Safety First

Guidelines for Responsible Mine Tailings Management

V2.0 MAY 2022

Safety First

Guidelines for Responsible Mine Tailings Management

V2.0 MAY 2022

Report available at earthworks.org/safety-first and miningwatch.ca/safety-first

AUTHORS

This report was written by Earthworks (Jan Morrill, Paulina Personius, and Payal Sampat), MiningWatch Canada (Ugo Lapointe, Jamie Kneen, and Rodrigue Turgeon), and London Mining Network (Richard Harkinson), with contributions from Dr. Ann Maest (Buka Environmental), Dr. David Chambers (Center for Science in Public Participation), Dr. Steven Emerman (Malach Consulting), and Dr. Bruno Milanez (Grupo Política, Economia, Mineração, Ambiente e Sociedade/Universidade Federal de Juiz de Fora). — *This report was written using publicly available data and interviews, and feedback from regional consultation workshops held by the authors with communities affected by tailings. The information contained herein is believed to be accurate but does not purport to be complete.*

ACKNOWLEDGMENTS

Thank you to Cathal Doyle, Emily Greenspan, Gavin Mudd, Lisa Sumi, Cindy Charleyboy, Loretta Williams, Catherine Coumans and Andrés Ángel (Scientific Advisor at AIDA) for reviewing this document. Thank you to all the participants in the regional consultation workshops, especially our co-organizers Joám Evans Pim, Isabel García Vila, Andrés Ángel, Marta Inês Romero, Tchenna Maso, Paul Robson, Jaybee Garganera, Merah Johansyah, Hassen Lorgat, Laura Pitkanen, and Sayokla Williams, as well as Catherine Coumans, Claudia Mueller Hoff, Jim Kuipers, Adan Olivares Castro, and Paul Robinson, for reviewing or providing input on the second version of this document.

COVER PHOTOS AND DESIGN

Cover photo: Workers from the Brazilian Ministry of Environment survey the catastrophic damage after the collapse of the Vale tailings dam in Brumadinho, Brazil, in 2019. Minas Gerais, Brazil. By IBAMA from Brazil.

Contributors and Endorsement pages photo: Tailings dam at the Red Chris mine operated by Imperial Metals, British Columbia, Canada. By Garth Lenz ©Garth-Lenz-1486 (courtesy of Salmon Beyond Borders).

Graphic Design by CreativeGeckos.com

TO CITE THIS REPORT

Morrill, J., Chambers, D., Emerman, S., Harkinson, R., Kneen, J., Lapointe, U., Maest, A., Milanez, B., Personius, P., Sampat, P., and Turgeon, R. (2022), *Safety First: Guidelines for Responsible Mine Tailings Management*, Earthworks, MiningWatch Canada and London Mining Network, XY pages.

TO ENDORSE

To endorse *Safety First: Guidelines for Responsible Mine Tailings Management* or to provide comments on the guidelines please email info@earthworks.org or submit comments or endorsements through this form.

EARTHWORKS

Earthworks • 1612 K St., NW, Suite 904 Washington, D.C., USA 20006
earthworks.org • 202.887.1872

MiningWatch Canada • 508-250 City Centre Avenue • Ottawa, ON K1R 6K7 Canada
miningwatch.ca • 1 (613) 569-3439 • 1 (613) 569-5138 FAX

London Mining Network • Finfuture • 225-229 Seven Sisters Road • London N4 2DA
londonminingnetwork.org • +44 (0) 7903 851695

Organizations endorsing these recommendations

A Community Voice – Louisiana – *United States*

A2 Rosewood Strong Community – *United States*

Action for Ecology & People Emancipation (AEER) – *Indonesia*

ACWA / Earth Island Institute – *United States*

African Resources Watch (Afrewatch) – *Regional-Africa*

AfrosRD – *Dominican Republic*

AGHAM-Advocates of Science and Technology for the People – *Philippines*

AIDA – *Latin America*

Alianza Centro Americana Frente a la Minería (ACAFREMIN) – *Central America*

Alyansa Tigil Mina (ATM) – *Phillippines*

Amazon Watch – *United States*

Amnesty International – *United Kingdom*

Andrew Lees Trust – *United Kingdom*

Arizona Mining Reform Coalition – *United States*

Arkansas Valley Conservation Coalition (AVCC) – *United States*

Armenian Environmental Front – *Armenia*

Assembly of Masses and Basic Sectors for Unity and Harmony-Initiatives for Normalization and Advancement for Human Security (AMBUH-INAH) – *Philippines*

B.C.E.N., C.E.N. Mining caucus and toxics caucus – *Canada*

Bank Information Center – *United States*

BAYAY SIBUYANON INC. – *Philippines*

BC Mining Law Reform Network – *Canada*

Bench Marks Foundation – *South Africa*

Bismarck Ramu Group – *Papua New Guinea*

Canadian Environmental Law Association – *Canada*

CATAPA – *Belgium*

Concerned Citizens of Quesnel Lake – *Canada*

Center for Environmental Concerns – Philippines Inc. – *Philippines*

Center for Global Nonkilling – *United States*

Center for Science in Public Participacion – *United States*

Centre for Applied Legal Studies, University of Witwatersrand – *South Africa*

Centro de Reflexión y Acción Social Padre Juan Montalvo – *Dominican Republic*

Centro de Saberes para a Sustentabilidade – *Spain*

Coalition to SAVE the Menominee River, Inc. – *United States*

Comisión Intereclesial de Justicia y Paz – *Colombia*

Comité citoyen de protection de l'esker – *Canada*

Comité por los derechos humanos en America Latina – *Canada*

Communities Against Mining (CAM) – *Ireland*

Concerned Citizens of Charles City County – *United States*

Corporación Geoambiental Terrae – *Colombia*

Conselva, Costas y Comunidades A.C. – *Mexico*

Conservation Colorado – *United States*

Conservation NW – *United States*

CooperAcción – *Peru*

Campbell River Environmental Committee (CREC) – *Canada*

Cultural Survival – *International*

David Suzuki Foundation – *Canada*

DECOIN – *Ecuador*

Denver Justice and Peace Committee (DJPC) – *United States*

E-Tech International Inc – *United States*

"EcoLur" Informational NGO – *Armenia*

Earthjustice – *United States*

Earthworks – *United States*

Eau Secours – *Canada*

Ecologistas en Acción – *Spain*

Environmental Defender Law Center – *United States*

European Center for Constitutional and Human Rights (ECCHR) – *Germany*

European Environmental Bureau – *Belgium*

Fair Mining Collaborative – *Canada*

Federation for a Sustainable Environment – *South Africa*

Fondation Rivières / Rivers Foundation – *Canada*

Freshwater Future – *United States*

Friends of Buckingham – *United States*

Friends of the Earth Canada – *Canada*

Friends of the Earth Norway – *Norway*

Fundação Montescola – *Spain*

Global Justice Clinic (Does not represent NYU School of Law – *United States*

Goa Foundation – *India*

Goenchi Mati Movement – *India*

Great Basin Resource Watch – *United States*

Greencastle community voices – *Ireland*

GRUFIDES – *Peru*

Grupo de Estudos e Pesquisas Socioambientais da Universidade Federal de Ouro Preto (GEPSA/UFOP) – *Brazil*

Grupo de Pesquisa e Extensão Política, Economia, Mineração, Ambiente e Sociedade (PoEMAS) – *Brazil*

Homa - Centro de Direitos Humanos e Empresas – *Brazil*

Inclusive Development International – *United States*

IndustriALL Global Union – *Switzerland*

Information Network for Responsible Mining – *United States*

IRPAD/Afrique – *Mali*

Instituto Socioambiental – *Brazil*

Justiça nos Trilhos – *Brazil*

Kamloops Area Preservation Association (KAPA) – *Canada*

Kamloops Moms for Clean Air – *Canada*

London Mining Network – *United Kingdom*

Lynn Canal Conservation – *United States*

Malach Consulting – *United States*

Mesa Nacional Frente a la Minería Metálica – El Salvador

MIICO – *Tanzania*

Mining Impact Coalition of Wisconsin – *United States*

Mining Justice Action Committee – *Canada*

Mining Watch Romania – *Romania*

MiningWatch Canada – *Canada*

Movimento dos Atingidos e das Atingidas por Barragem (MAB) – *Brazil*

Naturvernforbundet – *Norway*

continued

Organizations endorsing these recommendations

Northeast Ohio Black Health Coalition – *United States*

Northern Alaska Environmental Center – *United States*

Observatoire d'Etudes et d'Appui à la Responsabilité Sociale et Environnementale, OEARSE – *Democratic Republic of the Congo*

Okanogan Highlands Alliance – *United States*

Oxfam America – *United States*

Patagonia Area Resource Alliance – *United States*

Pax Christi International-Latin America and Caribbean Program – *Colombia*

Pembroke Clean Water – *United States*

PODER (Project on Organizing, Development, Education and Research) – *Mexico*

Progressive Leadership Alliance of Nevada – *United States*

Project HEARD (Hub for Environmental Activists and Rights Defenders) – *Netherlands*

Projet Resistaction - Centr'ERE, UQAM – Canada

Quebec Meilleure Mine – *Canada*

Radio Emergency Communication Operations Network (RECON Phil. Inc.) – *Philippines*

Regroupement Vigilance Mines de l'Abitibi et du Témiscamingue (REVIMAT) – *Canada*

Richwood Advisory Council – *United States*

Rivers Without Borders – *United States*

Rock Creek Alliance – *United States*

Save Our Cabinets – *United States*

Save our Seas and Shores Coalition – *Canada*

Save Our St Vrain Valley, Inc. – *United States*

Save The Scenic Santa Ritas – *United States*

Sibuyanon Against Mining – *Philippines*

Sierra Club – *United States*

Silver Valley Community Resource Center – *United States*

Society for Threatened Peoples – *Switzerland*

SOS Grenville sur la rouge – *Canada*

Southeast Alaska Conservation Council – *United States*

Southeast Alaska Indigenous Transboundary Commission (SEITC) – *United States*

Southwest Research and Information Center – *United States*

St. Mary's River Association – *Canada*

Sulamesi Wildlife Foundation – *Papua New Guinea*

The Friends of the Stikine Society – *Canada*

The Mining Observatory (Observatório da Mineração) – *Brazil*

Transport & Environment – *Belgium*

Unidos em Defesa de Covas do Barroso – *United Kingdom*

Union of British Columbia Indian Chiefs – *Canada*

vetoNu – *Sweden*

Vida e Ria ou Minaria – *Spain*

Wilderness Committee – *Canada*

Wildsight – *Canada*

Wisconsin Resources Protection Council – *United States*

Yukon Conservation Society – *Canada*

Individuals

Andre Oliveira Sawakuchi – *Instituto de Geociências da Universidade de São Paulo*

Andrew Hopkins – *Australian National University*

Cathal Doyle – *Middlesex University*

Cristiana Losekann – *Universidade Federal do Espírito Santo*

Daniela Campolina Vieira – Grupo de Pesquisa Educação Mineração e Território - *Universidade Federal de Minas Gerais*

Dr. Robin Broad – *American University*

Felipe Fayer Mansoldo – *Universidade Federal de Juiz de Fora*

Gavin Mudd – *Independent Academic Expert*

Joám Evans Pim – *Åbo Akademi University*

John Cavanagh – *Global Economy Project, Institute for Policy Studies*

Karine Gonçalves Carneiro – *Universidade Federal de Ouro Prieto*

Manoela Carneiro Roland – *Universidade Federal de Juiz de Fora*

Marcos Antonio Pedlowski – *North Fluminense State University*

Martha Priscylla Monteiro Joca Martins – *Université de Montréal*

Mbalenhle Mpanza – *University of Johannesburg*

Tatiana Ribeiro de Souza – *Universidade de Ouro Prieto*

Tchenna Fernandes Maso – *Universidade Federal de Juiz de Fora*

William Sacher – *Universidad Andina Simón Bolívar*

Indigenous Communities and Tribal Nations

Luutkudziiwus – *Gitsxan Nation*

Nuxalk Nation – *Nuxalkulmc*

To endorse *Safety First: Guidelines for Responsible Mine Tailings Management*, email us: info@earthworks.org

Contents

Executive Summary

The 2019 mine tailings dam collapse near Brumadinho, Brazil, killed 272 people and decimated houses and buildings for kilometers before flowing into the Paraopeba River. The catastrophe stunned the world but should not have come as a surprise. Tailings facilities, which contain the processed waste materials generated from mining metals and other materials, are failing with increasing frequency and severity.

At present, industry standards and governmental regulations still do not go far enough to adequately protect communities and ecosystems from tailings failures. The design, construction, operation and closure of tailings facilities require significant changes to protect people and the environment.

Tailings facilities can fail in many ways and with varying degrees of severity. While this document outlines guidelines aimed at preventing catastrophic failures, the authors recognize that chronic contamination can sometimes be equally disastrous for communities and the environment.

The primary goals of tailings management must be to ensure that public and environmental safety are the determinative factors governing the operation of tailings disposal systems and to achieve zero tolerance for human harm or fatalities. It is important to recognize the interconnected relationship between people and the natural environment; protecting ecological resources is an extension of human safety. While operating companies must aim to minimize environmental harm everywhere, it must be the goal of every mining operation to at least limit environmental harm to within the mine site.

Operating companies must commit to making safety the primary consideration in tailings facilities and dam design, construction, operation, closure and post-closure, and the primacy of safety must be independently verified. If a regulatory agency, an operating company or another party charged with overseeing the safety of a tailings facility determine that loss of life could occur as a result of a

The Doce River, polluted from the Samarco tailings spill, runs through a hydro-electric power plant in July 2016. Minas Gerais, Brazil. Photo: Júlia Pontés.

tailings dam failure, the dam must be designed to withstand the most extreme meteorological and seismic events theoretically possible at a given location.

Prior to permit approval and over the life of the mine, operating companies must demonstrate the meaningful engagement, participation and consent of potentially affected communities for any tailings facility, including the right of communities to say 'no' to facilities. The self-determination of all affected communities must be respected, particularly for Indigenous communities, and they must be allowed to determine what consultation mechanism is used and who is allowed to participate in the consultation process.

The use of upstream dams and all tailings facilities built on uncompacted tailings must be banned. Additionally, dams must not be built in close proximity to communities or upgradient from mining infrastructure, such as other dams or where workers are likely to be present. Tailings must never be discharged into bodies of water (rivers, streams, lakes, oceans, etc.), regardless of the challenges associated with other disposal methods.

The design, construction, operation and closure of a tailings facility must be subject to the best available technologies and practices. The Best Available Technology for tailings disposal is the use of filtered tailings, which reduces the probability and consequences of failure. Nevertheless, such technologies must also be subjected to strict social and environmental licensing processes. The disposal of filtered tailings improves the safety of closed facilities.

