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Managing environmental risks of mining critical minerals in Canada

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A stream runs along the outskirts of Neskantaga First Nation, which is part of northern Ontario's mineral-rich Ring of Fire. The Canadian Press/Chris Young

1. Introduction

The clean energy transition will demand a global surge of new greenfield mining for critical minerals.

As a nation that is home to almost half of the world's public mining companies and almost 200 mines worth a collective $74 billion in 2022 production, Canada appears well positioned to meet this future demand (Natural Resources Canada 2024a; Natural Resources Canada, 2024b). The federal government has already identified over 60 major critical mineral mining projects, planned or currently under construction, worth an estimated $60 billion in potential new investment (Natural Resources Canada 2023).

This surging demand for critical minerals represents a "generational opportunity," according to Canada's former federal Energy and Natural Resources Minister Jonathan Wilkinson (Government of Canada 2022). In late 2022, the federal government released a Critical Minerals Strategy identifying 31 minerals critical to Canada's energy future (recently updated to 34). The list includes copper, nickel, lithium, and rare earth elements—all metals projected to face significant demand growth in the decades to come.

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Canada's ability to successfully build new mining projects at the scale and speed required hinges on whether these projects can secure support from affected communities, including both Indigenous and non-Indigenous communities .[1] Unlike decades past, where projects could proceed with or without community support, future projects in Canada will need to achieve a much higher bar of social acceptance to operate. Investors will be more hesitant to commit capital to Canadian mining projects if community opposition increases risk of project delays, reputational damage, and litigation.

1 The Canadian Climate Institute did a spatial analysis and found that 69 per cent of active mines—including operational projects and those in development—are within 50 kilometres of federally recognized Indigenous territories.

Gaining this support will require a proactive and rigorous approach to addressing the mining sector's environmental risks and impacts. Federal, provincial, territorial, and increasingly, Indigenous governments have a wide range of existing policies and regulations designed to mitigate the environmental risks associated with building new projects. Mining companies are also signing onto a number of market-driven voluntary sustainability initiatives (VSIs), which can complement government regulations and sometimes set a higher bar. In the broadest sense, environmental risk has become a challenge that mining companies and investors must overcome if they want their projects to move ahead.

But the Canadian mining industry's track record poses challenges for building and maintaining the public trust required to rapidly develop new projects in Canada. Mining projects have a mixed and controversial legacy in Canada, marked by colonialism, large-scale environmental destruction, and community conflicts. Canada's rise as a world mining power has come at the cost of at least 10,000 abandoned mines across Canada, leaving governments on the hook for billions of dollars in cleanup costs (Canada's Ecofiscal Commission 2018). The threat of tailings dam failures looms large as the number of dams continues to grow. Meanwhile, a rapid build-out of new mines in remote locations could significantly damage biodiversity.

In the context of the larger good news story of the global clean energy transition, which promises a significant reduction in the need for mined, drilled, and fracked coal, gas, and oil, this paper focuses explicitly on the environmental impacts from mining activities in Canada. The paper examines how governments and companies can better manage these impacts to improve both public trust and investor confidence, in order to responsibly accelerate mine development.

Section 2 details the biggest environmental risks that Canada will need to address if the country is to scale up new mining operations: mine closure and reclamation, tailings management, and biodiversity impacts. Section 3 identifies the voluntary and regulatory best practices being deployed in Canada and internationally to better manage these environmental impacts. Section 4 concludes by exploring the policies required to implement these best practices more broadly to ensure the industry can move at the speed of trust to meet the global demand for critical minerals.

Notably, this paper does not assess the intersection between addressing environmental risks and upholding Indigenous rights and title. These important questions are addressed in two separate scoping papers published by the Canadian Climate Institute and covered in-depth in its major report on how Canada can secure its place in the global critical minerals race.

2. Canada's mining sector: The environmental challenge

This section identifies three major environmental challenges Canada's mining sector must confront: mine closure and reclamation, tailings management, and biodiversity impacts. Multiple examples provide a springboard for discussion of the current state of practice in Canada.

Addressing the environmental impacts outlined in this section will, in part, determine whether the country can dramatically increase the extraction and production of critical minerals. Without credible, effective measures to mitigate these environmental risks, local communities (and the general public) are unlikely to support new mining developments, which in turn will deter investors. Local opposition and community conflict are typically costly for project proponents and lead to delays in project developments (Davis and Franks 2014; Teschner and Holley 2021). The economic viability of future projects will therefore hinge to an important degree on whether industry and governments can demonstrate their willingness and ability to mitigate mining's major environmental risks and impacts.

