testing parameters and thresholds
- Event triggers for increased or changes to monitoring and surveillance
- Data collection, analysis and reporting procedures

Requirements for instrumentation installations and frequency of inspections and measurements should be based on the consequence classification of the facility. Where the requirements are not defined by regulatory requirements or permit conditions, the Engineer of Record defines the requirements.

MEM expects that surveillance and monitoring data will be collected, analysed and reported in a timely fashion. Instrumentation will be installed during construction and as the facility is raised in order to:

- Monitor dam, foundation and abutment performance over time and relative to design assumptions.

[12] Dunnicliff, J. Geotechnical Instrumentation for monitoring Field Performance, 1988.

- Provide performance information regarding displacement, pore pressures, settlement, deformation, stresses and flow rates.
- Continually improve the monitoring system to meet or exceed a continually evolving industry standard of practice.

Instrumentation represents a substantial financial and time investment, and serves as a vital link in understanding TSF and dam performance and safety. Therefore, any instrumentation should be justified, serve a specific purpose, and be protected or replaced in a timely manner in order to maintain continuity and confidence in the facility performance. Any damaged instruments should be reported immediately to the EoR, and if they are still required to maintain sufficient monitoring coverage they should be replaced promptly.

4.5 Register of Tailings Storage Facilities and Dams (*HSRC, 2016. 10.4.3)*

The register should contain all tailings and water retaining structures on site, regardless of whether or not they are classified as dams and regardless if they are currently operating or dormant structures.

At a minimum, the site inventory should contain the following key information. The inventory template is being developed and will be made available as soon as complete. Information collected may include the following:

- Structure location, function and geometry
- Consequence classifications (CDA and local)
- Site and EoR contact information
- Status of supporting documentation (permits, OMS manual, etc.)
- Inspection & review frequency
- Slope and Factor of Safety for the dams

4.6 Periodic Safety Reviews (*HSRC, 2016. 10.5.4)*

A valuable and important tool in ensuring the ongoing safety of engineered structures is the detailed review of the design, operation and performance of those structures by an independent experienced Professional Engineer. The Code now requires that all water storage facilities and tailings storage facilities undergo a Safety Review at a minimum every 5 years regardless of consequence classification.

For facilities that include a dam, these Periodic Safety Reviews are called Dam Safety Reviews, but tailings storage facilities that do not impound water are also subject to Periodic Safety Reviews.

The process and objectives for a Dam Safety Review, or DSR, are well laid out in guidance from CDA (Dam Safety Guidelines, 2013) and APEGBC *(Legislated Dam Safety Reviews in BC.* V2.0. March 2014.

(https://www.apeg.bc.ca/getmedia/a373a764-1869-41b5-b07d-81d36a0698c3/APEGBC-Legislative-Dam-Safety-Reviews.pdf.aspx). The purpose of the DSR is to review and evaluate the performance and operation of the facility relative to dam safety standard of practice. The DSR will be performed by an independent third party consulting firm not previously involved as Engineer of Record (EoR) for the facility. While CDA recommends a frequency for conducting DSRs based on the consequence classification, as stated above the Code requires that a DSR be conducted at a minimum every 5 years .

Periodic Safety Reviews for tailings storage facilities that do not impound water, such as dry-stacks, may not have the same types of associated infrastructure as a dam, but the general process laid out in the cited guidance from CDA and APEGBC should be adapted to achieve the same objectives.

4.7 As-Built Report (*HSRC, 2016. 10.5.1 (3)*)

The As-Built Report is the mechanism by which the Engineer of Record confirms that a constructed facility meets the intent of the design and certifies the facility as suitable for operation. It also compiles valuable documentation of the construction methodology, quality control and quality assurance results, and survey details of the final structure.

MEM expects that at a minimum As-Built reports should include:

- Statement that structures were constructed in accordance with design, meet the intent of the design, and are suitable for use;
- Details of pre-stripping and foundation preparation;
- Mapping of foundation materials (i.e. were unexpected soils encountered?);
- Materials used in construction;
- Method of construction;
- Summary of all QC/QA testing, including but not limited to: grain size analysis, proctor testing, *in situ* density testing, plasticity testing, strength testing and geosynthetic materials testing;
- Comment on adequacy of testing frequency and results;
- Surveyed plans;
- Representative cross-sections;
- Representative photographs;
- Location, types, and depths of instrumentation (compare with what was recommended in the design and rationalize any significant changes);
- Construction observations;
- Deviations from the design, and impact of those deviations;
- Non-conformances, if required;
- Outstanding works, if required, with target completion dates;
- Start date and end date of construction ;
- Weather during construction, including periods of shutdown due to weather;
- Dates of field review by engineer (or by a person reporting to the engineer);

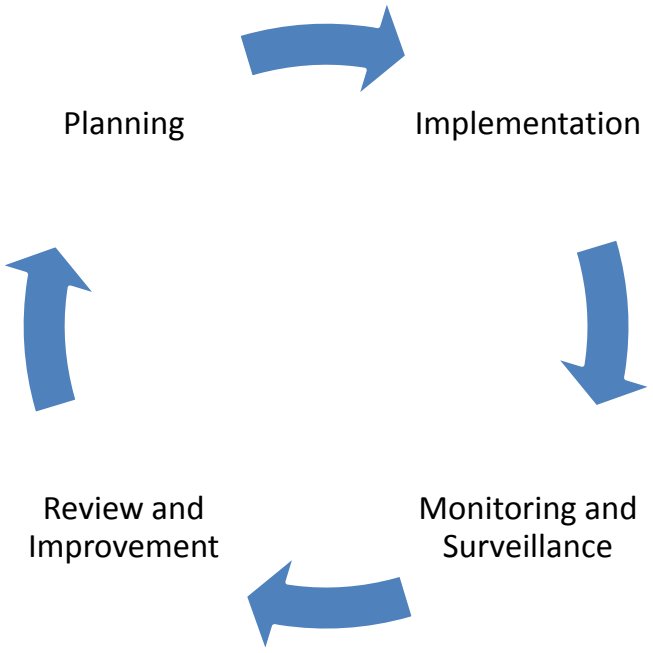
The report must be signed and sealed by the Engineer of Record.