Operating companies must document the results of a detailed characterization of the dam foundation and the tailings material properties, with special attention to clay content, liquefaction potential, and the presence of brittle tailings. An Engineer of Record must submit an annual report verifying that dam operations and construction adhere to the approved dam design.

Tailings facilities must be monitored, inspected, maintained and reviewed in perpetuity, or until there are no credible (physically possible) failure modes. Without perpetual oversight, the failure of a tailings dam is inevitable. Given that operating companies will not exist long enough to accomplish perpetual monitoring, inspection, maintenance and review, the operating companies' ability to eventually eliminate all credible failure modes must be a key consideration during the permitting process. If a tailings facility is proposed in a location where the consequences of failure are too great, the facility must not be built.

Worst-case tailings failure scenarios must consider the loss of all tailings at full tailings facility buildout, and the results must be made public prior to permitting. Modeled failure scenarios must also be annually updated. Emergency and evacuation drills related to the catastrophic failure of tailings facilities must be held on an annual basis, and their planning and execution must include participation from affected communities, workers, local authorities and emergency management personnel. Communities must have access to independent technical experts of their choosing to assist them in evaluating the potential for and consequences of a catastrophic tailings failure at the time the facility is proposed and throughout the life of the facility.

A culture of safety and responsibility must be upheld at the highest level within a corporation. The board of directors must be held accountable for its actions (or lack thereof). The board of directors must bear the primary responsibility for the safety of tailings facilities, including the consequences of dam failures, and demonstrate that the company has the necessary financial assurance to cover the implementation of closure and post-closure plans, and adequate public liability insurance to cover the full costs of all failures, including catastrophic failures.

The safest tailings facility is one that is not built. To avoid the long-term liability of mine waste facilities and their social and environmental impacts, we must reduce the volume of tailings produced and the overall demand for primary raw materials and new mining. A permanent above-ground tailings facility should be a last resort. Over the past 40 years, ore grades — the concentration of the metal or mineral of value — have declined on average by half for many commodities, effectively doubling the volume of mine waste generated for each unit of valuable material produced. Current trends suggest an additional 2- to 10-fold increase in the demand for many commodities, particularly those needed for energy transition technologies, by 2060. These trends are not sustainable. In order to transition away from fossil fuels in a way that is sustainable, just and equitable, we need to reduce the need for new mining and the amount of mine waste produced, while using the best standards and practices for any new mining activity.

SUMMARY OF GUIDELINES

- Make safety the guiding principle in design, construction, operation and closure of tailings facilities.
- Ban new tailings facilities in locations that would not allow for timely assisted evacuation of inhabited areas in the event of dam failure.
- Ban upstream dams at new mines and close existing upstream dams.
- Design dams to avoid any potential loss of life, which must be considered an extreme event.
- Mandate the use of best available technology for tailings facilities, including the use of filtered tailings, and implement rigorous controls for safety, including after mine closure.
- Demonstrate understanding of local conditions and tailings characteristics with robust monitoring systems.
- Develop appropriate emergency preparedness/response plans.
- Ensure the independence of reviewers to promote safety and transparency.
- Address financial risks, including proper financial assurance and insurance.
- Attempt to eliminate all credible failure modes to have safer facility closures.
- Establish grievance procedures, whistleblower protection, and community-based safety oversight for potentially affected communities.
- Obtain consent from potentially affected communities and guarantee the right to say 'no' to proposed or expanded tailings facilities.
- Make information regarding mine safety publicly available in relevant languages.
- Offer affected communities access to independent technical experts.
- Require corporate boards of directors assume full responsibility for the risks (including financial risks) and the consequences of tailings facility failures.

To understand how and why failures occur, we must understand the scope of the issue. A global inventory of the thousands of active and abandoned tailings disposal facilities does not exist, nor is there a complete registry of tailings dam failures. Compiling and sharing this information, publicly and transparently, is essential. An independent international agency, such as a United Nations-endorsed agency, in collaboration with civil society, States, and operating companies, must drive the process to collect information on tailings dams and tailings dam failures worldwide, and share it with the public to reduce the risks associated with these sites and promote the protection of human health and the environment.

This international agency must be able to provide guidance and transparency on tailings management worldwide to protect the health and safety of people and the environment. It must be a well-resourced agency capable of efficiently analyzing global standards, investigating failures, collecting and disclosing site-level data, responding to grievances and making publicly available recommendations. The governance structure for this agency must be a multi-stakeholder body that includes affected communities, Indigenous Peoples, labor, and civil society organizations. It must ensure a co-equal decision making process that includes all stakeholders, without undue influence by the sector that is being monitored. It must provide secure access to a grievance mechanism for community or worker reports and whistleblower complaints.

Language

This document uses the word "must" to indicate an action or guideline that is required. The word "should" is used when the action or guideline is optional or unattainable at this time.

The authors chose to use tailings disposal instead of tailings storage throughout the document. The term storage implies that tailings are temporarily stored until another use is identified. The authors use disposal to indicate that tailings are a waste material without a guaranteed secondary use.

Aerial view of mine waste, Catalão, Goiás, Brazil. Photo: Júlia Pontés.

Introduction

In January 2019, a dam at the Córrego do Feijão mine owned by Vale in Brumadinho, Brazil, collapsed, releasing about 9.7 million cubic meters of tailings. The mine waste traveled eight kilometers over land,[1] killed over 272 people,[2] destroyed houses and buildings, and eventually flowed into the Paraopeba River.

The Brumadinho catastrophe stunned the world, including the mining industry and investors, but should not have come as a surprise. It came on the heels of massive tailings dam collapses in 2014, at Imperial Metals' Mount Polley gold-copper mine in British Columbia, Canada, and in 2015 at the Samarco iron mine in Mariana, Brazil, a joint venture owned by Vale and BHP Billiton. The failure of the Samarco mine killed 19 people and sent tailings nearly 700 kilometers down the Rio Doce to the Atlantic Ocean. After the Mariana catastrophe, Vale's CEO vowed "never again." And yet, three years later, the dam at their Córrego do Feijão Mine collapsed.[3]

As tailings facilities fail with increasing frequency and severity,4 new regulations and standards have emerged in an effort to reign in dangerous practices and prevent future disasters. After the Brumadinho failure, investor intervention spearheaded by the Church of England, led to the swift rollout of the Global Tailings Review (GTR), co-convened by the International Council on Mining and Metals (ICMM), Principles for Responsible Investment (PRI) and the United Nations Environment Programme (UNEP). According to its website, the GTR sought "to establish an international standard for the safer management of tailings storage facilities."[5] The Global International Standard on Tailings Management (GISTM) was released in 2020.[6]

Current industry standards, including the GISTM, do not go far enough to adequately protect communities and ecosystems from the consequences of tailings failures. They often lack clear and

A fjord outside Kirkenes in Norway's northeastern corner, has filled up with tailings after decades of mining companies dumping waste in the harbor. Kirkenes Harbor, Finnmark, Norway. Photo: WikiCommons.

mandatory technical guidelines to move away from technologies and practices that present the greatest risk, as is done in other high-risk industries, such as aviation and long-distance pipelines. Significant changes must be made to current practices in design, construction, operation, and closure of tailings facilities. As climate change exacerbates the risk and consequences of failures, this has only become more urgent. The following document outlines guidelines for safety, respect for affected communities, and corporate accountability that must be incorporated into any tailings standard or regulations.

Mine tailings are the waste that remains after the metals or minerals of economic value have been removed from ore using physical and/or chemical separation methods. Tailings consist of processed rock or soil, water, and possibly other mining products, including blasting chemicals (ammonia, nitrate), trace quantities of chemicals used in the separation process (e.g., petroleum byproducts, cyanide, caustic agents), and metals and other constituents leached from the rock or soil (e.g., copper, cadmium, lead, zinc, iron, arsenic, aluminum, manganese, sulfate). Tailings can be backfilled in underground mine workings or exhausted open pits, but in general, tailings are held in a permanent surface impoundment behind a dam that is constructed from other mine wastes. While this document mandates the use of filtered tailings in new tailings facilities, the authors recognize that there are existing tailings facilities that do not use filtered tailings and, for this reason, also provide guidance for tailings ponds.

Catastrophic tailings dam failures have most often occurred at iron and aluminum mines, but many failures have also occurred at gold, copper, uranium, and other types of mines – including both open pit and underground mines. In addition to catastrophic failures, slower releases of contaminants can occur by seepage from the impoundment, windblown tailings, and an overtopping of the dam that does not result in a catastrophic release of tailings and tailings water. Catastrophic and slower releases from tailings facilities have long-term adverse effects on groundwater, surface water, soils, vegetation, and communities.

This document recognizes that the safest tailings facility is the one that is never built. A permanent above ground tailings facility must be a last resort. We must instead find ways to reduce the amount of tailings produced and the overall demand for primary raw materials to avoid the long-term liability of mine waste sites and their social and environmental impacts. World production has already increased 2- to 10-fold for various commodities over the last 40 years.[7] During the same period, ore grades have declined on average by half for many of those commodities, effectively doubling the volume of mine waste generated for each unit of valuable material produced. According to the World Bank and Australia's Institute for Sustainable Futures, demand for metals, specifically for the energy transition, is set to explode between now and 2050, with anticipated increases of 300 to 8000 percent for certain metals, depending on the scenario.[8,9]

Clearly, these trends are not sustainable. If virgin extraction to source metals and other raw materials, including those needed to support energy transition technologies, is needed, best standards and practices must be enforced. As a society, and particularly for countries in the Global North, we also need to actively find ways to reduce the overall demand for raw materials by redesigning our cities and transportation systems to reduce dependence on single family vehicle ownership, and shifting away from some of the current raw material uses. Research shows that material recycling and demand reduction strategies can help us build a future that is less reliant on extraction and is more just and equitable for mining-affected communities and ecosystems.[10]

To reduce the amount of tailings produced, and stored aboveground, it's important to:

1. Reduce the demand for metals and minerals by shifting away from disposable consumption and overconsumption.
2. Reduce the demand for new mines or expansion of existing mines by implementing circular economy solutions and minerals recycling, re-processing existing tailings, and deriving metals from other unconventional sources such as contaminated waters and other wastes.
3. Obtain commodities with the minimum production of tailings.
4. Maximize the conversion of tailings into useful and/or marketable products.
5. Maximize the use of tailings for the construction of mine infrastructure with proper safeguards in place to avoid contaminant leaching.
6. Maximize the backfilling of tailings into exhausted open pits or underground mine workings.[a]

This document is not intended to replace regulations or serve as a standalone comprehensive standard. However, any standard, regulation, or guidance document that is not protective of people, property and the environment, as outlined in this document, is insufficient. Additionally, there may be circumstances under which a tailings facility can meet all the guidelines in this document but must not be built or allowed to continue in operation.

Ultimately, protective tailings regulation must fall to the regulators charged with public safety. In many places, protective tailings regulations either do not exist or are not adequately enforced. Too frequently governmental agencies are unable, because of limited resources or technical expertise,

[a] Currently California, U.S. and New Caledonia have requirements for backfilling open-pit mines. In Quebec, Canada it is mandatory to submit a cost-benefit analysis of backfilling open-pit mines, while guidance from British Columbia, Canada states that backfilling should be maximized in mine design and operations.

or unwilling, because of political pressure, corruption or the undue influence of the mining industry, to enact and/or enforce regulations that prioritize safety. It is important to acknowledge the pervasive problem of "regulatory capture" in mining oversight, in which the mining industry directly or unduly influences decisions made by regulators.[11,] This can take the form of lobbying, and/or political contributions and "revolving doors" between regulators and mining operators, as well as a lack of clarity between public interest and corporate interests in public policy.[12] In some jurisdictions, regulatory agencies charged with the oversight of safety in mining activities are funded wholly by the industry itself.

Furthermore, while voluntary standards and third-party certification schemes can be instrumental in advancing best practice and technology, they are not substitutes for governmental regulations, monitoring, and enforcement.

Governmental regulators must ensure their independence from the mining industry, uphold their commitment to public safety in tailings permitting and monitoring, and enforce financial or other types of sanctions and corrective actions for regulatory violations. Throughout this document, the authors often refer to the need for independent technical assistance, and independent or third-party reviews of mining operations. This is to create mechanisms for oversight beyond operating companies and their direct employees, and to address the distrust that many mining-affected communities feel toward operating companies. The authors hope the revised version of Safety First will empower civil society groups, frontline communities, Indigenous Peoples, labor unions, academic researchers, and NGOs to take a more active role in tailings management and the enforcement of safer tailings disposal practices. At the same time, Safety First highlights the need for transparent regulatory agencies that can operate without undue influence from the mining industry.

Safety First was originally released in 2020 to address the need for more protective tailings management. After its release, the authors received feedback on the guidelines from frontline community, Indigenous, NGO, academic, and technical experts. In light of this feedback, the authors held a series of regional workshops to hear from mining-affected communities, local NGOs, and Indigenous Peoples about their experiences with tailings and to receive their comments on the guidelines. The workshops were held in four languages and included over 200 participants from five continents. The authors also solicited and received written comments.

These comments helped inform the 2022 version of Safety First. The authors would like to thank all the community members, organizations, academics, and scientists who provided invaluable feedback on the original version of the guidelines and helped us create a stronger, more community-centered revised document. The Safety First guidelines are not final and will be regularly updated to reflect changes in tailings design, management, regulation, and best practices. The authors hope this document can be one step toward proactively protecting the interests of frontline communities in tailings management.

The 2015 collapse of the tailings dam at the Samarco mine, owned by Vale and BHP, created a flash flood of tailings that covered houses in the town of Bento Rodrigues, Brazil. Minas Gerais, Brazil. Photo: Rogério Alves/TV Senado.

Scope

Tailings facilities can fail in many ways and with varying degrees of severity. A tailings failure is an unintended or uncontrolled release of materials, including tailings, water or dust, from a tailings disposal facility. This document outlines guidelines aimed at preventing catastrophic failures, defined as failures that constitute a rapid shock, and that happen without warning (even if they could have been foreseen).[13,b] Sudden failures are not the only type of tailings failure, and failures that occur more slowly or over a longer period of time can also have disastrous impacts. While this report does not attempt to comprehensively address all tailings failures, such as chronic environmental contamination, the authors recognize that such impacts represent serious public and environmental health concerns for many communities living in the vicinity of tailings sites.

For each aspect of tailings management, the authors have based the guidelines on the most conservative criteria (most protective of people, property and the environment) from among the existing guidance documents and regulations. *Safety First* sometimes draws from guidance for water-retention dams, if they are more conservative than existing tailings dam guidance. Operating companies must identify, prevent and mitigate any environmental and public health impacts in addition to taking steps to prevent sudden catastrophic failures.

