November 25, 2016

BC Ministry of Energy and Mines
6th Floor – 1810 Blanshard St.
Victoria, British Columbia
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Michelle Hynes
Senior Policy Analyst, Mines and Mineral Resources Division

Dear Ms. Hynes:

MEM Support
Comparison of Mining Legislation and Guidelines in British Columbia, Alaska and Montana

1 INTRODUCTION

The Ministry of Energy and Mines requested this review to compare the recently updated *Health, Safety and Reclamation Code for Mines in British Columbia* (updated in July 2016) with legislation and guidelines related to tailings dams in other jurisdictions to confirm the British Columbia code represents the best practice for mining legislation. Alaska was chosen because of the proximity to British Columbia. The Montana code was selected because, similar to the British Columbia code update, it was updated in 2015, following the Mount Polley dam failure.

The legislation and guidelines reviewed as part of this exercise are listed in Table 1. This letter summarizes the key differences between jurisdictions in the following areas:

- Legislation and Guidelines
- Responsibilities
- Dam Classification and Design Criteria
- Review Board (or Panel) Requirements
- Reporting Requirements
- Closure and Reclamation

Detailed excerpts of the legislation and guidelines are included in Table 2 to Table 10 (attached at the end of this letter) for comparison purposes.

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2 LEGISLATION AND GUIDELINES

Tailings dams in British Columbia fall under the *Health, Safety and Reclamation Code for Mines in British Columbia* legislation (MEM 2016a) which includes some prescriptive requirements. The legislation also refers to the *Canadian Dam Association (CDA) Dam Safety Guidelines* and the *HSRC (Health, Safety and Reclamation Code) Guidance Document* (MEM 2016b).

Tailings dams in Alaska fall under the *Alaska Administrative Code* and *Alaska Statute Legislation* (ASL 2015). However, the legislation is not prescriptive; the majority of detailed design considerations are included in the *Guidelines for Cooperation with the Alaska Dam Safety Program* developed by the Alaska Department of Natural Resources (ADNR).

Tailings dams in Montana fall under the *Montana Code* legislation (MLS 2015). The legislation is prescriptive; however, there is no guidance document in Montana.

Table 1 Relevant Legislation and Guidelines

Jurisdiction	Legislation or *Guidelines*	Description	Author	Reference
British Columbia	**Health, Safety and Reclamation Code for Mines in British Columbia (HSRC)**	Regulation of mines in British Columbia	British Columbia Ministry of Energy and Mines	MEM 2008
	Revisions to Part 10 [of the HSRC] Effective as of July 20, 2016	Revisions to the HSRC from the 2008 version		MEM 2016a
	Guidance Document: HSRC	Guidance on use of HSRC, including the 2016 revisions		MEM 2016b
	Canadian Dam Association Dam Safety Guidelines	Guidelines on dam safety, not specific to tailings impoundments	Canadian Dam Association	CDA 2007
	Engineers and Geoscientists Act	Responsibilities and Regulation of Engineers in British Columbia	British Columbia Queen's Printer	BCQP 2016a
	Mines Act	Regulation of mines in British Columbia		BCQP 2016b
Alaska	**11 Alaska Administrative Code 93.1 Water Management: Dam Safety**	Applies to tailings impoundments and other types of dams	The Alaska State Legislature	ASL 2015a
	11 Alaska Administrative Code 97 Mining Reclamation	Reclamation plans, bonding and requirements		ASL 2015b
	Alaska Statute 46.17 Supervision of Safety of Dams and Reservoirs	Supervision of dams by the Alaska DNR, not specific to tailings impoundments		ASL 2015c
	Alaska Statute 27.19 Reclamation	Reclamation plans, bonding and requirements		ASL 2015d
	Guidelines for Cooperation with the Alaska Dam Safety Program	Guidance on Alaska statutes and legislation relating specifically to dam safety in mining	Alaska Department of Natural Resources	ADNR 2005
Montana	**Title 85. Water Use; Ch 15 Dam Safety Act**	Not applicable to permitted tailings impoundments	The Montana Legislature	MLS 2015a
	Title 82. Minerals, Oil and Gas; Ch 4. Reclamation	Not applicable to filtered or dry stack tailings facilities		MLS 2015b
United States	**Mine Safety and Health Administration**	Federal regulation of mines, not specific to tailings impoundments	United States Department of Labour	USDL 2006

Notes:
Italicized text indicates guideline, not legislation.
Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

3 RESPONSIBILITIES (TABLE 2)

Engineer of Record (EoR)

The definitions of the Engineer of Record (EoR) are given in Table 2.

- British Columbia has the most comprehensive definition that includes responsibilities related not only to design but also to construction.
- Alaska does not define an EoR, but indicates that the EoR is the person who signs the design reports and construction specifications.
- Montana defines it as a qualified engineer who is the lead designer.

Mine Management/Operator – Responsible Party for the TSF

- British Columbia - the manager of the mine must designate a TSF Qualified Person to safely manage the TSF.
- Alaska - the Department of Natural Resources (ADNR) Indicates that the Owner is responsible.
- Montana - the most senior ranking agent of the operator at the site has ultimate responsibility for the Tailings Storage Facility (TSF).

Regulation

- British Columbia - the Ministry of Energy and Mines regulates tailings dams.
- Alaska – the ADNR both supervises and regulates dam safety in Alaska.
- Montana - the DNR regulates mining dam safety.

4 DAM CLASSIFICATION AND DESIGN CRITERIA

Dam Classification System (Table 3)

Dam classifications differ between the jurisdictions and are compared in detail in Table 3.

