

## Dam failure: addressing risk management challenges in the global mining sector

As climate change multiplies the potential for increased frequency and severity of tailings dams failures, the materiality of dam structures and maintenance to company valuations is becoming ever more evident. Fred Isleib, Director, ESG Research and Integration, and David Dugdale, Senior Investment Analyst, outline how investment managers and their clients can benefit from more robust direct engagement with their portfolio companies to drive more sustainable industry practices.

### Key takeaways

- Climate change and the ongoing decline in global ore grades will likely increase the risk and severity of tailings dam failures.
- Robust sustainability analysis—from tailings toxicity to local seismicity and surrounding population density—can allow investors to properly account for these risks in company valuations.
- We believe that investors must actively encourage companies to be more transparent about tailings dam risk and adopt standards to reduce the chance of future failures.

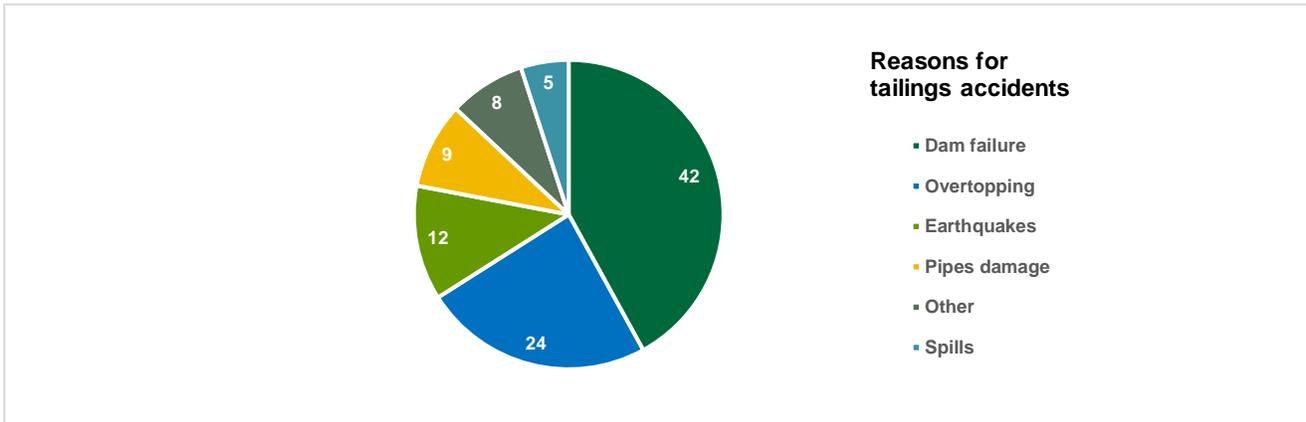
### Disasters with far-reaching impact

On January 25, 2019, in the small town of Brumadinho, Brazil, a 280-foot high tailings dam burst at the site of the Córrego do Feijão mine. The dam, which had been inactive for nearly three years, reportedly held 13 million cubic meters of iron oxide, water, and chemicals. When its retaining wall broke, a tsunami of sludge issued forth with terrifying speed, engulfing trees, buildings, cars, and anyone unfortunate enough to be in its path.

This disaster, which was the second major dam failure in this area of Brazil in three years, exacted a steep cost in human lives and inflicted massive environmental damage. With a death toll of over 300 and, by some estimates, roughly 75 miles of the adjacent Paraopeba river rendered unsustainable for marine life—and unsuitable for human consumption and agricultural purposes—the disaster will continue to have far-reaching effects for hundreds of communities.<sup>1</sup>

Most tailings accidents are a result of dam failures, but this fact has received surprisingly little attention over the years. In our view, that must change—both for the sake of the communities that lie in the shadow of these facilities and for the sake of the economic sustainability of the sector. As such, the recent disaster holds sobering lessons for investment managers who seek to derive value from the sector, as well as for the industry's standard practices for dam construction and regulatory oversight.

**Tailings dam failures are responsible for most mining waste storage accidents (%)**



Source: "Tailings Pond Life Cycle Safety Management System," Proceedings of the 8<sup>th</sup> International Conference on Sustainable Development in the Minerals industry. Data as of February 2017.

**Assessing the valuation impact of tailings dam failures**

The owner of the Feijão mine is Vale SA, the largest iron ore and nickel producer in the world and one of the crown jewels of the Brazilian economy. Without question, mining companies like Vale provide critical natural resources and inputs for global economic growth—consider, for example, how iron makes up the backbone of the world’s urban architecture and municipal infrastructure. But as tailings dam failures remind us, material risks in this segment of the global economy are pervasive.