EXAMPLES OF LONG-TERM ENVIRONMENTAL IMPACTS

WATER CONTAMINATION: Ongoing and periodic water contamination caused by leaching, seeping, spills, pipeline leaks, or overtopping of tailings disposal facilities. At the San Finx mine in Galicia, Spain, an average of approximately 50,000 liters of water contaminated with mine waste are released per hour into a nearby river, leading to cadmium, copper and zinc concentrations that are above maximum allowable levels kilometers downstream.[14]

- Prevention measures: Tailings facilities must use multiple mechanisms, including liners, covers, and stormwater run-on and run-off controls, to minimize seepage from the facilities and infiltration to groundwater to the greatest extent possible. Treatment systems for water collected from tailings facilities must adequately reduce toxic metal contaminants without using off-site dilution.

DUST EMISSIONS: Fugitive dust emissions from tailings disposal facilities lead to air pollution, causing health issues, like respiratory problems, and environmental contamination of vegetation, soil, wildlife, and surface water. In South Africa gold mines in the Witwatersrand region have dust fallout that is high in silica and uranium concentrations. This dust has led to adverse respiratory health effects in local communities.[15,16]

- Prevention measures: Operating companies must undergo concurrent reclamation with covers to minimize dust production.

[b] For example, the Mount Polley dam disaster could have been foreseen if the foundation had been properly characterized.

AQUEOUS TAILINGS DISPOSAL: Every year, mining companies dump 220 million metric tons of mine waste directly into oceans, rivers and lakes.[17] This practice smothers river beds, seabed floors and coral reefs, decimates fish populations in freshwater and marine environments, and floods wetlands and forests. Since 2012, the Ramu nickel mine in Papua New Guinea has dumped millions of metric tons of tailings into the ocean. A study of the area found elevated levels of heavy metals "much above the allowed limits" in agricultural soils, beach sands, and water from the river and sea, including drinking water and food.[18]

- Prevention measure: Tailings must never be discharged into bodies of water (rivers, streams, lakes, oceans, etc.), regardless of the challenges associated with more protective disposal methods.

While environmental, health and safety effects warrant protective guidelines and effective long-term monitoring and mitigation measures, addressing the full range of remediation options for all types of tailings failures is beyond the scope of this document.

Operating companies are responsible for the perpetual care of a tailings facility until there are no credible failure modes. Operating companies may avoid using the word "dam" in an attempt to skirt tailings dam safety requirements. However, it is important to note that these guidelines apply to any engineered structure that contains mine tailings, regardless of the terminology used by the operating company to describe the engineered structure. In particular, the guidelines in *Safety First* apply to:

1. Conventional tailings impoundments;
2. Waste dumps that store a mixture of tailings, ore reject material,[c] and/or waste rock;
3. Filtered tailings facilities (with or without the admixture of ore reject and/or waste rock);
4. Tailings that are stored in exhausted open pits that employ dikes, berms or similar structures, and;
5. The structural zones (containment structures) of tailings disposal facilities, including the structural zones of filtered tailings facilities

RELEVANCE TO OTHER MINE FACILITIES

Mine facilities that do not contain tailings, such as waste rock, heap leach, and dump leach facilities, also have inherent risks. Heap and dump leach facilities are commonly used in gold and copper mining, respectively. The material in heap and dump leach facilities is initially considered ore but becomes waste after the application of cyanide or acid ceases – and the spent materials typically remain on the surface in perpetuity. Surface waste rock facilities are common at nearly all mines, although mixing waste rock into tailings impoundments has become more common recently. The potential for these facilities to leach contaminants during and after their active lives and to become physically unstable presents an ongoing risk to downstream and downgradient communities and the environment. A major landslide associated with the waste rock pile caused failure of the Bellavista Mine cyanide heap leach facility in 2007 and resulted in closure of the mine, groundwater

[c] Ore rejects are the gravel-sized materials that remain after a process that separates lower-grade from higher-grade ore fragments prior to mineral processing for extraction of the commodity of value. The purpose of ore reject technology is to avoid the creation of excessive tailings from low-grade ore fragments.

contamination near the community of Miramar,[19] and is an example of the kind of adverse impacts that can occur at these types of facilities from slope instability.[20]

The 2015 collapse of the tailings dam at the Samarco mine, owned by Vale and BHP, created a flash flood of tailings that covered the town of Bento Rodrigues, Brazil. Minas Gerais, Brazil. Photo: Rogério Alves/TV Senado.

Guidelines

1. Make safety the guiding principle in design, construction, operation, and closure

Given the hazardous nature of mine tailings, the fundamental goal of tailings management must be to "ensure that public safety, environmental safety, and economic safety are the determinative factors in governing what tailings disposal system will be implemented."[21] Specifically, tailings management must ensure zero harm to people and zero tolerance for human fatalities. It is important to recognize that mining is a fundamentally destructive industry, meaning that a goal of zero harm to the environment is impossible to achieve. Nevertheless, operating companies must do all that they can to minimize environmental harm everywhere. In particular, they must limit any environmental harm that inevitably occurs to within the mine site.[d]

Safety must be evaluated by independent third-parties, such as an Independent Tailings Review Board, to ensure that cost reduction is not prioritized at the expense of people and the environment. Operating companies must document that, at all points of design, operation, closure, and post-closure of tailings facilities, protecting human and environmental health and safety is the primary concern. Taking lessons from the 2014 Mount Polley mine disaster in Canada, and citing the Independent Expert Engineering Investigation and Review Panel,[22] the 2017 UNEP-GRID Arendal rapid response assessment on tailings disposal also made safety its first recommendation: "Safety attributes should be evaluated separately from economic considerations, and cost should not be the determining factor."[23] If a mining project is uneconomic due to the costs of a safe tailings disposal system, then it is uneconomic — costs and risks must not be transferred to the environment, communities or host governments.

2. Consent of affected communities[e]

Consent must be achieved through an ongoing dialogue over the life of the mine for both proposed and existing facilities. The First Nations Mining and Energy Council states that, "consent is simple — it is the right to say yes, the right to say no, or the right to say yes with conditions."[24] Consent can be given or withheld at distinct stages of a project, including exploration.[25] Operating companies must ensure the meaningful engagement, participation, and consent of all affected communities for any tailings facility.

All engagement must be conducted in local languages and align with the cultural norms and communication styles of any affected communities and stakeholders. Engagement must begin as early as possible, before any exploration has taken place and as part of the mine

---

[d] A mine site is the area of surface disturbance necessary to conduct a mining operation. This includes extraction, processing, and waste disposal facilities, and roads. A mine site does not necessarily include the entire area as defined by the mine permit or claim.

[e] This guideline applies to both affected and potentially affected communities, including Indigenous, Afro-Descendant, Traditional, First Nation, Aboriginal, Adivasi, Janajati and non-Indigenous communities.

permitting process. For existing mines, permits and licenses must be reviewed by relevant regulatory agencies and consent must be sought.[26]

Consent must be obtained through culturally appropriate processes, time frames and mechanisms that are determined by the Indigenous Peoples or affected communities. These may include customary decision-making processes, local democratic processes and local governance mechanisms, or other processes such as referenda.

For Indigenous Peoples, the United Nations recognizes that Free, Prior and Informed Consent (FPIC) must be in place in order for a mine to be developed, operated, and closed. The rights of Indigenous Peoples are human rights and are indivisible from their cultural, territorial and self-governance rights.[27] Indigenous People hold title on their lands by virtue of their occupation and stewardship of those lands prior to colonization and continuing to the present day. Indigenous laws have always existed and governed Indigenous lands.[28] Therefore, Indigenous Peoples have both self-governance rights as distinct, self-determining peoples with specific decision-making processes, laws, practices, and institutions, and collective territorial, self-governance, and cultural rights. Indigenous and Afro-Descendant Peoples are increasingly documenting their governance rules for consultations and Free, Prior and Informed Consent (FPIC) in the form of Autonomous FPIC Protocols for which they demand compliance by all external actors.[29] An FPIC process cannot be carried out where Indigenous or Tribal Peoples are living in voluntary isolation, such as uncontacted tribes in the Amazon.[30]

Indigenous Peoples and affected communities must be afforded the opportunity to establish land-use plans and "no-go zones."[31] This acknowledges that certain areas must never be considered for tailings disposal, no matter how the tailings facility is designed, monitored or operated. "No-go zones" may include potentially affected areas located in the zone of influence of tailings facilities (e.g. sacred sites) that would not allow for the construction of a facility. In some cases, Indigenous governmental bodies may have their own standards, requirements, and monitoring and inspection systems for mining operations. In these

After a rigorous Environmental, Social and Cultural Impact Assessment led by local Indigenous protocols, the Stk'emlupsemc Te Secwepemc Nation rejected in 2017 a large tailings facility proposed by the company KGHM near their sacred Pipsell site area. Pipsell, Secwepemc Territory, British Columbia, Canada.
Photo: Stk'emlupsemc Te Secwepemc Nation (SSN).

instances, operating companies must comply with any directives made by relevant Indigenous governmental bodies.[32]

In accordance with the UN Declaration on the Rights of Indigenous Peoples, Indigenous People have the right to self-identify with an Indigenous community that accepts them as a member.[33] An operating company must respect any community that self-identifies as Indigenous and respect their right to establish no-go zones and autonomous FPIC protocols, regardless of whether or not they have obtained legally recognized status as Indigenous.[34]

Consent must be free of external manipulation, coercion or extortion. Indigenous Peoples and affected communities must be assured the right to say no to a tailings disposal facility without fear of potential backlash from local government, police or military forces, interested third-parties, and/or the operating company.[f] Given the power asymmetries that often exist between operating companies and communities, Indigenous Peoples and affected communities must be permitted to decide who is allowed to be present and participate in a consultation process.[35] This means that they may choose to hold consultation processes in which representatives from the operating company, national or local government, or police forces are not permitted to participate or be present.[36] The community can also choose how they will communicate the results of the consultation process to their government, relevant regulatory agencies, and the operating company. This helps ensure that consent is freely given.

Operating companies must provide a transparent risk analysis identifying and evaluating the geographic area and inhabited areas that could be affected by all proposed tailings facilities to all affected stakeholders.[37] The study must include, but not be limited to, both positive and negative impacts on affected communities and ecosystems, including chronic pollution, and labor and economic impacts.[38] It must also include an assessment of the outcomes where no mine or tailings facility is built. The study must be provided sufficiently in advance so as to give communities ample time to understand and analyze the proposed project. The time frame is dependent on the decision-making processes of the affected stakeholders, but consultation must be "sought sufficiently in advance of any authorization or commencement of activities, at the early stages of a development or investment plan, and not only when the need arises to obtain approval from the community."[39] The study must evaluate the impacts of all proposed facility designs and sites, and must be updated anytime a tailings facility's design is changed, expanded, or closed. Due to the ability of tailings to travel hundreds of kilometers and impact extensive areas in the event of a failure, the impact study must be based on the most comprehensive definition of affected people and area, with special consideration to any impacted watersheds.

Affected communities must have access to independent technical or other expert advice from the earliest stages of exploration, through monitoring and closure plans.[40] Affected communities must be able to select the experts in order to ensure they are trusted (See Guidelines 16).

---

[f] The right to say no to a tailings facility and provide freely given consent was a commonly expressed concern by communities in the 2021 consultation process.

If the representatives of affected communities or Indigenous Peoples clearly communicate, at any point during engagement with the operating company, that they do not wish to proceed with consent-related discussions, the company must recognize that it does not have consent, and must cease to pursue any proposed activities affecting the rights or interests of affected communities. The company may approach affected communities or Indigenous Peoples to renew discussions only if and when invited to do so by the communities' representatives.

Operating companies must document and report all steps taken towards community consent and/or FPIC. In some jurisdictions, there may be public agencies that mediate or supervise contact with Indigenous People. In these cases, operating companies must follow established protocols for contacting and obtaining consent from Indigenous People. Documentation on the consent process and FPIC must be made publicly available and filed with state agencies, however any public disclosures of FPIC or community consent must be approved by Indigenous Peoples and affected communities before their release. The operating company must document and make public how any feedback received was incorporated and addressed.

3. Ban new tailings facilities where inhabited areas are in the path of a tailings dam failure

The most effective way to minimize risk to people is to prevent the construction of new tailings facilities where there is a population living or working in close proximity, downstream, or down gradient from the facility. Operating companies must not build infrastructure in which workers are likely to be present—offices, cafeterias, warehouses—in the zone of influence. The zone of influence is the "area that would be significantly affected in case of a [tailings facility] failure and should be categorized as a risk zone."[41] New tailings facilities must not be constructed if the operating company cannot ensure the safe and timely assisted evacuation of any population that lives in the zone of influence.

The location and safety of a tailings facility must not only contemplate the impact to human lives in the case of a failure, but the environmental and economic impacts as well. Affected communities must be able to define no-go zones, or zones where a tailings facility is not permitted due to environmental, cultural or economic factors (See Guideline 2). Tailings facilities must not be constructed in a location where a failure would materially impact public water supplies or critical habitats, or near protected ecological resources. Additionally, tailings must never be deposited in bodies of water, such as rivers, streams, oceans, etc. Because tailings can flow for up to hundreds of kilometers during a failure, specific consideration of all downstream communities, ecosystems, cultural, sacred and touristic sites, and areas of economic production must be undertaken in the determination of potentially affected areas. It is important to recognize the interconnected relationship between people and the natural environment; protecting ecological resources is an extension of human safety.

The construction of new dams and the expansion of existing dams is banned in legislation in Ecuador and Minas Gerais, Brazil if there are settlements within 10 kilometers downstream along the course of the valley or if projections indicate that a flood from a tailings failure might reach nearby communities in less than 30 minutes. In Minas Gerais, the distance can be increased to 25 kilometers, depending upon the population density and the natural and cultural heritage of the area.[42] Although these geographic and temporal limits are better than no regulation, they do not necessarily ensure safe evacuation in every situation. Therefore, the minimum distance between communities and new dams must be defined on a case-by-case basis. This distance must be calculated based on the time it would take to evacuate the entire community with the support of a rescue team and the time it would take for a tailings flood to reach the community, with a safety buffer built into the calculation. The time it takes for a tailings flood to reach a community must be calculated based on a dam break study conducted for the specific tailings disposal facility.

When existing facilities are too close to communities to ensure safe evacuation, operating companies must negotiate with communities to close the tailings facility. While it is imperative that operating companies do all that they can to quickly close unsafe tailings facilities, in the case where a safe closure is not possible in a timely manner and no other solutions are available (see Guideline 11 for details on safe closure), the operating company must offer a package of voluntary resettlement. Involuntary resettlement must not be allowed under any circumstance. In many cases, however, resettlement that is called "voluntary" can be highly problematic and lead to forced relocation and inadequate compensation. Voluntary resettlement must be carried out in a manner that aligns with best practices and the highest international resettlement standards. Voluntary resettlement can only occur with the consent of affected communities (see Guideline 2), it must provide fair and appropriate compensation for loss of land and other assets, as well as security of tenure in the new location, and must result in improved livelihoods and standards of living for those who are resettled.[43,44,45]

Communities must have access to independent technical experts throughout the resettlement process (see Guideline 16). Any voluntary resettlement process must include collective and individual resettlement options.