- British Columbia - the dam classification is determined by the EoR, following Health, Safety and Reclamation Code for Mines in British Columbia (HSRC) Guidance Document (MEM 2016b) and the Canadian Dam Association Dam Safety Guidelines (CDA 2007).
- Alaska - the ADNR assigns the hazard classification or hazard class
- Montana - DNR assigns the hazard classification or hazard class.
- Dam classification systems evaluate the significance of loss of life differently between jurisdictions. Alaska has the most conservative system which assigns the highest classification (high; Table 3) to the probable loss of one or more lives, whereas the extreme CDA classification (Table 3) in British Columbia is for more than 100 losses of life of a permanent population.

Dam Slope and Factor of Safety (Table 4)

- British Columbia - the only jurisdiction reviewed that has a minimum downstream slope (i.e. 2H:1V) and a minimum factor of safety (i.e. 1.5) is British Columbia (Table 4).
- Alaska – none.
- Montana – none.

Seismic Design Event (Table 5)

- British Columbia – the minimum criteria is a 1/2475 year, and depending on the dam classification, will be higher.
- Alaska - seismic design criteria are based on the hazard classification (Table 6).
- Montana – the minimum seismic criteria return period is the greater of 1/10 000 year or Maximum Credible Earthquake.

Inflow Design Flood (Table 6)

Flood design criteria are also based on the hazard class or classification (Table 5).

- British Columbia – the minimum flood design criteria return period is 1/3 between 1/975 year and the PMF. For facilities that store the IDF, British Columbia has a minimum duration of 3 days for storage of the IDF.
- Alaska – the minimum flood design return period is 1/100 year.
- Montana – the minimum flood design return period is 1/500 year.

Risk Assessment (Table 7)

- British Columbia - risk assessments are required for tailings facilities and must be reviewed on an annual basis.
- Alaska –a risk assessment is only required before removal or abandonment of a dam, in its proposed final configuration. Annual risk assessment reviews are not required.
- Montana - requires a risk assessment in the design document. Annual risk assessment reviews are not required.

5 REVIEW BOARD (OR PANEL) REQUIREMENTS (TABLE 10)

- British Columbia - an independent tailings review board is required since July 2016, and the activities of the review board are reported annually by the Mine Manager to MEM.
- Alaska - does not require a review board and only recommends one for Class I (high hazard class) dams (Table 10).
- Montana - an independent review panel reviews the initial design and assembles at least every 5 years after.

6 REPORTING REQUIREMENTS (TABLE 10)

Inundation Study Requirements

- British Columbia - a dam breach analysis is required before operation begins.
- Alaska - specifies an assessment prior to removal or abandonment of the dam.
- Montana – a dam breach analysis is required before operations begins; however, an alternative to a dam breach assessment can be done such as a failure modes effects analysis.

Emergency Response Plan (ERP)

- British Columbia - requires the Emergency Response Plan to be updated at a specified interval, and should be maintained. British Columbia integrates a tailings storage facility Emergency Preparedness and Response Plan into the Mine Emergency Response Plan.
- Alaska - requires that Emergency Response Plans (ERP) are reviewed annually and updated at least every three years (Table 7).
- Montana - requires the Emergency Response Plan to be updated at a specified interval.

Dam Safety Inspections

- British Columbia - requires annual dam safety inspections and reporting.
- Alaska - specifies a periodic safety inspection at least every 3 years.
- Montana - requires annual dam safety inspections and reporting.

Dam Safety Reviews

Alaska, British Columbia and Montana all require dam safety reviews at least every 5 years.

- British Columbia - the inspection should be conducted by an independent professional engineer (Table 10).
- This is further described in the Association of Professional Engineers and Geoscientists guideline for Dam Safety Reviews in British Columbia.
- Alaska - DNR inspects the dam or may require the owner to have an engineer, approved by the department, inspect the dam.
- Montana - a panel must be assembled at last once every 5 years and one of their responsibilities is to inspect the dam.

Water Balance (Table 8)

- British Columbia - is the only jurisdiction that specifies reconciliation of the water balance annually and updating it, as required.
- Alaska - requires a water balance, only if a spillway does not exist in the facility.

- Montana - regulations require a detailed water balance in the design document and specify calibration, if possible, and ongoing monitoring to support it.

7 CLOSURE AND RECLAMATION

Closure and reclamation sections of the legislations and guidelines are extensive:

British Columbia

- requires closure or reclamation plans.
- requires that reclamation plans detail activities planned for the next 5 years every time they are updated, and that they should be updated at least every 5 years.
- requires a detailed construction cost estimate, schedule and monitoring plan in the Code (MEM 2016a) but details similar requirements to Alaska and Montana in the guidance (MEM 2016b).
- requires a cost estimate as part of the reclamation plan and a security may be required by the Chief Inspector (BCQPb 2016).

Alaska

- requires closure or reclamation plans.
- reclamation plans cannot be approved that exceed 10 years after exhaustion of the site or abandonment and annual reporting of reclamation activities is required if the reclamation plan exceeds a year.
- prescriptive within the legislation on what a closure plan should include.
- For reclamation costs, the Commissioner determines the amount of the financial assurance. Alaska specifies that the bond must cover post-closure monitoring and a post-closure monitoring plan is required before dam removal or abandonment.

Montana

- requires closure or reclamation plans.
- requires reclamation to be completed within 2 years of mine areas completed or abandoned, unless an exemption is made by the department.
- prescriptive within the legislation on what a closure plan should include.
- For reclamation costs, the DNR determines the amount of the financial assurance required.

8 CONCLUSIONS

Mining legislation in Alaska, British Columbia and Montana differs in the amount of detail and specific requirements for each jurisdiction. Overall, British Columbia is as conservative, or more conservative in its legislation (Table 11). Where more detail is provided in other jurisdictions, the information is often contained in the Guidance Document: Health, Safety and Reclamation Code for Mines in British Columbia (MEM 2016b), which is referenced in the British Columbia legislation.