2.1 Closure and reclamation

The first major environmental challenge facing mining projects in Canada is how mines are closed and affected lands are, or are not, reclaimed. Loopholes in existing regulations governing mine closure or lax enforcement have in the past frequently led to companies eschewing environmental cleanup costs and leaving the Canadian public to cover the bill—often over decades (see Box 1).

Public opposition to new mining projects will be high without appropriate safeguards in place to prevent private companies' environmental cleanup costs ending up in public budgets. Recently, both provincial and federal lawmakers have started taking steps toward increasing the requirements for mining

companies to set aside sufficient resources to cover future environmental liabilities but progress is slow overall.

When mining companies go bankrupt the public shoulders cleanup costs

In theory, the endgame of all Canadian mining operations is for the provincial or territorial government, in cooperation with Indigenous governments, to reassume control over the land being mined. Once mining operations come to an end, reclamation proceeds: the landscape is contoured with earth and life continues anew. In practice, very few mines actually achieve this outcome at the end of life. What the public and local communities can expect, instead, are various forms of perpetual care, environmental monitoring, and water treatment that can go on for decades or even indefinitely, as illustrated by some of the examples below. In these cases, the public is often left to pay the long-term costs.

Gaps in Canadian bankruptcy law have enabled some of the major problems with closure and reclamation for mine sites. Historically, under Canadian law, if a company declared bankruptcy or entered insolvency, and its remaining assets were not sufficient to meet environmental cleanup costs, "secured creditors" could recover their claims ahead of shareholders and other parties. (These secured creditors are parties that have the right to be paid before any other creditors out of the proceeds of its collateral). In practice, however, cleanup costs are often at the bottom of a long list of other priorities competing for scarce funds, which has meant that such obligations can become the responsibility of governments.

The Northwest Territories' Giant Mine (in operation from 1948 to 2004) illustrates these gaps. One of the gold mine operators, Royal Oak, declared bankruptcy in 1999 and was allowed to terminate its operations without paying to secure or clean up the site. The courts transferred the mine ownership to the Government of Canada, represented by Indigenous and Northern Affairs. The last owner, Miramar Mining Corporation, also went out of business and avoided paying cleanup costs (Canada's Ecofiscal Commission 2018). To this day, about 237,000 tonnes of arsenic trioxide waste are stored underground (Crown-Indigenous Relations and Northern Affairs Canada n.d.) In total, the waste site represents a $4.3 billion liability for Canadians—one that will never be adequately cleaned up.

BOX 1- The legacy of acid rock drainage

Britannia was one of the world's biggest copper mines (operating from 1904 to 1974), which existed long before the term "environment" entered the public consciousness. The public has to date paid $46 million to clean up the site, located north of Vancouver, and now must pay $3 million a year in perpetuity to operate a plant to treat acid rock drainage (Fionda et al. 2024a).

Acid rock drainage occurs when sulphide-bearing minerals (containing metals like copper) are exposed to water and air by mining. The storage of huge piles of sulphide-bearing waste rock, which are exposed to the elements on a mine site, can unleash a natural chemical reaction that is analogous to the decomposition of a leaf fallen from a tree. The sulphide-bearing rock degrades with this exposure, releasing acid and metals into surface and groundwater. Acid rock drainage can begin decades after a mine has closed, and once it starts, a perpetual chain reaction can result. Of the at least 60 mines in British Columbia with serious environmental liabilities, 40 of those had significant uncertainties around drainage chemistry in 2011 (Pollon 2011). The mining industry has developed guidance tools to manage this risk, but these remain voluntary (ICMM 2025).

Britannia mine concentrator as seen from Howe Sound. Wikipedia.

Upfront planning for mine closure and reclamation is key but not yet the law across Canada

At the national level, things are slowly improving, in part thanks to the 2019 Supreme Court Redwater ruling, which found that bankrupt companies must prioritize paying cleanup costs ahead of paying creditors (McNeil 2019). This development is a positive step toward protecting communities and governments from cleanup costs, but the challenge remains that companies, until recently, were not required to set aside sufficient resources to clean up a mine at the end of its useful life (Dyer, Ragan, and Shaffer 2019).