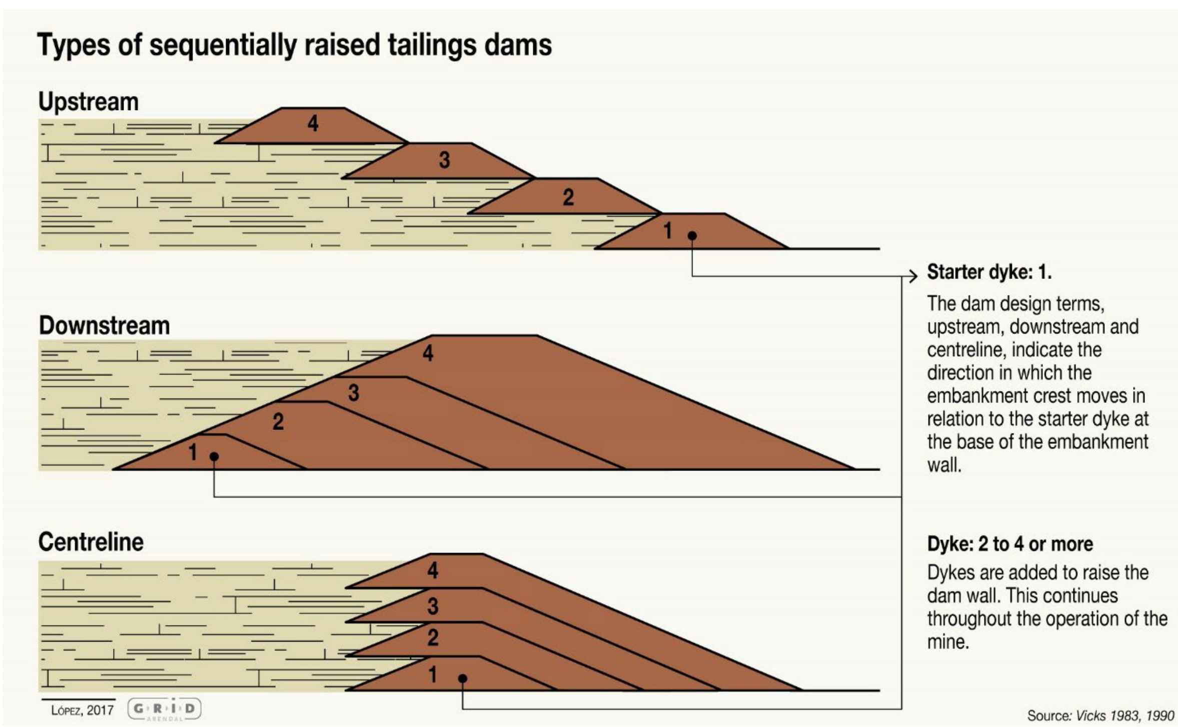
4. Ban upstream dams at new mines and close existing upstream facilities

Because of the demonstrated risk associated with upstream dam construction,[46,47,48] upstream dams must not be built at any new facilities. Upstream construction is especially problematic in areas with moderate or high seismic risk, or in wet climate areas with net precipitation (more precipitation than evaporation), especially as weather events become increasingly severe with climate change. The structural zone of a filtered tailings stack must not be constructed on top of uncompacted or lightly-compacted filtered tailings. If it is, it would be an upstream dam and must be prohibited.

The construction of new upstream tailings dams has already been banned in Brazil,[49] Chile,[50] Peru,[51] and Ecuador.[52] It is theoretically possible to safely construct and operate an upstream tailings dam under the limited conditions of low seismicity, low precipitation and highly-trained personnel. Even under those limited conditions, a very influential tailings industry paper, with many antecedents, has argued that there are ten rules for upstream dams and not a single one can be violated without substantial risk of failure.[53] There is broad consensus within the engineering community, especially in high-risk industries such as aviation and pipelines, that engineered structures should be robust, with multiple back-ups and defense mechanisms. The need to obey ten rules with no margin for error does not constitute a basis for safe design.

In comparison to upstream dams, centerline and downstream dams are much less vulnerable to all mechanisms of dam failure. A downstream or centerline raise constructed on top of an existing upstream dam or on top of uncompacted tailings still constitutes an upstream dam.[g] According to the International Commission on Large Dams (ICOLD) bulletin 181, variations on centerline dams include modified upstream or modified downstream dams.[54] In some jurisdictions where upstream dams have already been banned, operating companies have used the concept of "modified centerline" to avoid the prohibition. What these operating companies call a modified centerline design must be considered an upstream dam because it still includes construction of the dam on top of uncompacted tailings. Operating companies must correctly identify upstream construction to regulatory agencies.

Expansion of existing upstream tailings facilities must cease, and these facilities must be safely closed as soon as possible. This includes dams where companies have been approved for permits that have not begun or are just beginning construction. The deadline for safe closure must depend on engineering and the safety of affected communities, rather than economic considerations (see Guideline 11 for safe closure specifications).



Source: Grid

[g] The Riotinto Mine in Spain, operated by Atalaya Mining, can provide an example of this type of construction.

5. Any potential loss of life is an extreme event and design must respond accordingly

If an operating company, regulatory agency, or independent third-party identifies any potential loss of life as a result of a tailings dam failure, the dam must be designed to withstand the Probable Maximum Flood (PMF), which is the largest flood that is theoretically possible at a given location, and the Maximum Credible Earthquake (MCE), which is the largest earthquake that is theoretically possible at a given location.[55] Where the failure of a tailings dam would have no potential for the loss of human life, the facility must be designed to withstand a 10,000-year flood and a 10,000-year earthquake.

In the United States, the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation have guidelines for water-retention dams that require dams are able to withstand the Probable Maximum Flood and Maximum Credible Earthquake when there is potential loss of life in the event of a dam failure. Considering that there are currently no federal guidelines in the U.S. for tailings dams, U.S. federal guidelines for water-retention dams must apply to tailings dams. The U.S. Federal Emergency Management Agency (FEMA) has three Hazard Potential Classifications, which are Low, Significant and High. High Hazard Potential means "probable loss of life due to dam failure or misoperation." These regulations clarify that "probable loss of life" means "one or more expected."[56] A dam in the High Hazard Potential category must be designed for the PMF. In addition, the U.S. Army Corps of Engineers (USACE) has four categories of dam safety standards. The strictest, "Standard 1 applies to the design of dams capable of placing human life at risk or causing a catastrophe, should they fail."[57] For Standard 1, "structural designs will be such that the dam will safely pass an IDF [Inflow Design Flood] computed from probable maximum precipitation (PMP) occurring over the watershed above the dam site."

Additionally, according to FEMA (2005), High Hazard Potential dams must be designed for the Maximum Credible Earthquake (MCE). Similarly, USACE guidelines from 2016 state, "for critical features, the MDE [Maximum Design Earthquake] is the same as the MCE."[58] All modeling and design for floods must take climate change into account — this applies for both closed and operating facilities.

Freeport McMoran's Gasberg mine in West Papua dumps tailings waste into the Otomin and Ajkwa rivers. Photo: Earthworks.

6. Mandate the use of Best Available Technology for tailings, in particular filtered tailings

All new mines that create tailings must begin with an analysis of the best available technology (BAT) for tailings disposal. Best available technology[h] and practices in tailings management will continue to change, but tailings BAT was specified by the Mount Polley Independent Expert Engineering Investigation and Review Panel (the "Mount Polley Report") in the following way:

"While best practices [BAP] focus on the performance of the tailings dam, best available technology (BAT) concerns the tailings deposit itself. The goal of BAT for tailings management is to assure physical stability of the tailings deposit. This is achieved by preventing release of impoundment contents, independent of the integrity of any containment structures. In accomplishing this objective, BAT has three components that derive from first principles of soil mechanics:

1. Eliminate surface water from the impoundment.
2. Promote unsaturated conditions in the tailings with drainage provisions.
3. Achieve dilatant conditions[i] throughout the tailings deposit by compaction."[59]

The British Columbia Mining Code Guidance asserts, "Physical stability is of paramount importance, and options that require a compromise to physical stability should be discarded."[60] Reducing the water content in a tailings facility increases safety because it reduces both the probability and consequences of a tailings dam failure. When tailings are sufficiently filtered, they have a moisture content similar to that of a moist soil. Filtered tailings can be compacted in the tailings facility, which reduces the likelihood of liquefaction.

The initial disposal of filtered tailings facilitates an eventual safe closure. Tailings placed by conventional methods, i.e. slurry, thickened, and paste tailings, can be drained after placement, but this approach does not reduce the water content as low as filtering the tailings (See Guideline 11 for more discussion of safe closure). Nevertheless, filtered tailings do not eliminate all risks. Because they still require a structural zone (which is a type of dam) for containment,[61] they must be treated as an engineered tailings facility (i.e. tailings dam) from a regulatory standpoint. The structural zone of a tailings facility must not be placed on top of a non-structural zone, such as uncompacted or lightly compacted tailings (See Guideline 4).

---

[h] When Best Available Technology is capitalized in the document it refers to BAT as it was specified in the Mount Polley Report. When best available technology is not capitalized it refers to best available technology and practices more generally, without explicit reference to the Mount Polley Report.

[i] Tailings in a dilatant state are less likely to liquefy because they will tend to expand, rather than contract, in response to disturbance.

The Mount Polley Report recommends that:

- "For existing tailings impoundments. Constructing filtered tailings facilities on existing conventional impoundments poses several technical hurdles....[j] Attempting to retrofit existing conventional tailings impoundments is therefore not recommended … reliance instead (should be) on best practices during their remaining active life.
- For new tailings facilities. BAT should be actively encouraged for new tailings facilities at existing and proposed mines. Safety attributes should be evaluated separately from economic considerations, and cost should not be the determining factor.
- For closure. BAT principles should be applied to closure of active impoundments so that they are progressively removed from the inventory by attrition. Where applicable, alternatives to water covers should be aggressively pursued."[62]

The Mount Polley Report goes on to say, "Filtered tailings technology embodies all three BAT components" and "[t]here are no overriding technical impediments to more widespread adoption of filtered tailings technology." All three BAT components must be incorporated into tailings disposal. While filtered tailings are considered Best Available Technology, filtered tailings can still fail and their use is not an excuse to ignore other aspects of tailings safety.

Additionally, best available technology includes reducing the amount of tailings stored above ground as much as possible. The BC Mining Code Guidance recommends minimizing the surficial footprint of tailings facilities and maximizing in-pit or underground backfill.[63]

The use of subaqueous tailings disposal to prevent acid mine drainage can no longer be regarded as a best practice. The Mount Polley Report emphasized, "It can be quickly recognized that water covers run counter to the BAT principles … The Mount Polley failure shows why physical stability must remain foremost and cannot be compromised."[64]

Although subaqueous disposal of potentially acid generating tailings has been shown to effectively decrease acid-generation potential (AGP) in some cases, leaching can continue even after submergence, especially if oxidation and acid generation have already begun.[65,66] Filtered tailings reduces the amount of entrained water, but any leachate produced must be collected and often requires long-term treatment.[67] The design of filtered tailings facilities must include an effective drainage system, as well as the water management infrastructure for preventing the rewetting of the tailings by precipitation or surface runoff. If there are existing tailings facilities that use drainage ponds, they must be located a safe distance from the tailings facilities to prevent the failure of one structure from impacting the stability of the other structure. If long-term water treatment is required, a cover or other design that will eliminate or minimize infiltration must be utilized.[68]

---

[j] While there are examples of successful filtered tailings facilities constructed on top of conventional tailings impoundment, there are also examples where this has led to failure. For this reason, the authors agree with the Mount Polley Report and do not recommend it.

7. Implement rigorous controls for safety

The design, construction, operation, and closure of any tailings facility must be subject to best available technologies and practices. An annual report must verify that dam operations and construction adhere to the approved final dam design. If a feature of the design was approved by a regulatory agency, all requested changes to that design must be submitted to the same regulatory agency for approval. Any deviation from the original design must be justified, documented, and evaluated by an Independent Tailings Review Board (ITRB).

As a guidance for safe operation and closure, a conservative Factors of Safety (FoS), meaning the FoS that is the most protective of people, property and the environment, must be established and enforced for all tailings dams. When calculating FoS, single input values must be avoided and a range of values, methods, and/or models must be applied to assess the various possible FoS values (static and pseudo-static). For operation and closure of a tailings dam, a static FoS of 1.5 (in non-earthquake conditions), and pseudo-static FoS of 1.1 (in response to the design earthquake, which establishes that even during the strongest seismic acceleration theoretically possible, the dam will still have 10% more shear resistance than is necessary to avoid failure), is presently viewed as conservative.

The ICMM Tailings Management: Good Practice Guide notes that, "FoS is not a measurable value; it is an outcome based on inputs which are derived by the designer based on site data, laboratory testing, and modeling."[69] For this reason, the guide describes many limitations to the use of FoS and cautions against overreliance on FoS leading to complacency in tailings facility design and monitoring.

Although the FoS is still included in many regulations and guidelines, it is a poor predictor of the annual probability of failure.[70] In order to more accurately identify risk, dam designs

The Mount Polley (Imperial Metals) 2014 tailings spill in British Columbia created a 100 m wide flow path for over 10 km downstream before dumping 24 billion litres of mine tailings and other debris into Quesnel Lake, in the Fraser River watershed, home to one of the largest salmon runs in North-America. Secwepemc Territory, British Columbia, Canada. Photo: Chris Blake, Quesnel River Watershed Alliance.

and evaluations must consider the annual probability of failure, in addition to the FoS. Annual probabilities of failure have been relied upon in many industries, such as aviation and aerospace, since the Second World War. For tailings dams where failure would not result in the potential loss of human life, an acceptable annual probability of failure would be 0.01% (equivalent to design for a 10,000-year earthquake or 10,000-year flood). For tailings dams where failure would result in the potential loss of human life, an acceptable annual probability of failure must be no greater than 0.001%.[k]

The annual probability of failure must be periodically calculated by the operating company. The annual probability of failure and the methodology used to reach it must be published both as a technical document, and as a document that affected communities can access and understand. Risk analysis used to calculate the annual probability of failure must consider more than just the maximum credible precipitation or seismic events.