9 CLOSING

This letter is an instrument of service of Klohn Crippen Berger Ltd. The letter has been prepared for the exclusive use of the Ministry of Energy and Mines (Client) for the specific application to the British Columbia, Alaska, and Montana Mining Legislation and Guideline Review. The letter's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this letter, Klohn Crippen Berger has endeavored to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

Yours Truly,

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HM:dl

Attachments: Table 2 - Responsibilities
Table 3 - Dam Classification System
Table 4 - Minimum Stability and Slope Design Criteria
Table 5 - Minimum Design Earthquake Based on Dam Classification
Table 6 - Minimum Flood Design Criteria Based on Dam Classification
Table 7 - Risk Assessment, Operation, Maintenance and Surveillance (OMS) and Emergency Response Plan Requirements
Table 8 - Water Balance and Inundation Study Requirements
Table 9 - Signing, Stamping Requirements
Table 10 - Review Board and Reporting Requirements
Table 11 - Summary of Tailings Facility Related Legislation in Alaska, British Columbia and Montana

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Table 2 Responsibilities

Definition	Alaska **ASL 2015**, *ADNR 2005*	British Columbia **MEM 2016a,** *MEM 2016b* , *APEGBC 2014*	Montana **MLS 2015**
Definition of a Dam	**"Dam" includes an artificial barrier, and its appurtenant works, which may impound or divert water and which (A) has or will have an impounding capacity at maximum water storage elevation of 50 acre-feet and is at least 10 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; (B) is at least 20 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; or (C) poses a threat to lives and property as determined by the department after an inspection; (AS 26.17; ASL 2015)**	**"Dam" means a barrier on the surface preventing uncontrolled release of either water, slurry or solids or a barrier underground to prevent the uncontrolled flow of water, slurry or solids. (MEM 2016a)**	**"Dam" means an artificial barrier, including appurtenant works, used to impound or divert water. (85-15-106; MLS 2015)**
Definition of an Engineer of Record	*Becoming an "engineer of record" by placing a signature and seal on reports, drawings, specifications, and other engineering work products. ["Sealed" is defined in 11 AAC 93.201(12) to mean "prepared by an engineer or a person under that engineer's direct supervision, and bearing the signature and seal of that engineer as required by AS 08.48.221 and 12 AAC 36.185."] (ADNR 2005)*	**The Professional Engineer who: 1. Is retained as the engineer of record for each tailings storage facility and dam under their management. 2. As a qualified professional, has responsibility for assuming that a tailings storage facility or dam has been designed and constructed in accordance with the applicable guidelines, standards and regulations. 3. Acknowledges retainment as the Engineer of Record in the notification to the chief inspector. (Section 10.1.5; MEM 2016a)** *- 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. (MEM 2016b)*	**A qualified engineer who is the lead designer for a tailings storage facility. (82-4-303; MLS 2015)**
TSF Qualified Person	No TSF Qualified person is defined. Related legislation: **The department shall supervise the safety of dams and reservoirs. The department shall employ a licensed and qualified engineer, experienced in the design and construction of dams and reservoirs, and other employees necessary for performing the duties under this chapter. Under AS 36.30 (State Procurement Code), the department may contract with engineering consultants to assist in the performance of the department's duties under this chapter. (AS 46.17.020; ASI 2015)**	**"TSF qualified person" means the person designated under section 10.4.2 (1) (b) of this code. Section 10.4.2 (1): The manager of a mine with one or more tailings storage facilities shall … (b) designate a TSF qualified person for safe management of all Tailings Storage Facilities (MEM 2016a)** *- 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. (MEM 2016b)*	No TSF Qualified person is defined. Related legislation: **The operator or permit applicant shall develop the manual, which must contain: (a) an identification of the roles and responsibilities of the agents of the operator of the tailings storage facility. The specific organizational role with ultimate responsibility for the tailings storage facility must be identified as the senior ranking agent of the operator at the site of the tailings storage facility. (82-4-379; MLS 2015)**
Qualified Professional	**(a) The department will not approve proposals for hazard potential classifications as required under 11 AAC 93.157, design engineering reports, design and construction drawings, construction specifications, or other information or documents submitted under 11 AAC 93.171 or 11 AAC 93.172, or construction completion reports or record drawings as required under 11 AAC 93.171 (f)(6)(A), unless sealed by an engineer with (1) a valid certificate of registration issued under AS 08.48 and 12 AAC 36 as a professional engineer in the branch of civil engineering; (2) at least five years of experience, in this state or another state, as a licensed or registered professional engineer in the branch of civil engineering; and (3) significant work experience in the design, construction, inspection, and safety of dams. (b) The department will not approve an engineer under AS 46.17.050 and 11 AAC 93.159(b) for purposes of conducting a periodic safety inspection as required by 11 AAC 93.159, unless the engineer has (1) a valid certificate of registration issued under AS 08.48 and 12 AAC 36 as a professional engineer in the branch of civil engineering; and (2) at least five years of experience, in this state or another state, as a licensed or registered professional engineer in the branch of civil engineering; and (3) sufficient work experience to determine the safety of the particular dam being inspected and to make reliable recommendations regarding the operation and maintenance of that dam, inspections of that dam, and other matters related to the safety of that dam. (c) For purposes of the observation and inspection requirements in 11 AAC 93.173(c)(2), an owner shall use an engineer with the qualifications set out in (a)(1) - (3) of this section. (11 AAC 93.193; ALS 2015)**	**"qualified professional" means an individual who (a) is registered, and in good standing, with a professional organization in British Columbia governed under an enactment, and (b) is acting within his or her area of professional expertise. (MEM 2016a)** *A professional engineer member or licensee in good standing with APEGBC, and for the purposes of these guidelines, is typically registered in the disciplines of structural, civil, geological or mining engineering with the appropriate level of education, training and experience, as defined by these guidelines, to conduct dam safety reviews as described in these guidelines. (APEGBC 2014)*	**"Qualified engineer" means a professional engineer who has a minimum of 10 years of direct experience with the design and construction of tailings storage facilities and has the appropriate professional and educational credentials to effectively determine appropriate parameters for the safe design, construction, operation, and closure of a tailings storage facility. "Professional engineer" means a registered professional engineer licensed to practice in Montana under Title 37, chapter 67, part 3. (82-4-303; MLS 2015)**