Provincial laws and regulations also play an important role when it comes to mine closure and reclamation. British Columbia was one of the first provinces in Canada to enact mine reclamation legislation in 1969. That legislation required companies to post upfront financial securities to guarantee mine cleanup costs—an innovative approach. As of 2024, companies in B.C. must obtain a permit approving a mine plan, develop a program for protection of the land and watercourses, and prepare a reclamation and closure plan. Permittees are required to submit annual reclamation reports to the government (Government of British Columbia 2025a). Despite progress made, including no longer allowing on-site machinery to be used as financial surety, the provincial framework falls short on tackling mine closure issues by allowing bureaucratic discretion in the setting of financial sureties—including letting mining companies use reserves in some cases. For instance, the amount of security can be increased or decreased at the discretion of B.C.'s Chief Permitting Officer (Government of British Columbia 2024d).

The B.C. approach of phasing in financial assurance requirements that grow as the mine progresses would keep costs low for companies at the outset, but also add risk, as bankruptcy remains a loophole to this principle (Canada's Ecofiscal Commission 2018). The boom-and-bust cycle of mining projects—driven by price volatility in global commodity markets—can exacerbate these linkages between the value of reserves (a form of "soft" surety), bankruptcy, and cleanup obligations (see Box 1). Price swings can be particularly damaging to small-to-mid-cap mining companies.

For the 2022–23 fiscal year, the province had a shortfall of about $750 million of liabilities to clean up B.C. mines (Fionda et al. 2024b). Work to close this liability gap is ongoing: in May 2024, the government announced new information requirements to improve companies' reclamation liability cost estimates and to enhance the transparency of these processes to First Nations and the public (Government of British Columbia 2024c).

Abandoned mines are not just a legacy of the past but may put public support for future projects at risk

Across Canada, abandoned mines are not just a legacy of the past, despite the progress made to impose proactive, upfront payments for eventual closure and reclamation.

A recent example can be found in the Yukon, where government's practice of allowing case-by-case discretion in setting financial surety for new mines has resulted in at least two mines—Wolverine (zinc) and Minto (copper/gold)—going into either receivership or back into the hands of the Yukon government for long-term "care and maintenance" (Hong 2024).

Yukon Zinc, the subsidiary of a Chinese company, is behind the recently abandoned Wolverine mine. It is an example of a small corporation that was determined to develop a big mine (instead of the usual course of a small company discovering the mine and then selling it to a major), but that lacked the wherewithal to follow through with cleanup. The company, on paper, committed to pay over $35 million for closure costs, but only ever put down $10.5 million. The Yukon government has been forced to cover the shortfall, spending over $40 million to date on Wolverine's closure and reclamation (Hong 2024).

In this way, mines are still being abandoned in Canada or are at increased risk of becoming abandoned. "Governments can be persuaded, on the hopes of future economic potential, to reduce security deposits," said Larry Innes, a Yellowknife-based lawyer focused on mining and First Nations' rights during the research for this report. "Initially, the security deposit for Wolverine was by the Yukon government at 1.78 million in 2006. That amount was later increased as the mine expanded its footprint to $10.6 million in 2013. However, the increased security deposit didn't fully account for liabilities. When Wolverine's owners walked away from the site in 2015, the $10.6 million security was quickly depleted by the costs of maintaining the site. Ultimately, the government had to appeal to the court to put the company into receivership and is now trying to recover an additional $25 million to cover the reclamation costs from a project that has no real prospects."

2.2 Tailings management

Tailings management is the second major environmental challenge that undermines trust with host communities and the general public across Canada. Tailings are side-products of mining, arising when the ore is separated from the rock or soil. Tailings can significantly harm the natural environment and human health, and careful tailings management and storage is essential

to mitigating these risks. Tailings dam failures are costly to clean up and as with mining reclamation costs, regulations are often insufficient to hold companies accountable, instead burdening public budgets. The high visibility of tailing disasters also contributes to public apprehension of the mining industry. Risks related to tailings are only expected to increase with new mines being located in remote locations, for example close to retreating glaciers (see Box 3).

After more than a century of industrial mining in Canada, the richest deposits have been picked over. Miners must now chase ever lower ore grades. For example, consider the global trajectory of copper, a metal that economies will need for certain over the long term. In the early 1800s, miners targeted copper deposits at 20 per cent purity. Flashing forward to 2024, many of the massive, low-grade copper deposits in northern B.C. that miners seek to develop are grading around 0.5 per cent copper and less (Pollon 2023; Government of British Columbia n.d.) What this means is that nearly all of the rock that miners sift through to get the metal is waste, and it must be stored permanently at the mine site, as both waste rock and as tailings.