The slope of the outer embankment of the tailings dam must be low enough to keep the annual probability of failure due to piping (also called internal erosion) below an acceptable level. New outer embankments must be constructed with slopes 1V:5H or less, and additional fill must be added to existing outer embankments with a slope steeper than 1V:5H in order to reduce the slope to 1V:5H, as per guidance from the USACE.[71] A proposal to construct or maintain an outer embankment steeper than 1V:5H must be justified in writing to both regulators and the public. The justification cannot be based solely on economic considerations, but must demonstrate that, for a particular design, failure by internal erosion is still sufficiently unlikely even with a steeper slope. In all instances, a dam slope must not be steeper than 1V:2H. Regardless of the outer embankment slope, any new upstream dams must be banned and existing upstream dams must be safely closed in a timely manner.

The water management infrastructure prevents overtopping of the supernatant tailings pond. For tailings dams where failure could result in loss of life, the water management infrastructure, including, for example the beach, the required freeboard, spillways, internal drains, and diversion canals, must be sufficiently conservatively designed so that the tailings pond will not reach the dam crest even during the PMF. Otherwise, the water management infrastructure must ensure that the tailings pond will not reach the dam crest even during a 10,000-year flood. Maximum credible event calculations, such as the PMF, cannot rely solely on historical data and must consider changes produced by climate change. The operating company must provide documentation in Dam Safety Reviews (DSRs), overseen by a qualified engineer, that show that the entire system of water management of the tailings facility is capable of resisting either the PMF or the 10,000-year flood, depending on its consequence classification.

---

[k] This annual probability of failure derives from the statement from the USACE Hydrologic Engineering Center's 2003 Application of paleohydrology to Corps flood frequency analysis: RD 47 on page 34 that says "the PMF [Probable Maximum Flood] does not incorporate a specific exceedance probability, but is generally thought to be well beyond the 10,000 year recurrence interval." In other words, the PMF has an annual probability of exceedance significantly less than 0.01%. It also derives from the statement by FEMA's 2005 Federal guidelines for dam safety—Earthquake analyses and design of dams: FEMA-65 on page 75 that says "for high-hazard potential dams, movement of faults within the range of 35,000 to 100,000 years BP is considered recent enough to warrant an 'active' or 'capable' classification." In other words, the MCE (Maximum Credible Earthquake) could be as rare as a 100,000-year earthquake (annual probability of exceedance of 0.001%).

8. Ensure a detailed evaluation of the dam foundation and of the tailings properties

Prior to permitting approval, operating companies must provide relevant regulatory agencies a detailed engineering evaluation of the dam foundation, and a physical and chemical characterization of the tailings, with special attention to tailings clay content, brittleness and susceptibility to liquefaction. The characterization of the underlying geology must be conducted before the dam and the impoundment are constructed. The failure of the Mount Polley dam was related in part to the presence of an unstable glaciolacustrine layer underlying the dam.

The 2019 Brazilian Brumadinho Dam I failure was caused in part because the dam stored brittle tailings,[72] so all tailings must be evaluated for contractive or brittle behavior. The structural zone of a tailings dam must not include contractive or brittle tailings due to their increased risk of failure by liquefaction.

Tailings and tailings supernatant and pore water must be characterized and the results used to estimate the likelihood and consequence of a potential dam failure. The geochemical characteristics of the supernatant and pore water of a tailings facility, as well as the tailings themselves can affect the consequences of a dam failure and control the extent and recoverability of ecosystems. As acid generation and contaminant leaching potential increase, the consequences associated with dam failure increase. Tailings and tailings water must be sampled and the results reviewed, considering potential environmental risk, at least every three years, or when there is a substantial change in the ore deposit being processed or the processing methods.

Because tailings with high acid generation or a contaminant leaching potential increase the severity of consequences in the event of a failure, tailings with those geochemical characteristics must be designed to withstand the PMF and the MCE. Tailings facilities must be designed to withstand the 10,000-year flood or the 10,000-year earthquake only when the tailings are non-potentially acid generating with low contaminant leaching potential and there is no potential for loss of human life. The GARD Guide provides state-of-the-art recommendations for tailings geochemical characterization methods and interpretation of the results (for design criteria related to potential loss of life refer to Guideline 5).[73] Scanning Electron Microscope (SEM) and other mineralogic and geochemical techniques must be used for tailings characterization during mining and after mining ceases, especially at iron ore mines, or where iron-ore tailings are used for dam construction. As more is learned from past failures, best practice characterization methods must be regularly updated to ensure that the most relevant and comprehensive approaches are incorporated in tailings management and assessment guidance.

The abandoned Panguna mine, Bougainville, Papua New Guinea. Photo: Damian Baker.

9. Appropriate monitoring systems must be in place to identify and mitigate risk

Tailings facilities must have appropriate monitoring systems in place to identify and mitigate risk. Tailings facilities must also have a clearly defined Adaptive Management Plan (AMP) linked to tailings monitoring results that encompasses a complete set of predictions and pre-planned actions.[74] The AMP is a way to rigorously implement the Observational Method, and the two terms are often used interchangeably. The Observational Method must be applied only under the oversight and concurrence of an Independent Tailings Review Board and there must be a system in place to respond to the observations.[I]

The AMP must include:

- Numeric and measurable expected performance criteria based on predictions of engineering behavior.
- Numeric trigger levels related to monitoring results that will identify risks before they occur, such as piezometer readings, supernatant pool characteristics, tailings and tailings water chemistry, and other characteristics.
- Mitigation measures designed for each performance criterion or trigger aimed at avoiding a catastrophic or other type of facility failure.
- An evaluation of the effectiveness of the measures taken.
- Reporting responsibilities for the operating company and responses by the regulatory agency and to relevant stakeholders.
- An annual AMP report for the tailings facility that reviews any triggers met or exceeded, mitigation actions taken, the effectiveness of the actions, and any AMP modifications needed. The report and its raw data must be made public, and a meeting must be held to explain the results to any affected communities and other interested stakeholders.

I The Observational Method must not be used for the prevention of liquefaction because liquefaction tends to occur without warning, i.e. with no time to make relevant observations (see Jefferies, M and K. Been. 2016. "Soil Liquefaction: A Critical State Approach"(2nd ed.). CRC Press. 690 p.). For the avoidance of liquefaction, all appropriate preventive actions must be carried out from the outset of the project.

10. Ensure the independence of reviewers to promote safety

There must be an independent evaluation of all aspects of the design, construction, operation, and maintenance—including during closure and rehabilitation—of tailings and other mine waste facilities, regardless of the projected consequences of failure of the mine waste facility, by a group of competent, objective, third-party reviewers (e.g., an Independent Tailings Review Board).[75] The competence of reviewers must include demonstrated experience and skill engaging with communities, including rural and Indigenous communities, in a meaningful way. An ITRB provides ongoing advice on tailings operations that complement periodic DSRs. The ITRB must not be used exclusively as a means for obtaining regulatory approval.[76]

The independence of those performing reviews is essential for safety. The operating company must not be able to influence decisions made by the ITRB, and its members must not be dismissed or terminated during a review in an attempt to influence the outcomes or as an intimidation tactic. Any fees paid to the ITRB must be independent of the conclusions reached during the review.

In order to ensure objective reviews, the ITRB should be contracted through public procurement by local regulatory agencies and compensated by the operating company through those agencies. ITRBs must have a mandate to protect communities and the environment.[77] ITRBs must be obligated to engage with all stakeholders, and must have an accessible way to receive third-party information from whistleblowers and civil society.

Every jurisdiction should have a regulatory agency with the expertise and capacity to appoint independent reviewers to ITRBs. However, this has not been prioritized in many jurisdictions. When operating companies appoint their own reviewers, ITRB members, as individuals or as representatives of organizations, must not have a financial conflict with the mine being reviewed. Financial conflicts include but are not limited to direct financial interest (employment, contracts, stock, etc.),[78] and personal or family connections to the mine or operating company that could incur any kind of benefits. Reviewers must sign a disclosure declaration about past and present personal and economic relationships between the operating company/commissioning party and the reviewer, as well as a personal declaration by the specific reviewer that no incompatible parallel contracts or negotiations exist with the

The 2015 collapse of the tailings dam at the Samarco mine, owned by Vale and BHP, created a flash flood of tailings that covered the town of Bento Rodrigues, Brazil. Minas Gerais, Brazil. Photo: Bruno Milanez.

operating companies whose facilities are under review. These declarations must include a fine for misrepresentation. Operating companies must not hire the same independent reviewers for multiple projects simultaneously or for subsequent reviews for three years prior to and after a review is completed.[79] Reviewers must not be dependent on a single operating company for the majority of their income.

The report and recommendations of the ITRB, the response of the operating company, and the subsequent response of the ITRB must be provided to the local regulatory agency and any communities affected by the tailings facility. The operating company must also publicly disclose the recommendations, as well as its rationale for any non-acceptance or inaction.

Additionally, operating companies must conduct an independent DSR yearly. An Environmental Social Impact Assessment (ESIA) must be carried out for every mining operation that includes a tailings disposal facility. The ESIA must be scientifically credible, respectful of local and Indigenous knowledge, have a transparent methodology, and be made publicly available. The authors of the ESIA must be subject to the same requirements for independence as the ITRB.

11. Towards safer closure with no credible failure modes

It is imperative that the reclamation and closure of tailings facilities be a factor in their initial design and siting. The failure of a tailings facility is inevitable, because no engineered structure can survive indefinitely without ongoing monitoring, inspection, and maintenance. This leaves the "reduction of failure consequences as the only effective strategy for risk reduction during closure."[80] A tailings facility is safely closed when deposition of tailings has ceased and all closure activities have been completed so that the facility requires only routine monitoring, inspection and maintenance in perpetuity or until there are no credible failure modes.

If the consequences of failure at some future time are unacceptable, the tailings facility must not be built in that location. Currently, there is no technology to ensure that an active tailings facility can be closed in such a way so as to withstand the PMF or MCE indefinitely without perpetual monitoring, inspection, and maintenance.

Operating companies must not be allowed to declare bankruptcy or sell to junior companies to avoid closure monitoring and liability (for additional details on closure costs see Guideline 12).

Given that operating companies will not exist long enough to accomplish perpetual monitoring, inspection, maintenance, and review, the operating company's ability to eventually eliminate all credible failure modes must be a key consideration during the permitting process. If a regulatory agency does not believe an operating company can carry out perpetual care and financial responsibility, or eliminate all credible failure modes, they must not approve the facility. Operating companies must prove they have successfully eliminated all credible failure modes to the relevant regulatory agencies.

Operating companies must provide transparent documentation of the estimated cost of the cleanup of a mine site, including closure and reclamation, and all monitoring and maintenance. Cleanup must be self-funded from financial resources, which must be demonstrably large enough to ensure sufficient funding in perpetuity (See Guideline 12).

12. Addressing financial risks, including securities for site closure and proper insurances for accidental spills

Operating companies must have the necessary financial assurance to cover the full cost of closure and post-closure plans. The purpose of financial assurance is to ensure that there is a source of funds available to local regulators if the operating company fails to perform adequate reclamation activities, including necessary closure and postclosure maintenance. All existing facilities must have financial assurance in place. For new facilities, financial assurance must be secured during the permitting process and before construction begins. Any sale or transfer of ownership of the tailings facility must be conditional on the new operating company retaining such financial assurance. Because of the relatively low rate-of-return on investments that are typically utilized by the public agencies that assure long-term financial stability, post-closure financial assurance value calculations must be run for a minimum of 300 years.

Financial assurance must be independently guaranteed, reliable, and readily liquid to ensure that funds will be available in the event of bankruptcy by the operating company.[81] This means that all required funding must be immediately available upon request of the regulatory agency, and there must be no limitations on the use of funds for mine-related cleanup activities. Financial assurance must undergo review by third-party analysts, using accepted accounting methods, at least every three years or whenever there is a material change either to the tailings facility or to the social, environmental, and local economic context.[82] Unless the financial assurance is updated annually, the cost for inflation until the next financial review must also be included in the financial assurance calculation.

Destruction from the 2019 Minas Gerais tailings dam collapse near Brumadinho, Brazil. Photo: IBAMA Brazil.

Additionally, operating companies must have public liability insurance to cover economic, social and environmental damages from sudden, accidental, or gradual pollutant releases including waste dump and tailings dam failures. The amount must be sufficient to financially compensate for harm to people, property, and natural resources that may occur, on or off the mine, including after closure of the tailings facility. Insurance or pooled assurance for unintentional hazardous spills is already required for many industries in certain jurisdictions, including for tankers, offshore drilling, nuclear energy production and pipelines.[83] The State of Maine requires "proof of comprehensive general liability insurance for the site for sudden and accidental occurrences" and "[n]on-sudden occurrence insurance may be required by the Department on a case by case basis and, and shall be required whenever there are land disposal units, land storage units, or mine waste units."[84] As per Guideline 11, tailings facilities must be monitored, inspected, and maintained in perpetuity or until there are no credible failure modes. Therefore, operating companies must have public liability insurance in perpetuity.

An analysis of public liability resulting from the tailings facility failure must be updated on a yearly basis and made publicly available. It must be based on the worst-case outcomes derived from dam break studies, which must account for a complete loss of tailings at full tailings facility buildout during a failure. Assessments of previous catastrophic tailings dam failures indicate that financial responsibilities can exceed U.S. $32 billion.[85,86]

Operating companies must not be allowed to self-bond or use parent or corporate guarantees[m] for mine closure, financial assurance or public liability insurance.[87,88]

Safety risks are not separate from financial risks. It is of paramount importance that operating companies be able to pay for the safest technologies and practices. In addition to financial assurance and insurance mechanisms, financially risky operations must be identified and fully considered as part of tailings safety prior to permitting and throughout the mining lifecycle.

As stated by in the Mount Polley Report: "Future permit applications for a new TSF should be based on a bankable feasibility that would have considered all technical, environmental, social and economic aspects of the project in sufficient detail to support an investment decision, which might have an accuracy of ±10%–15% ... [including] a detailed evaluation of all potential failure modes and a management scheme for all residual risk [and a] detailed cost/benefit analyses of BAT tailings and closure options so that economic effects can be understood, recognizing that the results of the cost/benefit analyses should not supersede BAT safety considerations."[89,90]

---

[m] According to the U.S. EPA, a corporate guarantee is when an operating company ensures another company will provide coverage for closure and post-closure costs (https://www.epa.gov/hwpermitting/financial-assurance-requirements-hazardous-waste-treatment-storage-and-disposal).