Notes:
Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

Table 3 Dam Classification System

	Alaska		British Columbia		Montana	
	Hazard Class	**Description**	**Dam Class**	**Description**	**Hazard Classification**	**Description**
	ASL 2015, *ADNR 2005*		*CDA 2007*		**MLS 2015**, *MDNRC n.d.*	
Lowest	III (Low)	**a Class III (low) hazard potential classification if the department determines that the failure or improper operation of the barrier will result in** **(A) limited impacts to rural or undeveloped land, rural or secondary roads, and structures;** **(B) property losses or damage limited to the owner of the barrier; or** **(C) insignificant danger to public health.** **(93.157; ASL 2015)** *Insignificant danger to public health* *Limited impact to rural or undeveloped land, rural or secondary roads, and structures.* *Loss or damage of property limited to the owner of the barrier.* *(ADNR 2005)*	Low	***Loss of life:*** *0 (no population)* ***Environmental & Cultural Values:*** *Minimal short-term loss, no long-term loss* ***Infrastructure & Economics*** *: Low economic losses; area contains limited infrastructure or services*	Not High Hazard	**82-4-376 (MLS 2015) describes the design criteria for a new tailings storage facility, regardless of the classification of the facility.** *The hazard classification is determined by the Department of Natural Resources and Conservation (MDNRC n.d.). An application must be made to the DNRC in order to obtain a classification for a facility and the necessary permits if it is classified as a high-hazard dam.*
	II (Significant)	**a Class II (significant) hazard potential classification, if the department determines that the failure or improper operation of the barrier will result in** **(A) a significant danger to public health;** **(B) the probable loss of or probable significant damage to homes, occupied structures, commercial property, high-value property, major highways, primary roads, railroads, or public utilities, other than losses described** *No loss of life expected, although a significant danger to public health may exist* *Probable loss of or significant damage to homes, occupied structures, commercial or high-value property, major highways, primary roads, railroads, or public utilities, or other significant property losses or damage not limited to the owner of the barrier* *(ADNR 2005)*	Significant	***Loss of life:*** *unspecified (temporary population)* ***Environmental & Cultural Values:*** *No significant loss or deterioration of fish or wildlife habitat, loss of marginal habitat only, restoration or compensation in kind highly possible* ***Infrastructure & Economics:*** *Losses to recreational facilities, seasonal workplaces and infrequently used transportation routes.*		
			High	***Loss of life:*** *10 or fewer (permanent population)* ***Environmental & Cultural Values:*** *Significant loss or deterioration of important fish habitat. Restoration or compensation in kind highly possible.* ***Infrastructure & Economics:*** *High economic losses affecting infrastructure, public transportation, and commercial facilities.*		
	I (High)	**a Class I (high) hazard potential classification, if the department determines that the failure or improper operation of the barrier will result in probable loss of human life** **(ASL 2015)** *Probable loss of one or more lives* *May include losses or effect to property as described in Class II or III, but irrelevant for classification* *(ADNR 2005)*	Very High	***Loss of life:*** *100 or fewer (permanent population)* ***Environmental & Cultural Values*** *: Significant loss or deterioration of critical fish and wildlife habitat. Restoration or compensation in kind possible but impractical.* ***Infrastructure & Economics:*** *Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities or for dangerous substances)*		
Highest			Extreme	***Loss of life:*** *More than 100 (permanent population)* ***Environmental & Cultural Values:*** *Major loss of critical fish and wildlife habitat. Restoration or compensation in kind impossible.* ***Infrastructure & Economics:*** *Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)*	High Hazard	

Notes:
Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

Table 4 Minimum Stability and Slope Design Criteria

Criteria	Alaska	British Columbia	Montana
	-	**MEM 2016a**, *MEM 2016b* , *CDA 2007*	**MLS 2015**
Minimum Stability	N/A	**Factor of Safety: 1.5** **For a tailings storage facility design that has a calculated static factor of safety of less than 1.5, the manager shall submit justification by the engineer of record for the selected factor of safety and receive authorization by the chief inspector prior to construction.** **(Section 10.1.10; MEM2016a)** **Factor of Safety:** **1.3: End of construction before reservoir filling** **1.5: Long term (steady-state seepage, normal reservoir level)** **1.2-1.3: Full or partial rapid drawdown** **(CDA 2007)** **The HSRC guidance specifies a minimum factor of safety of 1.5 and doesn't mention the exemption.** **(MEM 2016b)**	**Factor of Safety:** **Normal Operating: 1.5** **Construction: 1.3**[1] **Post Earthquake: 1.0 to 1.2** **(MLS 2015; 82-4-376)**
Minimum Downstream Slope	N/A	**2H:1V** **For a tailings storage facility design that has an overall downstream slope steeper than 2H:1V, the manager shall submit justification by the engineer of record for the selected design slope and receive authorization by the chief inspector prior to construction.** **(Section 10.1.9; MEM 2016a)**	N/A