Tailings disasters recently captured public attention

In the last decade, the world was rocked by at least three large-scale tailings disasters—two in Brazil and one in B.C. (see Box 2). These events put the issue of tailings management into public and investor consciousness like never before. More recently in Canada, on June 24, 2024, an estimated 800,000 cubic metres of cyanide-tainted mine waste spilled into the surrounding environment from the Eagle Gold Mine in the Yukon (McGee 2024). As of April 2025, the Yukon Government is overseeing remediation work, and water quality tests show unsafe levels mercury, cyanide and cobalt at some water monitoring locations (Government of Yukon n.d.). Meanwhile, in mid-August, the mine's operator Victoria Gold was put into court-ordered receivership, which means that

Contents from a tailings pond from Mount Polley mine pictured going down the Hazeltine Creek into Quesnel Lake, August, 2014. The Canadian Press/Jonathan Hayward

a third-party steps in to take control of the mine, sell off assets, and manage remediation. Victoria Gold has posted security to the Yukon government for $104 million as required by its licences, to secure remediation, reclamation and final closure costs. As of January 2025, Yukon estimates the full remediation costs to be somewhere between $100 and $150 million (Hong 2025).

BOX 2 - The Mount Polley tailings disaster

In August 2014, a tailings dam failure at the Mount Polley copper-gold mine in central B.C. released 22 million litres of water and mine waste into Quesnel Lake, one of the world's last great salmon systems, during the summer sockeye salmon migration (Pollon 2018). In the aftermath of the disaster, the B.C. government ended up paying millions to support the cleanup. In the end, the company won over $100 million in damages, in a court settlement with their engineer contractors (Pollon 2023).

Mount Polley returned to operations in 2015. A surge of phosphorus, nitrates, and sulphate released into Quesnel Lake by the breach, followed by the last nine years of discharges, continues to have a negative impact on the water quality of the lake, including local community drinking water, according to local residents. To this day, the long-term effects of this pollution event—which included the release of arsenic, selenium, and various heavy metals into the region's rich salmon habitats—remains unknown (Pollon 2018). The water treatment plant currently authorized to operate at the site by the province is not designed to remove selenium.

The Mount Polley case illustrates some of the weaknesses of the principle of professional reliance in the management of natural resources, a form of industry self-regulation, when it came to designing and monitoring its tailings dams (Government of British Columbia 2018). B.C. made changes to its professional reliance regime in the disaster aftermath regarding how tailings dams are constructed, operated, and monitored, introducing additional oversight (Haddock 2018). Environmental lawyer Larry Innes notes that "professionals now need to assess against specific standards set out in [B.C. law], rather than exercising 'professional judgement'".[2]

The disaster also demonstrated the high degree of discretion both federal and provincial governments employed in enforcing otherwise strong laws around tailings. Two private prosecutions, one brought by a local First Nation, the other by an environmental organization, were taken over by the provincial Crown and federal government respectively, and both were stayed without public explanation (CBC 2018). Charges under the federal Fisheries Act—on paper, one of the world's strongest environmental laws, with potential jail time and serious fines for polluting marine and salmon-bearing waters—were not laid until December 2024, after more than 10 years had passed after the disaster (Government of Canada 2024).

2. For more, see Code Guidance: Health, Safety and Reclamation Code for Mines in British Columbia (**Government of British Columbia 2024b**).

Declaring bankruptcy allows mining companies to eschew cleanup costs

As with mine closure and reclamation obligations, bankruptcy remains an escape hatch for companies seeking to dodge cleanup costs associated with tailing disasters. In the case of Mount Polley, Imperial Metals faced the threat of bankruptcy immediately following the spill, but was buoyed by the company's largest shareholder and managed to weather the storm. The provincial government still paid an estimated $40 million in tax refunds and direct costs, but it could have been much worse had the company gone bankrupt (Lavoie 2017). That's because the public remains exposed to cleanup costs in cases where a company is forced out of business by a disaster. If a mining company knows it can pass on the costs of a worst-case disaster scenario by declaring bankruptcy, it "reduces their incentive to reduce environmental risks" that might prevent the disaster from occurring, making such disasters more likely to happen (Canada's Ecofiscal Commission 2018). Closing this loophole is critical for mining in Canada. As the Independent Expert Engineering Investigation and Review Panel assembled in the wake of the Mount Polley disaster predicted, British Columbia, home to 123 active tailings dams, can expect an average of two failures every decade. "In the face of these prospects, the Panel firmly rejects any notion that business as usual can continue" (Independent Expert Engineering Investigation and Review Panel 2015). Another key panel recommendation was that if future tailings dam failures are to be avoided, B.C. and Canada must join together to remediate the existing abandoned and orphaned tailings dams that dot the landscape—not just in B.C., but across the country.