13. Grievance procedures and whistleblowers

Independent grievance procedures must be established and made available in a culturally appropriate manner to all employees, contractors, suppliers, regulators, and affected community members. The system for reporting and filing grievances must be available in multiple formats, such as online, by mail, in person, etc. All pertinent information and documentation related to the grievance procedure must be provided in relevant languages.[91] All grievance mechanisms must adhere to the effectiveness criteria outlined in Principle 31 of the United Nations Guiding Principles on Business and Human Rights, which stipulates that they be: (a) legitimate, (b) accessible, (c) predictable, (d) equitable, (e) transparent, (f) rights-compatible, (g) a source of continuous learning, and (h) based on engagement and dialogue.[92] Rights holders must have decision-making power in the design and operation of grievance mechanisms. Operating companies must not use non-disclosure agreements to prevent individuals from openly filing and/or pursuing a complaint. Remedy for complaints must be adequate, effective, and prompt, and may include one or more of the following: an apology, guarantees of non-repetition, restitution, rehabilitation, financial or non-financial compensation, and punitive sanctions.[93]

Grievance mechanisms must be functionally independent from the project's operating company, for example, it may be run by a third-party trusted by the rights holders for whom it is intended. Grievance mechanisms must allow the complainants confidentiality and anonymity, if requested. Complainants must be provided the funds necessary to access independent forms of support (e.g. legal, technical or medical) in all phases of engagement with the procedure, including during the initial filing of the complaint (see Guideline 16). Additionally, a settlement through the operational level grievance procedures must not require the complainant(s) to sign legal waivers prohibiting them from civil legal action at a future date. There must be a clear, established time frame within which grievance mechanisms are resolved. There must be regular, timely and clear communication with the complainant in their relevant language throughout all steps of the grievance process. The operating company must publish the number of grievances received annually, the nature of the grievances, as well as any official decisions or resolutions.[94]

Whistleblower protection best practices must apply to all workers as well as vendors, contractors and auditors.[95] Mine workers have the right to refuse unsafe work, and must be allowed to stop their tasks at any time if they identify imminent risk to health and safety without suffering any punishment, as is already stipulated in Brazilian regulation.[96]

14. Emergency preparedness and response

Emergency preparedness and response plans, or emergency action plans, related to catastrophic failures of tailings facilities must be discussed and prepared together with all potentially affected communities, mine workers, agricultural producers and businesses downstream of the flow of a potential failure, and in collaboration with first responders and relevant government agencies.[97,98]

In the case of a sudden failure, the operating company is responsible for taking all steps necessary to save lives and provide appropriate humanitarian aid. The operating company must provide all needed resources and support to local and national governments and first responders during and after a failure. The operating company must assume the entirety of the costs of indemnification, remediation, and reclamation for a failure, including any additional damages incurred during remediation and reclamation efforts.

The full scope of indemnification, remediation, and reclamation criteria must be determined through a participatory process subject to the approval of affected communities, agricultural producers, and businesses, and made publicly available. Discussions with affected communities to establish identification criteria must begin before construction of a tailings disposal facility, undergo periodic updates, and continue in the event of a failure. Affected communities must have access to independent technical assistance at every stage of this process (see Guideline 16).

Community members standing on a mine waste pile at the Porgera mine in Papua New Guinea. Photo: Porgera Alliance.

Worst-case tailings failure scenarios must consider the loss of all tailings at full tailings facility buildout, and the results must be made public prior to permitting. Failure model scenarios must also be annually updated to account for changes in the material consequences of a dam break due to social, economic or environmental changes in areas surrounding or downstream of the facility. Worst-case scenarios must model the complete loss of stored tailings and water, as occurred, for example, in the failure of the tailings dams at the Xiangjiang Wanji mine in China, the Church Rock uranium mill and the Buffalo Creek coal plant in the United States, and the El Soldado mine in Chile.

Emergency and evacuation drills related to catastrophic failure of tailings facilities must be held on an annual basis, and their planning and execution must include participation from affected communities, workers, local authorities, and emergency management. Emergency and evacuation drills can be traumatizing for communities. Special care must be given during planning so that communities are able to access the information they need for their safety, while ensuring they are not negatively impacted by the process.[99]

Tailings facilities must not be constructed where there are facilities that present considerable evacuation challenges in the zone of influence, including, but not limited to, jails or prisons, hospitals, and assisted-living or elder care facilities (See Guideline 3). Even if operating companies carry out training and emergency drills, certain social groups (the elderly, small children, people with disabilities, etc.) require special assistance. Based on the goal of zero harm to people, companies must ensure that trained professional support will be provided during an emergency and will reach all affected populations in a timely manner.

Contamination of the Paraopeba River after the 2019 tailings dam collapse near Brumadinho, Brazil. Photo: Maria Otávia Rezende.

15. Information regarding mine safety must be made publicly available

Operating companies must make all information relevant to the safety and stability of tailings facilities publicly available, including the name, exact location, ownership, date of initial operation, footprint, and height. Information related to tailings disposal facilities must be made publicly available during the design stage and must be updated on a regular basis over the life of the mine.

Operating companies must immediately publicly disclose the date, location, amount of tailings released, and impacts on surrounding areas following any tailings failure.

Safety practices must be considered non-competitive. Industry association guidelines related to tailings safety must be freely available. While some operating companies assert that revealing information about tailings facilities presents a national security risk, there is no evidence for these claims and the authors reject this argument.

Relevant information that must be publicly available includes, but is not limited to:

- Dam Safety Reviews (DSRs)
- Consequence or hazard classification and decisions made by the board of directors or corporate management to approve the classification
- Environmental Impact Assessments (EIAs) or Environmental Social Impact Assessments (ESIAs)
- Design, maintenance, and monitoring documents (Design Basis Report, Construction Record Report, Construction vs. Design Intent Verification Report, (Annual Tailings Facility Performance Report, Deviance Accountability Report, etc.)
- Documentation of stability of the facility, including a record of past stability issues
- Closure and reclamation plans
- Dam break studies and assessments of social, economic, and environmental impacts
- Environmental monitoring and Social Management System summaries and reports
- Independent Tailings Review Board reports
- Adaptive Management Plan reports
- Impact and mitigation plans for affected communities, including compensation and indemnification criteria
- Documentation of FPIC and any community consent processes (the information divulged must be approved by the affected communities)
- Complaints and grievance procedures
- Emergency Preparedness and Response Plans
- Documentation of financial assurance and public liability insurance (including insurance estimates)
- Reports that are required by and filed with governmental agencies.

Governments and regulators must also make all information relevant to the safety and stability of tailings facilities publicly available, including but not limited to environmental baseline studies on ground stability, geology, watersheds, fault lines, etc; all documents related to permitting and monitoring; and all information related to emergency preparedness and response.

This information must be made available by operating companies and regulators at no charge, as soon as possible, in one or more languages as necessary, in an accessible format, and in plain language whenever possible to afford adequate access for all interested stakeholders. This must also include all raw data obtained, input parameters used, and any updates to the models and simulations carried out as part of continued environmental monitoring. Proprietary software should be avoided in favor of commercial or freely available software.

Operating companies and regulators must respond to all stakeholder requests for information regarding the tailings facility to the fullest extent possible in formats and languages that are understandable to all stakeholders. If requests are not met in full, or in a timely manner, the company must provide written justification to those filing the requests.

16. Ensure access to independent technical assistance

Resources are unequally distributed between operating companies and affected communities; affected communities often do not have the same level of financial, technical, and logistical support that is available to operating companies. Many regulatory bodies are also out-resourced by operating companies. Too often, affected communities are forced to depend on operating companies to provide information about the scope, impacts, and potential consequences of tailings disposal facilities. Operating companies can withhold, misinterpret, or falsify information, and affected communities may not have the internal capacity to analyze documents to identify errors and/or omissions. Therefore, in order for affected communities and Indigenous Peoples to exercise their rights to access information, participate, and consent, they often require independent technical assistance at various stages of the life of a tailings facility.

Operating companies must fund access to independent technical assistance for affected communities and Indigenous Peoples. Experts must be trusted and chosen by the affected communities, Indigenous Peoples or individuals. The scope of services provided must encompass the full range of assistance needs, including, but not limited to, technical, legal, medical, social, and economic support. Operating companies must fully fund these services.[100] Communities must have the ability to change independent experts or choose new experts at any time over the life of the mine, if the experts do not demonstrate the necessary competencies for working with affected communities.

Affected communities and Indigenous Peoples must be offered access to independent technical assistance during the earliest stages of the lifecycle of the mine, starting with exploration, through monitoring and closure, and specifically during any consultation or FPIC processes (Guideline 2). Additionally, communities may request technical assistance to analyze and interpret publicly available information (Guideline 15). If a rights holder decides to use the grievance mechanism to file a complaint, they must have access to independent forms of support (e.g. legal, technical or medical) in all phases of engagement with the procedures (Guideline 13). If an operating company proposes a voluntary resettlement agreement, communities must have access to independent technical assistance throughout the agreement process (Guideline 3).

In the event of a tailings dam failure, operating companies must pay for independent technical assistance for affected communities to address collective and individual remediation, reconstruction, and compensation needs. Technical assistance is a critical tool for communities to understand the scope and impacts of a tailings facility failure, as well as to advocate for their collective rights. The technical experts hired must be able to clearly articulate the impacts and importance of the failure for affected and/or Indigenous communities.

Access to technical experts chosen by affected communities and funded by the operating company after dam failures is mandated in mining legislation in Minas Gerais, Brazil.[101] For example, after the 2015 Fundão tailings dam failure, the community of Barra Longa selected 13 independent technical experts in agriculture, law, architecture, urban planning, psychology, engineering, and social services to help determine the scope and extent of reparations and indemnification criteria. While accountable to the community and individuals affected by the failure, the experts were paid by the mining company through a foundation established for remediation and indemnification.[102]

17. Accountability for risk, minimizing the consequences of failure, preventing failure, and the consequences of failure must primarily rest with the board of directors

The corporate board of directors, as the body that is ultimately responsible for the well-being of the operating company, must bear the primary responsibility for the safety of tailings facilities, including the consequences of dam failures.[103] A push for profit maximization creates a tendency for operating companies to prioritize production over all other considerations, including safety considerations.[104] Liability for tailings dam failures must extend to the corporate board of directors.

The board of directors must have the capacity and tools to guarantee that safety considerations are not sacrificed at the expense of production. The board must proactively ensure that safety extends throughout the entire operating company by approving policies and budgets that identify and mitigate the risks posed by tailings disposal facilities and that prioritize safety, including in staff performance evaluations. The board of directors must take an active role in identifying and signing off on safety risks related to tailings disposal facilities where human lives could be at stake or severe environmental damage could occur.

The Control of Major Accident Hazards (COMAH) Competent Authority in the United Kingdom, the intragovernmental regulatory body that inspects major hazard enterprises, suggests that at least one board member have an appropriate competence level on major hazard risk to advise the board and senior leadership team on relevant issues.[105] Operating companies must ensure that the board of directors includes at least one member with expertise in tailings disposal facility failure risks.

Additionally, the board of directors must be responsible for approving and overseeing the implementation of company procedures to ensure that no employee or contractor is participating in, promoting or facilitating bribery. For example, facilitation payments to government officials to fast-track tailings facility permits must be prohibited, and there must be zero tolerance for any bribery by mine employees or contractors of auditors, consultants, and government officials.

Destruction from the 2019 tailings dam collapse near Brumadinho, Brazil. Photo: Maria Otávia Rezende.

Next Steps

The safest tailings facility is the one that is never built. It is imperative that we find ways to reduce overall demand for primary raw materials; our current consumption levels, especially in the Global North, are unsustainable. Implementing strong standards and best practices for tailings disposal is a necessary stopgap for frontline communities already dealing with the impacts or threat of unsafe tailings facilities, however research shows that we can build a future that is less reliant on extraction and generates less mine waste.[106] This document aims to provide a tool that helps frontline and Indigenous communities, civil society, States, regulators, and operating companies prevent catastrophic tailings failures, nevertheless the guidelines contained here must be implemented alongside transformative changes that move us away from an extractive economy.

Worldwide, there are many thousands of tailings disposal facilities and dams, some under the responsibility of private corporations, others under the responsibility of States. Because there is currently no global inventory of tailings disposal facilities, including the thousands of abandoned facilities, there is an urgent need for a transparent assessment, in which the results are made publicly available in a global tailings database. Ecosystems, livelihoods, and human lives are at stake.

This inventory must include all relevant information regarding the safety of tailings disposal facilities (See Guideline 15). In 2020, GRID-Arendal launched The Global Tailings Portal in collaboration with the Investor Mining and Tailings Safety Initiative to catalog voluntary disclosures and publicly available data on tailings disposal facilities.[107] While it is an important step towards the creation of a comprehensive registry, the portal must continue to expand in scope of facilities and depth of information collected. There are also a number of national registries, including ones in Brazil,[108] the United States,[109] Chile,[110] Mexico,[111] Spain.[112]

Mount Polley Mine tailings dam failure, 2014. Photo: Courtesy of IRMA.

The database must also include a registry of dam failures. It is essential to better understand how and why each failure occurred in order to prevent them in the future. The work being compiled by the Center for Public Participation database can serve as a model for this type of documentation and analysis.[113]

An independent international agency, such as a United Nations-endorsed agency, in collaboration with responsible States, operating companies, and civil society, must drive this process, collect information on tailings dams and tailings dam failures worldwide, and share it with affected communities in order to de-risk tailings facilities and support the creation of proper emergency action plans.

It is crucial that United Nations agencies and international partners, including States, industry, labor representatives, civil society organizations, and independent experts, establish or endorse a credible, transparent, and independent international agency capable of certifying safe tailings disposal worldwide. This must be a well-resourced agency capable of efficiently updating global standards, investigating failures, and making publicly-available recommendations. This agency must not rely solely on industry experts, must include broad State or civil society engagement, and must be accountable to the public and affected communities. The governance structure for this agency must be a multi-stakeholder body that includes affected communities, Indigenous Peoples, labor, and civil society organizations. It must ensure a co-equal decision making process that includes all stakeholders.

The polluted Doce River after the 2015 Samarco mine tailings dam failure. Minas Gerais, Brazil. Photo: Júlia Pontés.

Glossary

Adaptive Management

A structured, iterative process of robust decision-making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring. It includes the development of management practices based on clearly identified outcomes, and monitoring to determine if management actions are meeting desired outcomes. If outcomes are not being met, the process requires development and implementation of management changes to ensure that outcomes are met or re-evaluated. Adaptive Management is similar to the Observational Method (see definition below), and sometimes the terms are used interchangeably.

Source: Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms.

Affected Community

A community that is subject to actual or potential impacts from a project. Impacts include, but are not limited to, socioeconomic, environmental, and public health or safety impacts, impacts to cultural, touristic or sacred sites, and risk of intimidation, violence or coercion.

Source: Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms. IRMA Standard Adapted from IFC. IFC Policy & Performance Standards and Guidance Notes. Glossary of Terms.

Brittle Tailings

Tailings that exhibit substantial (> 40%) strength loss or strain-softening in response to an exceedance of the peak or yield strength.

Source: Adapted from Bishop, A.W., 1967. Progressive failure with special reference to the mechanism causing it. Proceeding of the geotechnical conference, Oslo, Sweden.