Notes:
1. If the independent review panel pursuant to 82-4-377 agrees that site-specific conditions justify the reduced factor of safety and that the extent and duration of the reduced factor of safety are acceptable.
Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

Table 5 Minimum Design Earthquake Criteria Based on Dam Classification

	Alaska		British Columbia			Montana	
	Hazard Class	Annual Exceedance Probability	Dam Class	Annual Exceedance Probability		Hazard Classification	Annual Exceedance Probability
	ADNR 2005		**MEM 2016a**, *MEM 2016b*, *CDA 2007*			**MLS 2015**	
Lowest	III (Low)	*Maximum Design Earthquake: 1/500 to 1/1000* *Operating Basis Earthquake: 50 to 150* *(ADNR 2005)*	Low	*1/100* *(CDA 2007)*	**Minimum 1/2475 years for facilities that store water or saturated tailings** **Minimum 1/975 years for facilities that cannot retain water or saturated tailings** **(MEM 2016a)** *1/2475*[1] *(MEM 2016b)*	Not High Hazard	**Greater of 1/10 000 or Maximum Credible Earthquake** **(82-4-376; MLS 2015)**
	II (Significant)	*Maximum Design Earthquake: 1/1000 to 1/2500* *Operating Basis Earthquake: 70 to 200* *(ADNR 2005)*	Significant	*Between 1/100 and 1/1000* *(CDA 2007)*			
	I (High)	*Maximum Design Earthquake: 1/2500 to Most Credible Earthquake* *Operating Basis Earthquake: 150 to >250* *(ADNR 2005)*	High	*1/2475* *(CDA 2007)*			
			Very High	**Minimum 1/2475 years for facilities that store water or saturated tailings** **Minimum 1/975 years for facilities that cannot retain water or saturated tailings** **(MEM 2016a)** *1/2 between 1/2475 and 1/10 000 or MCE*[1] *(MEM 2016b; CDA 2007)*			
Highest			Extreme	**Minimum 1/2475 years for facilities that store water or saturated tailings** **Minimum 1/975 years for facilities that cannot retain water or saturated tailings** **(MEM 2016a)** *1/10 000 or MCE*[1] *(MEM 2016b; CDA 2007)*		High Hazard	

Notes:
1. Adapted from CDA 2007. Further context and guidance provided there.
Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

Table 6 Minimum Flood Design Criteria Based on Dam Classification

	Alaska			British Columbia			Montana	
	Hazard Class	**Annual Exceedance Probability**		**Dam Class**	**Annual Exceedance Probability**		**Hazard Classification**	**Annual Exceedance Probability**
	ASL 2015, *ADNR 2005*			**MEM 2016a**, *MEM 2016b*			**MLS 2015**	
Lowest	III (Low)	*Minimum: 1/100* *Maximum: PMF* *(ADNR 2005)*	**For purposes of 11 AAC 93.164 and 11 AAC 93.171, the information for determining the inflow design flood shall be developed in substantial accordance with (1) the Federal Emergency Management Agency's Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams (FEMA 94), as revised as of October 1998 and adopted by reference; or (2) methods approved by the department that adequately assess and characterize the design hydrology, and that are based on the hazard potential classification assigned under 11 AAC 93.157. (11 AAC 93.195; ALS 2015)**	Low	*1/100 (CDA 2007)*	**Minimum 1/3 between 1/975 and PMF, 72 hour storm[1,2] (MEM 2016a)**	Not High Hazard	**PMF; or a flood event design criterion less than the probable maximum flood but greater than the 1-in-500-year, 24-hour event if the panel agrees that site specific conditions justify that design to the PMF standard is unnecessary. (82-4-376, MLS 2015)**
	II (Significant)			Significant	*Between 1/100 and 1/1000 (CDA 2007)*			
	I (High)			High	**Minimum 1/3 between 1/975 and PMF, 72 hour storm[1,2] (MEM 2016a)** *1/3 between 1/1000 and PMF, 72 hour storm[1,3] (MEM 2016b; CDA 2007)*			
				Very High	**Minimum 1/3 between 1/975 and PMF, 72 hour storm[1,2] (MEM 2016a)** *2/3 between 1/1000 and PMF, 72 hour storm[1,3] (MEM 2016b; CDA 2007)*			
Highest				Extreme	***Minimum 1/3 between 1/975 and PMF, 72 hour storm[1,2] (MEM 2016a)*** *72-hour PMF[1,3] (MEM 2016b; CDA 2007)*		High Hazard	

Notes:
1. Minimum design event duration of 72 hours if the facility stores the inflow design flood.
2. For tailings storage facilities that cannot retain water or saturated tailings, the water management design shall include an assessment of tailings facility erosion and surface water diversions as well as measures to prevent impounded tailings from becoming saturated that consider the consequence classification (MEM 2016a).
3. Adapted from CDA 2007. Further context and guidance provided there.

Bolded black text indicates legislation.
Blue italicized text indicates a guideline.