These examples illustrate the need for better tailings management at existing mine sites, but they also exemplify the environmental stakes if future mine sites are going to be located in more remote areas. Box 3 explores the risks associated with building new mine sites—and the requisite tailings management infrastructure—in mountain ranges affected by glacial retreat.

BOX 3 - A cautionary link between glacial retreat and tailings disasters

There are an estimated 16,000 glaciers in British Columbia, with many of them located in the so-called Golden Triangle—an aspiring mining district in the northwest corner of the province that holds most of the province's identified reserves of copper, gold, and silver (Pollon 2021). About 20 per cent of the mining claims in this mountainous region bordering southeast Alaska are in glaciated landscapes (EIA 2024). By 2100, climate change will have eliminated 70 per cent of these glaciers, which miners expect will be a boon for mining, opening up new ground to mining exploration in this mineral-rich region (Pollon 2021).

Glacial retreat will make it ever more risky to build tailings dams in these destabilized environments, however. Retreating glaciers leave destabilized rock that is no longer held in place by ice. Seabridge's KSM Project, one of the biggest proposed copper-gold mines in the Golden Triangle, is planning to build multiple open pits in a sprawling alpine site amid several glaciers, requiring multiple tailings dams, including one that will stand 20 metres higher than the Hoover Dam. While construction of some mine components have begun, the company has not yet applied to bring the mine into operation. If it is built, over two billion tonnes of tailings generated over its 52-year mine life could be perched above the salmon-rich Nass River. Meanwhile, the open pits will drain into southeast Alaska (Pollon 2018b).

A bald eagle perches on a driftwood stump on the Nass River tidal flats at Gingolx (Kincolith) B.C. Canada.

2.3 Biodiversity impacts

In addition to reclamation and tailings management, addressing Canadian mining's environmental risks requires confronting a third major challenge: biodiversity impacts. Increasing Canadian production of critical minerals will disturb significant tracts of land and will require new infrastructure, both on-site and off: everything from new roads and railways to power lines and clean energy generation. Much of this will be needed in remote, pristine, and biodiverse locations, including northern landscapes that are already under pressure from climate change.

Unless it's handled carefully, Canada's critical mineral mining imperative risks jeopardizing the country's biodiversity commitments.

Unless it's handled carefully, Canada's critical mineral mining imperative risks jeopardizing the country's biodiversity commitments. Canada has committed under the United Nations-led Kunming-Montreal Global Biodiversity Framework to conserve 30 per cent of land, sea, and inland waters, restore 30 per cent of degraded ecosystems by 2030 (known as 30 by 30), and cut invasive species introductions in half (Government of Canada n.d.a).

Assessing and managing cumulative effects is key to protecting biodiversity

Because biodiversity is dependent on the interaction of many complex systems, it's the cumulative impact of projects that matters. The Canadian Council of Ministers of the Environment defines cumulative impacts as "a change in the environment caused by multiple interactions among human activities and natural processes that accumulate across space and time" (CCME, 2014). In mining, cumulative impacts can be understood as the collective effect of all of the projects in a region, such as their collective fragmentation of wildlife habitat or degradation of the natural ecosystem.

One of the experts consulted for this report stated that the cumulative impact of mining projects remains poorly understood and little measured in Canada.

The Ring of Fire in Northern Ontario illustrates current challenges in measuring cumulative effects

Prospective mining developments in Northern Ontario are a powerful example of potentially extensive cumulative effects on biodiversity, where there are over 31,000 mineral claims covering a 4,972-square kilometre area of the James Bay Lowlands, about 350 kilometres north of Thunder Bay (Wildlands League 2023). The area, known variously as the Ring of Fire or the Breathing Lands, represents one of the world's largest intact peatlands, which provides rich

ecosystem goods and services to Canada and the world more broadly (Ray and Chetkiewicz 2020).