Board of Directors

The ultimate governing body of the Operator typically elected by the shareholders of the Operator. The Board of Directors is the entity with the final decision-making authority for the Operator and holds the authority to, among other things, set the Operator's policies, objectives, and overall direction and oversee the firm's executives. As the term is used here, it encompasses any individual or entity with control over the Operator, including, for example, the owner or owners. Where the State serves as the Operator, the Board of Directors shall be understood to mean the government official with ultimate responsibility for the final decisions of the Operator.

Source: Adapted from the Global Tailings Review, 2020. Global Industry Standard on Tailings Management. 25 p.

Catastrophic Tailings Failure

A tailings facility failure that results in material disruption to social, environmental and local economic systems. Such failures are a function of the interaction between hazard exposure, vulnerability, and the capacity of people and systems to respond. Catastrophic events typically involve numerous adverse impacts, at different scales and over different timeframes, including loss of life, damage to physical infrastructure or natural assets, and disruption to lives, livelihoods, and social order.

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management. 26 p.

Centerline Construction

The centerline raising method is a compromise between the upstream and downstream methods in many respects. As a result, it shares to a degree the respective advantages of the two methods, while mitigating their disadvantages. … Initially, a starter dike is constructed, and tailings are peripherally spigotted from the dike crest to form a beach. Subsequent raises are constructed by placing fill onto the beach and onto the downstream slope of the previous raise. The centerlines of the raises are coincident as the embankment progresses upward, giving rise to the method's name.

Source: Source: Vick, S. G., 1990. Planning, Design, and Analysis of Tailings Dams. 77 p.

Contaminant Leaching Potential

The potential for tailings samples to release contaminants based on short- and long-term leach tests. The potential for adverse water quality effects from a tailings dam breach can also be determined from the quality of supernatant and pore fluids in the impoundment. If leach test results or tailings do not exceed water quality standards (e.g., aquatic life criteria), the contaminant leaching potential would be considered low; if concentrations exceed standards by 1 to 10 times, the potential would be intermediate; and if concentrations exceed standards by more than 10 times the potential would be high.

Source: The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide).

Credible Failure Mode

A physically possible sequence of events that could potentially end in tailings dam failure. According to the GISTM, "the term 'credible failure mode' is not associated with a probability of this event occurring."

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management. 27 p.

Dam Break Study

Also called an inundation study or dam-breach or failure-consequence analysis, a dam break study assumes a failure of the tailings facility and estimates its impact. The analysis must be based on credible failure modes. The results should determine the physical area impacted by a potential failure, flow arrival times, depth and velocities, duration of flooding, and depth of material deposition. The Breach Analysis is based on scenarios which are not connected to probability of occurrence. It is primarily used to inform emergency preparedness and response planning and the consequence of failure classification. The classification is then used to inform the external loading component of the design criteria.

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management. 26 p.

Dam Safety Review

A periodic and systematic process carried out by an independent qualified review engineer to assess and evaluate the safety of a dam or system of dams (or in this case a tailings facility) against failure modes, in order to make a statement on the safety of the facility. A safe tailings facility is one that performs its intended function under both normal and unusual conditions; does not impose an unacceptable risk to people, property or environment; and meets applicable safety criteria.

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management.

Downstream Construction

A method of dam construction in which the centerline of the dam is shifted downstream with subsequent raises, resulting in a core inclined in the downstream direction. This method requires that the structural fill be placed in the downstream shell during raising to support the inclined core.

Source: Klohn Crippen Berger, 2017. Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program, MEND Report 2.50.1, 164 p.

Facilitation Payments

Facilitation payments are sums of money paid to get preferential treatment for something the receiver is otherwise still required to do — for example, paying an official to speed up, or "facilitate," an authorisation process.

Source: Responsible Jewelry Council, 2019. Code of Practices Guidance. 105 p.

Factor of Safety (FoS)

The lowest ratio of available shear resistance along a potential plane of failure to the activating shear forces along the same plane, as considered over all possible failure surfaces.

Source: Canadian Dam Association, 2013. Dam safety guidelines 2007 (2013 edition).

Filtered Tailings

Tailings dewatered such that they behave like a moist soil; achieved by thickening followed by vacuum or pressure filtration.

Source: Klohn Crippen Berger, 2017. Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program, MEND Report 2.50.1, 164 p.

Free, Prior and Informed Consent (FPIC)

Consent based on: engagement that is free from external manipulation, coercion and intimidation; notification, sufficiently in advance of commencement of any activities, that consent will be sought; full disclosure of information regarding all aspects of a proposed project or activity in a manner that is accessible and understandable to the people whose consent is being sought; acknowledgment that the people whose consent is being sought can approve or reject a project or activity, and that the entities seeking consent will abide by the decision.

Source: Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms.

Grievance

A perceived injustice evoking an individual's or a group's sense of entitlement, which may be based on law, contract, explicit or implicit promises, customary practice, or general notions of fairness of aggrieved communities.

Source: Ruggie, J., 2011. Guiding Principles on Business and Human Rights.

Grievance Mechanism

Any routinized, State-based or non-State-based, judicial or non-judicial process through which mining-project related complaints or grievances, including business-related human rights abuses, stakeholder complaints, and/or labor grievances, can be raised and remedy can be obtained.

Source: Ruggie, J., 2011. Guiding Principles on Business and Human Rights.

Independent

In order for an individual, institution, mechanism or agency to be considered independent it must be objective, impartial, consistent, transparent and accountable to all stakeholders. It also requires that payment for services, funding of work, long-term financial stability and the potential for future contracts do not depend on outcomes or conclusions that are favorable to an operating company or the mining industry.

Source: Adapted from The Organisation for Economic Co-operation and Development, Creating a Culture of Independence: Practical Guidance against Undue Influence.

Independent Review

The Mining Association of Canada defines independent review as "independent evaluation of all aspects of the design, construction, operation, maintenance of a tailings or other mine waste facility by competent, objective, third-party review on behalf of the operating company/mine owner." In addition to the MAC's definition, independent review must demonstrate financial independence from the operating company/mine owner (see above definition of independence).

Source: Adapted from Mining Association of Canada, 2017. A Guide to the Management of Tailings Facilities.

Indigenous Peoples

An official definition of "[I]ndigenous" has not been adopted by the United Nations system due to the diversity of the world's [I]ndigenous [P]eoples. Instead, a modern and inclusive understanding of "[I]ndigenous" includes peoples who: identify themselves and are recognized and accepted by their community as [I]ndigenous; demonstrate historical continuity with pre-colonial and/or pre-settler societies; have strong links to territories and surrounding natural resources; have distinct social, economic or political systems; maintain distinct languages, cultures and beliefs; may form non-dominant groups of society; and resolve to maintain and reproduce their ancestral environments and systems as distinctive peoples and communities. In some regions, there may be a preference to use other terms such as: [T]ribes, [F]irst [P]eoples/[N]ations, [A]boriginal, ethnic groups, Adivasi and Janajati. All such terms fall within this modern understanding of "[I]ndigenous."

Source: Adapted from Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms.

Internal Erosion (see Piping)

Inundation Study (see Dam Break Study)

Maximum Credible Earthquake (MCE)

The largest earthquake magnitude that could occur along a recognized fault or within a particular seismotectonic province or source area under the current tectonic framework.

Source: FEMA ((U.S.) Federal Emergency Management Agency), 2005. Federal guidelines for dam safety—Earthquake analyses and design of dams: FEMA-65, 75 p.

Meaningful Engagement

Described by the United Nations (UN), The World Bank, the International Finance Corporation (IFC), the Organization for Economic Cooperation and Development (OCED), the Inter-American Bank, amongst other international and multilateral organizations and agencies, as a process whereby project proponents not only have an obligation to consult and listen to stakeholder perspectives, but also have an obligation to take their perspectives into account. Meaningful engagement involves understanding and addressing structural and practical barriers to the active participation of diverse groups of people, for example: women, ethnic minorities, people who live in remote areas, and/or different language groups. Access to relevant information that can be reasonably understood by the external party and transparent communication is a precondition of meaningful engagement. Affected communities must have a say in what meaningful engagement looks like for them.

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management.

Mine Site

A mine site is the area of surface disturbance necessary to conduct a mining operation. This includes extraction, processing, and waste disposal facilities, and roads. A mine site does not necessarily include the entire area as defined by the mine permit or claim.

Source: Modified definition created by the authors.

Modified Centerline Construction

Modified centerline construction is similar to conventional centerline construction, but with the contact between the compacted fill and the tailings sloping slightly upstream. Since modified centerline construction still involves constructing a portion of the dam on top of the uncompacted tailings, it must be considered a variant of upstream construction, similarly subject to the cautions and restrictions associated with upstream-type dams presented in this document.

Source: Adapted from J.P. Haile & K.J. Brouwer, Knight Piesold Ltd, Modified Centreline Construction of Tailings Embankments, 3rd International Conference on Environmental Issues and Waste Management in Energy and Mineral Production, August, 1994. Perth, Australia; and Independent Expert Engineering Investigation and Review Panel, 2015. Report on Mount Polley Tailings Storage Facility Breach, Province of British Columbia.

Observational Method

A project management method in which observed performance from instrumentation data is used for implementing preplanned design features or actions in response. According to the Mount Polley Report, the Observational Method is useless without a way to respond to the observations. The Observational Method is similar to Adaptive Management (see definition above), and sometimes the terms are used interchangeably.

Source: Independent Expert Engineering Investigation and Review Panel, 2015. Report on Mount Polley Tailings Storage Facility Breach.

Operating Company

Any person, corporation, partnership, owner, affiliate, subsidiary, joint venture, or other entity, including any State agency, that operates or controls a tailings facility.

Source: Global Tailings Review, 2020. Global Industry Standard on Tailings Management. 30 p.

Piping (also called Internal Erosion)

A phenomenon where seeping water progressively erodes or washes away soil particles, leaving large voids (pipes) in the soil. These voids simply continue to erode and work their way backward under the structure, or they may collapse. Either way, if piping is not stopped promptly, failure is imminent. The critical place for piping is usually right at the corner of the toe of a dam.

Source: R.D. Holtz, Kovacs, W.D., and Sheahan, T.C., 2011. An Introduction to Geotechnical Engineering, 2nd ed., Pearson, 863 p.

Potentially Acid Generating (PAG)

An indication, based on laboratory testing, that the mine sample could produce acid drainage under field conditions. Samples are considered PAG if the neutralizing-potential (NP) to acid production potential (AP) ratio (NP:AP) is <1 and non-PAG if NP:AP is >2. Samples with NP:AP between 1 and 2 have an uncertain potential to generate acid (GARD Guide, Section 5.4.16; INAP, 2009). Site-specific and mineralogic evaluations and longer-term testing are needed to set appropriate ratios. Safety factors may be needed to address limitations in sampling, material handling, or prediction (INAP, 2009). Conservative non-PAG ratios ranging from 1.3 to 5 have been recommended by some practitioners (Maest et al., 2005).

Source: Adapted from The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide), and Maest, A.S. and J.R. Kuipers (primary), C.L. Travers, and D.A. Atkins (contributing). 2005. Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art. Earthworks, Washington, DC.

Probable Maximum Flood

The flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible in the drainage basin under study.

Source: FEMA ((U.S.) Federal Emergency Management Agency), 2013. Selecting and accommodating inflow design floods for dams: FEMA-94, 38 p.

Stakeholders

Persons or groups who are directly or indirectly affected by a project, such as rights holders, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.

Source: Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms Adapted from IFC, 2007. Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets.

Structural Zone

The containment structure of a tailings disposal facility. In a filtered tailings facility, "typically, the filtered tailings form the containment structure ('structural zones') and uncompacted tailings, which can have a lower solids content, can be placed in the interior" (ICOLD, 2021). The structural zone of a filtered tailings facility serves the same function as a dam.

Source: ICOLD (International Commission on Large Dams), 2021. Tailings dam design—Technology update: ICOLD Bulletin 181, 97 p. Klohn Crippen Berger, 2017. Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program, MEND Report 2.50.1, 164 p.

Tailings

Tailings are the materials left after the extraction of metals or minerals of interest from ore.

Source: Dougherty and Schissler, 2020. SME Mining Reference Handbook, 2nd Edition, p. 513

Tailings Dam

A structure or embankment that is built to retain tailings and/or to manage water associated with the disposal of tailings, and includes the content of the structure.

Source: Adapted from Guidelines on Tailings Dams, Planning, Design, Construction, Operation and Closure, Australian National Committee on Large Dams, ISBN: 978-0-9808192-4-3, May 2012; and Klohn Crippen Berger, 2017. Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program, MEND Report 2.50.1, 164 p.

Tailings Dam Failure

A tailings dam failure can generally be defined as the inability of the dam to meet its design intent, whether in terms of management, operational, structural or environmental function, resulting in potential loss of life, loss to the stakeholders, or adverse environmental effects.

Source: Canadian Dam Association Tailings Dam Breach Analysis (2022).

Upstream Construction

A method of dam construction in which the centerline is translated upstream, over the tailings beach, with subsequent raises. This method requires that material placed in the upstream direction is well-drained and compacted or that it settles naturally to an adequate density.

Source: Klohn Crippen Berger, 2017. Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program, MEND Report 2.50.1, 164 p.

Voluntary Resettlement

Voluntary land transactions (i.e., market transactions in which the seller is not obliged to sell and the buyer cannot resort to expropriation or other compulsory procedures sanctioned by the legal system of the host country if negotiations fail) that lead to the relocation of willing sellers.

Source: Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of TermsGlossary of Terms.

Worker

All non-management personnel including outsourced workers and contractors.

Source: Adapted from Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, Glossary of Terms.

Zone of Influence

The zone of influence is the area that would be significantly affected in case of a TSF failure and should be categorized as a risk zone.

Source: Atif, I., et al., 2020. "Modelling and analysis of the Brumadinho tailings disaster using advanced geospatial analytics." In the *Journal of Southern African Institute of Mining and Metallurgy*. 405 p.

Endnotes

1 Darlington, S. et al., 2019. *Tidal Wave of Mud,* New York Times.

2 Robertson, P. et al., 2019. Report of the Expert Panel on the Technical Causes of the Failure of Feijão Dam I. 12 p.

3 Robson, Paul. 2017. "The River is Dead: The Impact of the Catastrophic Failure of the Fundão Tailings Dam." London Mining Network. 5 p.

4 Bowker, L.N. and Chambers, D.M., 2015. *The Risk, Public Liability, and Economics of Tailings Storage Facility Failures*.

5 Global Tailings Review. https://globaltailingsreview.org/.

6 Global Tailings Review, 2020. Global Industry Standard on Tailings Management.

7 Mudd, G., 2019. *Mining & Its Growing Environmental Impacts*.

8 Hund,K, et al., 2020. *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*. World Bank Group.

9 Dominish, E., et al., 2019, *Responsible Minerals Sourcing for Renewable Energy*. Report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney.