**Tailings dams: a history of disaster**



Source: Manulife Asset Management, "Root Causes of Tailings Dam Overtopping: The Economics of Risk & Consequence," Bowker and Chambers, 2016.

In our view, there are numerous factors that investors need to consider for appropriate valuation of mining companies that have active or inactive tailings dams. These include the risk of criminal and civil liabilities arising when deaths occur or authorities perceive corporate negligence from dam collapses. In addition, companies can experience post-event loss of labor, closure of production capacity, loss of the social license to operate, tighter regulations, and changes to insurance premiums.

Although a weak correlation does exist between the total costs of the failures and the volume of tailings lost, total costs tend to be more a function of the amount of collateral destruction caused, including area of land covered, the estimated toxicity of materials released, and the loss of life.<sup>2</sup> Looking at past dam failures, we believe factors that increase the potential liability from a failure include population density around a mine, dam proximity to a river system, seismicity of the area, and toxicity of the tailings material.

The material impact on valuation is not diminished when tailings dams transition from active to inactive status. While approximately 75% of failures are attributable to active mines,<sup>3</sup> the Feijão dam is a case in point of how mining companies face liabilities for the failure of inactive dams—and have to bear the costs of ensuring inactive dam safety in perpetuity.

The transmission of these risks to investors can be seen in the stock price volatility that flares in the aftermath of waste storage failures. Shortly after Feijão, Vale's stock dropped 25%, wiping almost US\$20 billion from Vale's market capitalization before recovering. Because it's the world's biggest producer of iron ore, government-enforced reduction in Vale's production has caused prices to soar, offsetting the impact of lower production volumes and the prospect of significant fines/remedial dam work.

Stock price impact is higher where companies are less diversified and derive the majority of revenue from one or two operating mines. For instance, it has been five years since the Mt. Polley dam failure in British Columbia, but share prices of Canadian miner Imperial Metal has yet to recover from the incident. In our view, investors are right to take major mining incidents seriously—the risk they're exposed to as shareholders could go well beyond stock price volatility. In some cases, the long-term viability of these companies may be at stake.

### Tailings management is complicated by climate change

Tailings dams, particularly upstream dams, are so dangerous because of the large amount of the water they hold. Ore extraction processes commonly require the crushing and grinding of ore to a fine texture and mixing with water to facilitate the capture of specific minerals. Some extraction processes use chemicals to separate the mineral from ore, which makes tailings ponds toxic. Therefore, the bulk of tailings produced is a poisonous slurry of solids and water, with tailings making up as much as 98% of the total amount of ore mined. As there is no productive use for tailings, managing this waste is a straightforward cost to mining companies that they are incentivized to minimize.

Unlike water retention dams, tailings dams are continuously constructed by “raisings” during the life of a mine. With each expansion comes more weight, which creates pressure and potential instability. Of course, this weight is also affected by rainfall volumes. As climate change increases the frequency and intensity of storms in certain regions, that greatly increases the aggregate risk of dam failure, as older tailings may liquify or break down over time when exposed to heavier rainfall. Based on our review of physical risk from climate change, which we're able to conduct through our relationship with climate science firm Carbon Delta, we find that mining enterprises in Malaysia, Indonesia, and Thailand could be particularly exposed to risks of increased precipitation.

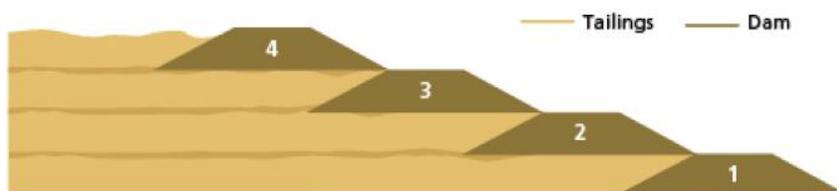
On top of this, the scale and challenges of mining projects have increased significantly over the past 30 years, including higher throughput of material and challenging site specifics.<sup>4</sup> Therefore, climate change-related weather patterns could well prove to be the industry's greatest multiplicative risk factor precisely during the period when the base cost of running tailings dams is increasing in line with the declining quality of ore being extracted from reserves close to their end of life.