Table 7 Risk Assessment, Operation, Maintenance and Surveillance (OMS) and Emergency Response Plan Requirements

Criteria	Alaska **ASL 2015,** *ADNR 2005*	British Columbia **MEM 2016a, MEM 2008,** *MEM 2016b*	Montana **MLS 2015**
Risk Assessment	**Before removing or abandoning a dam, a person must apply to the department under this section for a certificate of approval. Unless the department determines that an item or document is not required for the protection of life or property, the following information and documents must be submitted to the department for review and approval:** **for mine tailings dams, a description of the probable potential failure modes of the dam and tailings storage system in the proposed final configuration;** **(11 AAC 93.172; ASL 2015)** *Dam Safety will consider arguments presented by dam owners for hazard potential classifications that are in dispute, including risk assessments that quantitatively assign probabilities to certain outcomes. Nevertheless, those arguments should be cooperatively developed, technically sound, and justifiable.* *Dam Safety will consider a risk assessment submitted by a dam owner if it is appropriately conducted by a team that includes a qualified engineer familiar with the dam and a qualified and experienced risk assessment consultant.* *A risk assessment focused on a dam may take the form of a failure mode and effects analysis.* *(ADNR 2005)*	**The manager of a mine with one or more tailings storage facilities shall review annually the tailings storage facility risk assessment to ensure that the quantifiable performance objectives and operating controls are current and manage the facility risks.** **(Section 10.4.2; MEM 2016a)** **When required by the chief inspector, the owner, agent or manager shall commission an ecological risk assessment.** **(Section 10.7.18; MEM 2016a)** *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.* *(MEM 2016b)*	**The design document must contain:** **a dam breach analysis, a failure modes and effects analysis or other appropriate detailed risk assessment, and an observational method plan addressing residual risk.** **(82-4-376; MLS 2015)**
Operation, Maintenance and Surveillance (OMS)	**An owner that is required under 11 AAC 93.167, 11 AAC 93.171, or 11 AAC 93.173 to prepare or provide an operation and maintenance manual must describe in that manual, in detail, how a dam will be operated, inspected and maintained, including** **(1) a physical description of the dam;** **(2) any operating limitations on the dam;** **(3) critical design criteria;** **(4) a schedule and procedures for routine safety inspections, monitoring, and maintenance of the dam;** **(5) detailed instructions and maintenance procedures for operating valves, gates, or other equipment;** **(6) maintenance procedures, calibration information, and instructions for instrumentation and for monitoring and alarm systems;** **(7) site-specific visual inspection checklists; and** **(8) other information requested by the department to provide sufficient detail regarding dam operation, inspection, and maintenance for the protection of life and property.** **(11 AAC 93.197; ALS 2015)**	**(1) An Operations, Maintenance and Surveillance Manual shall be prepared by one or more qualified person and submitted to the chief inspector prior to operation of the Tailings Storage Facility or dam.** **(2) The Operations, Maintenance and Surveillance Manual shall be reviewed by the engineer of record and approved by the manager prior to implementation.** **(3) All employees involved in the operation of a tailings storage facility or dam shall be trained and qualified, based on the OMS requirements, prior to commencing work at the facility.** **(4) The Operations, Maintenance and Surveillance Manual shall be reviewed annually and revised as required during operations of a tailings storage facility or dam.** **(MEM 2016a)**	**(1) A tailings operation, maintenance, and surveillance manual is required for a tailings storage facility.** **(4) The engineer of record shall certify by seal that:** **(a) the tailings operation, maintenance, and surveillance manual is consistent with the facility's design;** **(b) the inspections and monitoring described in the tailings operation, maintenance, and surveillance manual are reasonably sufficient to ensure the tailings storage facility will perform as intended and will reasonably be expected to detect deviations if they occur; and** **(c) the emergency preparedness and response plan describes reasonable measures that can be taken to protect human health and the environment.** **(5) The operator shall review the tailings operation, maintenance, and surveillance manual annually to ensure that the manual reflects current conditions. Any revision of the manual during operation or at closure must be certified by the seal of the engineer of record.** **(82-4-379; MLS 2015)**
Emergency Response Plan	**(a) The owner of a Class I or Class II dam shall develop and maintain an emergency action plan in accordance with this section.** **(b) The department will approve an emergency action plan if** **(1) the plan adequately protects life and property, given the particular risks presented to life or property if the dam fails or in anticipation of imminent dam failure;** **(2) the plan provides adequately for the coordination of emergency responders in the community;** **(3) the plan contains information that the department considers necessary to minimize danger to life and property; that information must include, if required by the department, a** **(A) detailed inundation map, prepared in substantial accordance with 11 AAC 93.195;** **(B) dam break analysis; and** **(C) schedule for exercise and revision of the plan; and** **(4) for a Class I dam, the plan is developed and maintained in accordance with** **(A) the Federal Emergency Management Agency's Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners (FEMA 64), as revised as of October 1998 and adopted by reference; or** **(B) other requirements that the department determines are necessary to protect life or property.** **(c) The owner of a Class I or II dam shall review the emergency action plan at least annually, and shall submit any revision of the plan to the department for approval.** **(d) The owner of a Class I or II dam shall exercise the emergency action plan to a level specified by the department as sufficient to maintain adequate preparation for an actual emergency, and shall revise the emergency action plan at least every three years, or at a frequency that the department determines sufficient to maintain adequate preparation for an actual emergency. The plan shall be revised after the exercise in order to address any problems or areas for improvement identified during the exercise, and shall be submitted to the department for approval. Revised plans must be distributed to all persons with responsibilities identified in the plan.** **(e) The owner of a Class II dam may include the emergency action plan in the operations and maintenance manual required under 11 AAC 93.167, 11 AAC 93.171, or 11 AAC 93.173.** **(11 AAC 93.164; ASL 2015)**	**The manager shall develop and file with the chief inspector, a Mine Emergency Response Plan which shall be kept up to date and followed in the event of a emergency. The Mine Emergency Response Plan shall contain all of the elements required in the "Mine Emergency Response Plan Guidelines for the Mining Industry," that may be amended from time to time.** **(Section 3.7.1; MEM 2008)** **The manager of a mine with one or more tailings storage facilities shall maintain tailings storage facility emergency preparedness and response plans integrated into the Mine Emergency Response Plan.** **(Section 10.4.2; MEM 2016a)**	**The operator or permit applicant shall develop the manual, which must contain: an emergency preparedness and response plan based on the failure modes and effects analysis or other appropriate risk assessment;** **The engineer of record shall certify by seal that: the emergency preparedness and response plan describes reasonable measures that can be taken to protect human health and the environment.** **(82-4-379; MLS 2015)**