10 Dominish, E., et al., 2021. Reducing new mining for electric vehicle battery metals: responsible sourcing through demand reduction strategies and recycling. Report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney.

11 Marshall, J., 2018 *Tailings dam spills at Mount Polley and Mariana: Chronicles of Disasters Foretold* CMP, CCPA–BC Office, PoEMAS (Grupo Política, Economia, Mineração, Ambiente e Sociedade), the Wilderness Committee. 10 p.

12 Marshall, J., 2018 Tailings dam spills at Mount Polley and Mariana: Chronicles of Disasters Foretold CMP, CCPA–BC Office, PoEMAS (Grupo Política, Economia, Mineração, Ambiente e Sociedade), the Wilderness Committee. 10 p.

13 Hopkins, A. and Kemp, D. 2021. Credibility Crisis: Brumadinho and the Politics of Mining Industry Reform. (CCH Australia).

14 Álvarez-Iglesias, et al., 2020. "Assessment and timing of the anthropogenic imprint and fisheries richness in marine sediments from Ría de Muros (NW Iberian Peninsula)." *Quaternary International* 566-567. 337–356 p.

15 Mpanza, M. et al., 2020. "*Dust Deposition Impacts at a Liquidated Gold Mine Village: Gauteng Province in South Africa*." Int J Environ Res Public Health. 2020 Jul; 17(14): 4929.

16 Iyaloo, S. et al. 2020. "*Respiratory Health in a Community Living in Close Proximity to Gold Mine Waste Dumps, Johannesburg, South Africa.*" Int J Environ Res Public Health. 2020 Apr; 17(7): 2240.

17 Moore, Ellen. 2018. *Dumping by the Numbers*.

18 Swiss Association for Quality and Environmental Management. 2020. *Ramu NiCo Impacts Fact Sheet by SVQ Updated 20 01 2020.*

19 Earthworks, Miramar.

20 Braun, T., 2020. *Rumble in the Jungle - Untangling the Roles and Liabilities After a Waste Rock Heap Leach Failure.*

21 University of Victoria Environmental Law Centre, 2019. *Waste Disposal & Management.* BC Mining Law Reform.

22 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach*.

23 Roche, C., et al., 2017. *Mine Tailings Storage: Safety Is No Accident: A UNEP Rapid Response Assessment*. United Nations Environment Programme and GRID-Arendal. 11 p.

24 BC First Nations Mining and Energy Council, 2021. *Indigenous Sovereignty: Consent For Mining On Indigenous Lands.* 24 p.

25 Food and Agricultural Organization of the United Nations (FAO), 2016. *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities.*

26 BC First Nations Mining and Energy Council, 2021. *Indigenous Sovereignty: Consent For Mining On Indigenous Lands.* 35 p.

27 Doyle, C. and Cariño, J., 2013. *Making Free Prior & Informed Consent a Reality Indigenous Peoples and the Extractive Sector.* 3 p.

28 BC First Nations Mining and Energy Council, 2021. *Indigenous Sovereignty: Consent For Mining On Indigenous Lands*. 16 p.

29 Doyle C., et al., 2019. Free Prior Informed Consent Protocols as Instruments of Autonomy: Laying Foundations for Rights Based Engagement. Infoe, FPP, Middlesex University.

30 Initiative for Responsible Mining Assurance, 2018. *IRMA Standard for Responsible Mining IRMA-STD-001*. Glossary of Terms. Chapter 2.2.

31 Food and Agricultural Organization of the United Nations (FAO), 2016. *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities.*

32 BC First Nations Mining and Energy Council, 2021. *Indigenous Sovereignty: Consent For Mining On Indigenous Lands*. 40 p.

33 UN General Assembly, 2007. *UN Declaration on the Rights of Indigeneous Peoples (A/RES/61/295)*.

34 UN General Assembly, 2007. *UN Declaration on the Rights of Indigeneous Peoples (A/RES/61/295)*.

35 Doyle C., et al., 2019. Free Prior Informed Consent Protocols as Instruments of Autonomy: Laying Foundations for Rights Based Engagement. Infoe, FPP, Middlesex University.

36 WoMin, 2022. *What is the Right to Say NO?*

37 CAFTA DR and U.S. Country EIA, 2011. *EIA Technical Review Guidelines: Non-Metal and Metal Mining.*

38 Food and Agricultural Organization of the United Nations (FAO), 2016. *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities.*

39 Food and Agricultural Organization of the United Nations (FAO), 2016. *Free Prior and Informed Consent: An indigenous peoples' right and a good practice for local communities*. 15 p.

40 Initiative for Responsible Mining Assurance, 2018. *IRMA Standard for Responsible Mining IRMA-STD-001*. Chapter 2.2.

41 Atif, I., et al., 2020. "*Modelling and analysis of the Brumadinho tailings disaster using advanced geospatial analytics." In the Southern African Institute of Mining and Metallurgy*. 405 p.

42 Assembleia Legislativa de Minas Gerais, 2019. *Lei 23291, De 25/02/2019.* Art 12.1º- Art 12.3º.

43 Initiative for Responsible Mining Assurance, 2018. IRMA Standard for Responsible Mining IRMA-STD-001, 61 p.

44 The International Finance Corporation, 2012. "*Performance Standard 5 Land Acquisition and Involuntary Resettlement.*"

45 Niobec, 2012. *Guidelines and Best Practices for a Harmonious Acquisition and Compensation Process.*

46 Franks, D.M., et al., 2021. *"Tailings facility disclosures reveal stability risks," Nature Scientific Reports,* vol. 11. 7 p.

47 ICOLD (International Commission on Large Dams) and UNEP (United Nations Environment Programme), 2001. *Tailings dams risk of dangerous occurrences—Lessons learnt from practical experiences.* Bulletin 121, 146 p.

48 Canadian Dam Association, 2019. Application of dam safety guidelines to mining dams (2019 edition), 61 p.

49 Brazil, 2019. Resolution Nº 13, August 8, 2019.

50 Chile, 2007 Decreto Supremo *Nº 248*: *Reglamento Para La Aprobación De Proyectos De Diseño, Construcción, Operación Y Cierre De Los Depósitos De Relaves*.

51 Perú, 2014. Decreto Supremo *N° 040-2014-EM: Reglamento de Protección y Gestión Ambiental para las Actividades de Explotación, Beneficio*, Labor General, Transporte y Almacenamiento Minero.

52 Ministerio de Energía y Recursos No Renovables, 2020. ACUERDO Nro. MERNNR-MERNNR-2020-0043-AM.

53 Martin,T.E., McRoberts, E.C., Davies, M.P., 2002. *A Tale of Four Upstream Tailings Dams*. Association of State Dam Safety Officials. 25 p.

54 ICOLD (International Commission on Large Dams), 2021. Tailings dam design—Technology update: ICOLD Bulletin 181, 97 p.

55 Federal Emergency Management Agency (FEMA), 2005. *Federal Guidelines for Dam Safety Earthquake Analyses and Design of Dams.*

56 Federal Emergency Management Agency (FEMA), 2013. *Selecting and Accommodating Inflow Design Floods for Dams.*

57 U.S. Army Corps of Engineers (USACE), 1991. Inflow design floods for dams and reservoirs: Engineer Regulation ER 1110-8-2(FR)*.* 10 p.

58 U.S. Army Corps of Engineers (USACE), 2016. *Earthquake design and evaluation for civil works projects: Engineer Regulation*. ER 1110-2-1806, 28 p.

59 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach.* 121 p.

60 British Columbia Ministry of Energy and Mines, 2016. *Guidance Document Health,Safety and Reclamation Code for Mines in British Columbia v1.0.* 12 p.

61 Klohn Crippen Berger, 2017. *Study of tailings management technologies: Report to Mining Association of Canada and Mine Environment Neutral Drainage (MEND) Program,* MEND Report 2.50.1.

62 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach.* 121 p.

63 British Columbia Ministry of Energy and Mines, 2016. *Guidance Document Health,Safety and Reclamation Code for Mines in British Columbia v1.0.* 12 p.

64 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach.*124 p.

65 Newman, C. P., et al., 2019. "Aqueous Geochemistry and Limnology of the Sleeper Pit Lake, Nevada, USA: Evidence for Long-Term Subaqueous Solute Generation in Mine Pit Lakes." *Journal of Geoscience and Environment Protection*, 07(03), 64–81 p.

66 The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide). Section 6.6.7.

67 The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide). Section 6.6.8.

68 Davies, M., 2018. "Filtered Dry Stacked Tailings-The Fundamentals" *Tailings and Mine Waste 2011*. 7 p.

69 International Council on Mining & Metals (ICMM), 2021. *Tailings Management: Good Practice Guide.* 91 p.

70 Vick, S.G., 2002. Degrees of belief—Subjective probability and engineering judgment. ASCE Press, Reston, Virginia, 455 p.

71 U.S. Army Corps of Engineers (USACE), 2000. *Design and construction of levees: Manual No. 1110-2-1913.* 164 p.

72 IMNE (International Centre for Numerical Methods in Engineering), 2021. Computational analyses of Dam I failure at the Corrego de Feijao mine in Brumadinho—Final Report—August 2021. Report prepared for Vale S.A., 561 p.

73 The International Network for Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide). Chapters 4 and 5.

74 National Research Council, 2006. *Geological and Geotechnical Engineering in the New Millennium: Opportunities for Research and Technological Innovation.* Washington, DC: The National Academies Press.

75 Initiative for Responsible Mining Assurance, 2018*. IRMA Standard for Responsible Mining IRMA-STD-001,* Glossary of Terms.

76 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach.* 130 p.

77 Bellringer, Carol, 2016. *An Audit of Compliance and Enforcement of the Mining Sector.* Office of the Auditor General of British Columbia.

78 Montana, 2021. *Montana Code Annotated 2021. Title 82. Minerals, Oil, And Gas Chapter 4. Reclamation Part 3. Metal Mine Reclamation.*

79 Diário Oficial do Estado de Minas Gerais. 2021. *Regulamenta dispositivos da Lei nº 23.291, Artículo 10.*

80 Vick, S.G., 2014. *"The use and abuse of risk analysis."* Tailings and Mine Waste '14 Proceedings of the 18th International Conference on Tailings and Mine Waste, Keystone, Colorado, USA, October 5 – 8, 2014, 49-56 p.

81 Dion, J., 2019. *Mining Risk and Responsibility: How putting a price on risk can help British Columbia reduce it.* Report prepared for the First Nations Energy and Mining Council.

82 Initiative for Responsible Mining Assurance, 2018. *IRMA Standard for Responsible Mining IRMA-STD-001*. 72 p.

83 Dion, J., 2019. "Reducing the Risk of Mining Disasters in BC: How financial assurance can help." Report prepared for the First Nations Energy and Mining Council. 12 p.

84 Maine Department of Environmental Protection, 2017. "Chapter 200: Metallic Mineral Exploration, Advanced Exploration and Mining." 56 p.

85 Brígido, Carolina, March 25, 2022. "CNJ costura maior acordo ambiental do mundo para compensar estragos da Mariana." CNN Brasil.

86 Bowker, L.N. and Chambers, D.M., 2015. *The Risk, Public Liability, and Economics of Tailings Storage Facility Failures*.

87 Initiative for Responsible Mining Assurance, 2018. *IRMA Standard for Responsible Mining IRMA-STD-001*. 72 p.

88 Maine Department of Environmental Protection, 2017. "Chapter 200: Metallic Mineral Exploration, Advanced Exploration and Mining." 56 p.

89 Independent Expert Engineering Investigation and Review Panel, 2015. *Report on Mount Polley Tailings Storage Facility Breach*.

90 For further details on financial risk criteria, see the last section of MiningWatch Canada's submission to the Global Tailings Review, December 2019.

91 The Institute for Multi-Stakeholder Integrity (MSI Integrity), 2017. *The Essential Elements of MSI Design.*

92 United Nations Office of the High Commissioner, 2011. United Nations Guiding Principles on Business and Human Rights. 33 p.

93 Federal Institute for Sustainable Development, 2018. Toolbox for Operational-Level Grievance Mechanisms.

94 The Institute for Multi-Stakeholder Integrity (MSI Integrity), 2017. *The Essential Elements of MSI Design.*

95 G20 Anti-Corruption Action Working Group, 2010. *G20 Anti-Corruption Action Plan: Protection of Whistleblowers.*

96 Brazil, 2001. Norma Regulamentadora da Mineração, *Portaria DNPM 237/2001.*

97 Initiative for Responsible Mining Assurance, 2018. *IRMA Standard for Responsible Mining IRMA-STD-001*, Chapter 4.1.

98 Gabelhouse, Timothy, 2015. *Awareness and preparedness for emergencies at local level: A Process For Improving Community Awareness And Preparedness For Technological Hazards And Environmental Emergencies*. Ed. 2. United Nations Environment Programme.

99 O Lábaro, 2022. "*Moradores de Paracatu participam de formação sobre os direitos das pessoas atingidas por barragens".*

100 Souza, Tatiana and Karine Carneiro, 2019. "The Right Of The Affected People To Independent Assistance: The Case Of Barra Longa (MG)" Revista Sapiência: Sociedade, Saberes e Práticas Educacionais. V.8, N.2. 199 p.

101 Assembleia Legislativa de Minas Gerais, 2021. Lei 23795 de 15/01/2021.

102 Souza, Tatiana and Karine Carneiro, 2019. "The Right Of The Affected People To Independent Assistance: The Case Of Barra Longa (MG)" Revista Sapiência: Sociedade, Saberes e Práticas Educacionais. V.8, N.2. 205 p.

103 Mining Association of Canada, 2019. *A Guide to the Management of Tailings Facilities VERSION 3.1*. 20 p.

104 Hopkins, A., 2020. "Addressing The Organisational Weaknesses That Contribute To Disaster" Towards Zero Harm – A Compendium Of Papers Prepared For The Global Tailings Review. 142 p.

105 Control of Major Accident Hazards (COMAH), 2019. *Major Hazard Leadership Intervention Tool.* 5 p.

106 Seas at Risk, 2021. *Breaking free from mining: A 2050 blueprint for a world without mining – on land and in the deep sea.*

107 https://tailing.grida.no/about.

108 Brazilian National Mining Agency. *https://app.anm.gov.br/sigbm/publico*.

109 https://nid.usace.army.mil/#/.

110 https://www.sernageomin.cl/datos-publicos-deposito-de-relaves/.

111 https://geomaticaportal.semarnat.gob.mx/arcgisp/apps/webappviewer/index.html?id=95841aa3b6534cdfbe3f53b3b5d6edfa.

112 http://igme.maps.arcgis.com/home/webmap/viewer.html?webmap=e5631cfafb2c409ca2ff6fcff70950c5.

113 http://www.csp2.org/tailings-dam-failures-from-1915.