### Types of sequentially raised tailings dams



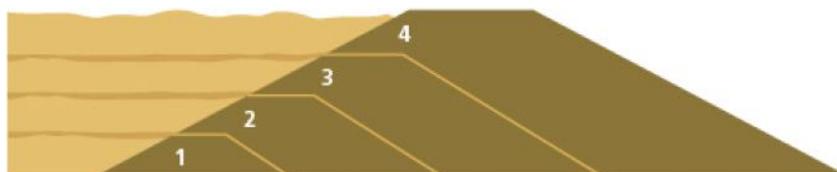
#### Upstream dams

- Lowest cost, most popular design
- Should only be used in dry climates
- Strength of drainage system is key



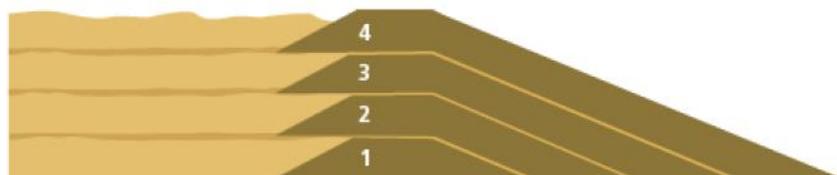
#### Downstream dams

- Developed to reduce risks associated with upstream dams
- Disadvantage is large volume of required fill



#### Centerline dams

- Compromise between upstream and downstream designs
- Relies on strength of tailings for stability



Source: Manulife Asset Management, March 2019, based on illustrations by Steven G. Vick.

### Regulation has been inconsistent

In some developing countries, regulations for tailings management frequently don't exist or are only mildly restrictive. In addition, there's currently no oversight from a global perspective on tailings dam regulations and practices. Where countries use tailings dams, we would expect mining companies to continue using their current approach rather than spending more capital on dry stacking. Although there's an audit process for tailings dams in most countries, the disaster in Brazil highlighted a lack of measures to ensure independence between mining companies and their auditors.

Due to the magnitude of the Feijão dam collapse, we expect additional regulations will be implemented in multiple countries, as witnessed in the recent actions by Brazil, which will mean more inspections and greater attention paid to health and safety. This will in turn force companies to spend more capital on meeting more stringent regulations.

### Engaging with mining companies

In anticipation of these changes, we structure our engagement with mining companies to deepen our understanding of their exposure to dam-failure risk and to encourage greater climate-risk resiliency. Questions we ask of companies include:

- What percentage of your dams have upstream design? What countries are they located in and what is the topography of the area, including the vulnerability of these areas to climate change-induced extreme weather patterns?
- How do you ensure the operating conditions of the dam remain in compliance with the initial design—considering throughput, tonnage, and height restrictions—and that decommissioned dams maintain compliance?
- Detailed questions on exacerbating risk factors, including dam height, contained volume, density of neighboring population centers, and weather conditions.
- How toxic is the slurry contained in your dams?
- How regularly are your dams inspected? Are some inspections done by independent third parties?
- What processes are in place to ensure complete independence of the auditor opinion and subsequent reports?
- Is tailings dam risk on the organizational risk register and are the scope of risks periodically reported to the board or the relevant board committee?

### Racing to change before the next disaster

The most recent dam failure in Brazil underscores how poor governance, weak risk management, geographical hazards, and climate change have deepened a key risk associated with an economically vital sector. The extractive industries are important contributors to the global economy. But companies in this sector have frequently been derelict in their risk management duties—a fact that's been partially guaranteed by failures at government agencies charged with regulatory oversight. Sadly, history suggests we will see more disasters like Feijão. Regulation and investor engagement are in a race with aging infrastructure whose deterioration is worsened by economic pressures and climate change.

In this regard, we believe the value of company engagement cannot be underestimated, both as a method for understanding companies' risk exposures and potentially reducing absolute risk of further failures through supporting companies to implement better waste management practices. The Feijão dam failure is another wake-up call for the mining industry. Considering the leverage investment managers can bring to bear in their discussions with company managements, it's imperative for Manulife Asset Management and other investors to use their influence to raise risk management standards.

<sup>1</sup> Water Management Institute of the State of Minas Gerais (IGAM), February 2019. <sup>2</sup> Manulife Asset Management proprietary research assessment. <sup>3</sup> tailings.info, as of March 2019. <sup>4</sup> CLSA Blue Book, Tailings Dam – Risk Management Checklist for Investors, October 2016.

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