Notes:
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Table 8 Water Balance and Inundation Study Requirements

Criteria	Alaska ASL 2015, *ADNR 2005*	British Columbia MEM 2016a	Montana MLS 2015
Water Balance	*During the operating phase, an emergency spillway might not exist and the reservoir must then retain the full volume of the IDF. In this case, a detailed water balance methodology must be developed to carefully monitor and maintain a reserve storage capacity.* *(ADNR 2005)*	**The manager shall ensure that a tailings storage facility has a water balance and water management plan for the permitted life of mine that is prepared by a qualified person.** **(Section 10.1.1.11; MEM 2016a)** **After commencement of operations, the water balance and water management plans shall be reconciled annually and updated as required.** **(Section 10.4.1; MEM 2016a)**	**(2) The design document must contain:** **a detailed water balance, evidence of calibration if available, and the raw data used to develop the water balance;** **(z) a detailed description of how water, seepage, and process solutions are to be routed or managed during construction, operation, and closure;** **(aa) a detailed description of storm water controls, including diversions, storage, freeboard, and how extreme storm events will be managed;** **(bb) a design storm event for operation and closure conforming to current engineering best practices for the type of facility proposed that includes:** **(i) a rationale for the selection of the design storm event;** **(ii) the magnitude of the design storm event;** **(iii) the magnitude of runoff generated by the design storm event to and around the impoundment; and** **(iv) evidence that the dynamic nature of climatology was considered;** **(cc) for a new tailings storage facility, design sufficient to store:** **(i) the probable maximum flood event plus maximum operating water or solution volume plus sufficient freeboard for wave action; or** **(ii) a flood event design criterion less than the probable maximum flood but greater than the 1-in-500-year, 24-hour event if the panel agrees that site-specific conditions justify that design to the probable maximum flood standard is unnecessary;** **(82-4-376 2y through 2cc; MLS 2015)** **(3) The operator or permit applicant shall develop the manual, which must contain:** **(f) an identification of monitoring and data collection necessary to maintain and calibrate the tailings storage facility's water balance;** **(82-4-379 3f; MLS 2015)**
Dam Break and Inundation Studies	**11 AAC 93.157. Hazard classification** **(3) a proposed hazard potential classification, and any supporting information for that proposed classification; supporting information may include maps, an inundation map prepared in substantial accordance with 11 AAC 93.195, a dam break analysis, photographs, and engineering calculations.** **11 AAC 93.195. Inundation maps and inflow design flood information** **(a) An inundation map prepared under 11 AAC 93.157(b) or 11 AAC 93.164 must** **(1) indicate the extent of flooding below a dam after failure under the normal operating level of the reservoir, under the inflow design flood, and under other scenarios as the department considers necessary to evaluate danger to life and property;** **(2) identify downstream structures or other development, flood wave depth and arrival times, roads, evacuation routes, staging areas, and other information required by the department to minimize danger to life and property; and** **(3) be based on a dam break analysis, if required.** **11 AAC 93.172. Dam removal or abandonment** **Before removing or abandoning a dam, a person must apply to the department under this section for a certificate of approval. Unless the department determines that an item or document is not required for the protection of life or property, the following information and documents must be submitted to the department for review and approval:** **(6) for mine tailings dams, a (A) description of the probable potential failure modes of the dam and tailings storage system in the proposed final configuration;** **11 AAC 93.164 Owner's emergency action plan** **(3) the plan contains information that the department considers necessary to minimize danger to life and property; that information must include, if required by the department, a (B) dam break analysis.** **(ASL 2015)**	**A tailings storage facility shall have a breach and inundation study or a failure runout assessment prior to commencing operation, or as required by the chief inspector.** **(Section 10.1.11; MEM 2016a)**	**a dam breach analysis, a failure modes and effects analysis or other appropriate detailed risk assessment, and an observational method plan addressing residual risk;** **(82-4-376 2n; MLS 2015)**

Notes:
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Table 9 Signing Requirements

Alaska	British Columbia	Montana
Dam safety documents that require a seal by an engineer: **Form for hazard classification review by ADNR** **Preliminary design package** **Engineer design report** **Final drawing package** **(11 AAC 93; ASL 2015)**	*A member or licensee receiving a seal or stamp under this section must use it, with signature and date, to seal or stamp estimates, specifications, reports, documents, plans or things that have been prepared and delivered by the member or licensee in the member's or licensee's professional capacity or that have been prepared and delivered under the member's or licensee's direct supervision. (Engineers and Geoscientists Act RSBC 1996 c. 116)* *As-built reports must be signed and sealed by the Engineer (MEM 2016b)*	**The engineer of record shall: certify and seal designs or other documents pertaining to tailings storage facilities submitted to the department.** **(82-4-335; MLS 2015)**

Notes:
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Table 10 Review Board and Reporting Requirements