4.8 Tailings Management System (*HSRC, 2016. 10.4.2(1)*)

The code requires mines to develop and implement a management system that defines how the mine will manage the tailings storage facility and which includes regular system audits. Several bodied provide guidance of how to develop a tailings management system, including:

- The Mining Association of Canada (MAC). *A Guide to the Management of Tailings Facilities*. Second Edition, 2011.
- The International Organization for Standardization (ISO-14000).
- Governments of Australia and New Zealand.

Regardless what kind of system works best for a particular mine, the key is that the management system be a framework for continually improving the process of building, operating and maintaining a tailings storage facility by adhering to a cycle of:



The key elements of a system for managing tailings comprise the following:

- Planning
- Risk Identification and Management
- Operational Controls
- Communication & Reporting
- Review & Corrective Actions
- Documentation & Records
- Emergency Preparedness and Response Planning

Some general recommendations for an effective management system for tailings and water retaining structures include the following:

- Structures will be managed with a level of effort appropriate to their consequence classification.
- For operations with multiple TSFs, including structures at various life phases, management systems and functions common to all structures should be documented in a single tailings management system manual, with structure specific details and operational controls contained in individual operation, maintenance and surveillance (OMS) manuals.
- The tailings management system should be developed, implemented and updated considering industry standard of practice.
- The tailings management system should be developed considering and complementing without duplicating the site Environmental Management System (EMS), which is expected to have been developed in conformance with ISO 14001.
- The system elements can be developed by operations personnel or suitably experienced external consultants, and shall be reviewed by the appropriate site stakeholders throughout the development process.
- The audits of the tailings management system should be conducted by an independent body, the results should be documented, maintained onsite, and provided to the Chief Inspector on request. Findings should be incorporated in a comprehensive review and update of the system. Audits should, at minimum, occur annually.

Development, implementation, annual review and update of the tailings management system manual is the responsibility of the Mine Manager, and is implemented by the TSF Qualified Person under the guidance and authority of the Mine Manager.

4.8.1 Documents (*HSRC, 2016. 10.4.2(1))(f)*)

The TSF qualified person shall be responsible for maintaining tailings documentation and records and ensuring they are integrated into a site document control system. Key documents and records to be retained are summarized in Table 5.8.1-1.

Table 4.8.1-1: Records Retention for Tailings and Water Facilities

Record	Retention
Design Documents	Permanent
TWRS Structure Inventory	Permanent
Permits & Licenses	Permanent
Regulatory Submissions & Responses	Permanent

Tailings & Water Management Plans	10 + years
Closure Plan	10 + years
Construction QA/QC and As-built reports	Permanent
OMS Manual	As revised
Training Records	5 years
Instrumentation and monitoring data	10 years
HSEC Incident & Inspection Reports	10 years
COI Communications	10 years
Monthly Reports	10 years
Annual Reports	10 years
Inspections and reviews (DSI, DSR)	10 years
Audits and independent reviews	10 years

5 Reclamation and Closure

5.1 Reclamation and Closure Plan

A Reclamation and Closure Plan describes how a mine will be reclaimed and closed to return the mine site to an environmentally stable condition suitable for future land uses.

Elements of a Reclamation and Closure Plan

A reclamation and closure plan should address, but not be limited to, the following:

- reclamation objectives, including closure design criteria;
- the progressive reclamation of the site during the life of the operation;
- the removal or stabilization of any structures and workings;
- the design of tailings and waste rock disposal areas;
- the reclamation and re-vegetation of the surface disturbances wherever practicable;
- methods for protection of water resources;
- a temporary closure plan;
- a cost estimate of the work required to close and reclaim the mine; and
- a plan for ongoing and post-closure monitoring and reporting at the site. A plan should include the establishment of thresholds and identified adaptive management responses should such thresholds be reached.

The mine manager must file an annual report stating what progressive reclamation has been accomplished and the results of environmental monitoring programs.

6 Abbreviations

CDA	Canadian Dam Association
COI	Community of Interest
EDF	Environmental Design Flood
EDGM	Earthquake Design Ground Motion
EPR	Emergency Preparedness and Response
EoR	Engineer of Record
ERP	Emergency Response Plan
FLNRO	Ministry of Forests, Lands and Natural Resource Operations
FS	Feasibility Study
HFMEA	Hazard, Failure Mode and Effect Assessment
HSEC	Health, Safety, Environment and Community
HSEC RMC	Health, Safety, Environment and Community Risk Management Committee
IDF	Inflow Design Flood
ITRB	Independent Tailings Review Board
MAC	Mining Association of Canada
MEM	Ministry of Energy and Mines
OMS	Operations, Maintenance and Surveillance
PDG	Project Development Group
PFS	Pre-Feasibility Study
PPM	Project Procedures Manual
RA	Regulatory Approval