Requirement	Alaska ASL 2015, *ADNR 2005*	British Columbia MEM 2016a	Montana MLS 2015
Review Board Regulations	*The design scope proposal should also specify the level of design quality assurance (DQA) and design quality control (DQC) to be conducted during the design. For example, for new Class I dams, a design review board may need to be established.* *(ADNR 2005)*	**The manager of a mine with one or more tailings storage facilities shall establish an Independent Tailings Review Board, unless exempted by the chief inspector.** **(Section 10.4.2; MEM 2016a)**	**An independent review panel reviews the design document.** **(82-4-377; MLS 2015)** **At least once every 5 years following department approval of a design document during mining, or as required in a reclamation plan, the operator shall assemble a panel.** **(82-4-380; MLS 2015)**
Reporting Requirements	**Minimum periodic safety inspection every 3 years for Class III dams.** **(11 AAC 93.159; ASL 2015)** **Dam incidents shall be reported to the department including: performance after seismic or hydrologic events; uncontrolled releases of water; indications of stress; severe deterioration or erosion, and modifications or repairs.** **(11 AAC 93.177; ASL 2015)**	**Annual reports on:** **Tailings storage facility and dam safety reports inspections, including a summary of recommendations and a scheduled completion date;** **the activities of the independent Tailings Review Board;** **reclamation and environmental work;** **the performance of high-risk dumps;** **updates to the tailings storage facility register as required; and** **other information as directed by the chief inspector.** **(Section 10.4.4; MEM 2016a)**	**Annual Engineer of Record Inspection** **(82-4-381; MLS 2015)** **Closure Activities Annual Reports** **(82-4-339; MLS 2015)**
Dam Safety Inspections (DSIs)	**The owner of a Class I or Class II dam shall provide for a periodic safety inspection of the dam at least once every three years. The owner of a Class III dam shall provide for a periodic safety inspection of the dam at least once every five years. The department may order a dam owner to provide for a periodic safety inspection more often than required by this subsection if the department determines that the dam might be unsafe or that more frequent inspections are necessary to protect public safety.** **(11 AAC 93.159; ALS 2015)**	**Tailings storage and water management facilities and associated dams shall be inspected annually and a report shall be prepared by the engineer of record in consideration of the HSRC Guidance Document** **(Section 10.5.3; MEM 2016a)**	**The engineer of record shall inspect a tailings storage facility annually during operation or as required during closure pursuant to a reclamation plan under 82-4-336.** **(82-4-381; MLS 2015)**
Dam Safety Reviews (DSRs)	**At least once every five years the department shall inspect every dam and reservoir that is subject to this chapter. The department may require the owner of a dam or reservoir to perform the required inspection, according to the department's inspection standards, using a qualified engineer approved by the department. To protect public safety, the department may inspect, or may require the owner to inspect, a dam or reservoir more frequently than every five years. The department may require the owner of the dam or reservoir to pay the cost of an inspection under this section. (AS 46.17.050; ASL 2015)** *The State Dam Safety Engineer or other members of the ADNR may conduct a field inspection in accordance with AS 46.17.060 and 11 AAC 93.161 or 11 AAC 93.173(c)(3). A field inspection is defined herein as a limited inspection conducted onsite by the ADNR before, during, or after construction. Field inspections may also occur during routine operation or emergency conditions at the dam.* *(ADNR 2005)*	**A Dam Safety Review Report on the tailings storage, water management facilities and associated dams shall be prepared by an independent Professional Engineer in consideration of the HSRC Guidance Document at least every 5 years or as directed by the chief inspector.** **(Section 10.5.4; MEM 2016a)**	**At least once every 5 years following department approval of a design document during mining, or as required in a reclamation plan, the operator shall assemble a panel.** **The panel shall prepare a report detailing the scope of review and include any recommendations resulting from the review.** **(82-4-380; MLS 2015)**

Notes:
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Table 11 Summary of Tailings Facility Related Legislation in Alaska, British Columbia and Montana

Topic	Alaska	British Columbia	Montana	Comparison
Minimum Downstream Slope	N/A	2H:1V	N/A	BC more stringent
Factor of Safety	N/A	1.5	1.5 (normal operating) 1.3 (construction, if approved by independent review board) 1.0 to 1.2 (post earthquake)	BC more stringent
Minimum Design Earthquake Return Period (years)	1/500 to 1/1000 (Design) 1/50 to 1/100 (Operating)	1/2475 (retains water or saturated tailings) 1/975 (cannot retain water or saturated tailings)	greater of 1/10 000 or Maximum Credible Earthquake	BC middle
Minimum Design Flood Return Period (years)	1/100	1/3 between 1/975 and PMF, 72 hour storm	1/500, 24 hour storm, if approved	BC more stringent
Review Board	not required, recommended for Class I dams (high hazard)	required, annual reporting	required to review initial design and assemble at least once every five years	BC more stringent
Risk Assessments	required before removal or abandonment of a dam	required, review required annually	required in design document	BC more stringent
OMS Manual	required	required, review required annually	required, review required annually	Equal
Dam Breach and Inundation Studies	required before removal or abandonment of a dam may be required for hazard classification of dam may be required in the emergency action plan	required prior to operation and as required by the Chief Inspector	required in the design document or similar equivalent (e.g. detailed risk assessment)	Equal
Emergency Response Plan	required, review required annually, revision required every three years	required	required	Equal
Dam Safety Inspections	at least once every 3 years	annually	annually during operations as required during closure	BC more stringent
Dam Safety Reviews	at least once every 5 years, or as required by the ADNR	at least once every 5 years, or as required by the Chief Inspector	at least once every 5 years, or as required	Equal
Water Balance	required only if a spillway does not exist	required in design for life of mine, reconciliation required annually	required in design for life of mine, calibration required	Equal
Reporting Requirements	all dam incidents, inspections and reviews	annually, includes activities of ITRB	annually, inspections and closure activities reports	Equal
Closure and Reclamation Plans	requires reclamation plan is less than 10 years	requires updating every five years detailing plans for the next five years	requires reclamation is completed within 2 years	BC more stringent

Note: details and references are provided in Tables