Scattered across this vast, unroaded expanse of peatbog, swamp, and fen are the building blocks of the clean energy transition: nickel, copper, and platinum group metals, as well as other commodities like chromite (used in steel making), diamonds, and gold (Government of Ontario 2022). Unlocking these mineral deposits would require a massive buildout of new all-season infrastructure, which is necessary to get the minerals to market and ultimately make these projects economically viable. Yet development plans in this region have emerged without a clear picture of the potential cumulative impacts from multiple potential projects within a relatively small area.

There are currently multiple proposals progressing through Ontario's provincial environmental assessment process for road infrastructure in the region, including supply and community access roads, as well as the so-called Northern Road Link, which could potentially connect future mines to the Ontario highway system (Impact Assessment Agency of Canada 2024a). Such infrastructure would touch the region's vast peatlands, one of Canada's biggest intact, natural carbon sinks. Moreover, this infrastructure could be the starting point for a future network of access roads that could unlock many new projects, each adding to the cumulative impacts on the region. As one of the experts consulted for this report points out, major rivers would have to be crossed, fording a water-world facing land destabilization from seasonal melting (including melting permafrost in places).

Scientists warn that disturbing one of the largest intact peat bogs on earth by building the potential mining district could emit enough greenhouse gas emissions to undermine the downstream benefits from clean technologies these projects are aiming to supply (Harris et al. 2021). According to the Wildlands League, mining development covering a mere three per cent of the Ring of Fire area alone would suffice to undo nearly all of Canada's emissions reductions between 2005 and 2021 (Wildlands League 2023).

In addition to these poorly understood impacts, there is also a lack of consensus across affected Indigenous nations about the future of mining in the region. At least two Indigenous communities are conditional supporters of the Northern Road Link, but other communities, including those downstream of potential mining activity, continue to voice serious concerns (Law 2023). There is now an Indigenous-led proposal to establish the Mushkegowuk National Marine Conservation Area, led by Cree communities, that would see the immense biodiversity of the entire coastline of James and Hudson Bays protected (including a 20-kilometre coastal buffer from development) (Talaga 2024).

It is, therefore, crucial for policy makers to understand the total impact that many new mining projects will have on the landscape to ensure that sound development decisions are made for the region. This is why in 2020, following requests from the Wildlife Conservation Society of Canada, the Aroland First Nation, and the Osgoode Environmental Justice and Sustainability Clinic, the federal government mandated a Regional Assessment for the Ring of Fire region (Government of Canada n.d.b). The late assessment promises to address cumulative effects of proposed projects on biodiversity in the region, but it is unclear what role this assessment will have, if any, in shaping future developments in the region. In April 2025, the government of Ontario announced legislation to fast-track assessments and permitting for mining projects in the Ring of Fire, raising concerns among some local Indigenous communities about a lack of consultation and consent (Jones and Casey 2025).

Lithion Saint-Bruno, a commercial plant for the extraction of critical minerals in Saint-Bruno-de-Montarville, east of Montreal. The plant dismantles and shreds lithium-ion batteries to produce black mass, a composite material rich in minerals which can be reused to make new batteries. The Canadian Press/Christinne Muschi

3. Follow the leaders: Voluntary and regulatory best practices

While it is impossible to build a mine—or any major project—with zero environmental risk or impact, companies and countries around the world are demonstrating that these risks and impacts can be effectively addressed and reduced. This section considers best practices for addressing the environmental issues discussed in Section 2.

The first way to mitigate environmental risk is through direct government regulation and policy, which, in Canada, is a responsibility that is shared across provincial, federal, territorial, and Indigenous governments (see Box 4). This section highlights initiatives both within Canada and internationally where government and voluntary action is minimizing environmental risk.

BOX 4 - A Canada's shared jurisdiction over mining

Provinces and territories are primarily responsible for regulating mining activities in Canada. The Constitution Act of 1867 lays out that provinces have exclusive jurisdiction over the "exploration… development, conservation and management of non-renewable natural resources" (Constitution Act 1867). It is at this order of government that most laws are applied, covering everything from exploration and claim staking to closure and remediation.

As a consequence, mining laws across Canada are a patchwork of rules. The federal government plays a role in limited ways: for larger projects beyond certain size thresholds, they will participate in the Environmental Assessment process. And certain areas that touch mining—including the pollution of marine waters, or impacts to anadromous fish like salmon through the Fisheries Act—are within federal jurisdiction as well.

Indigenous governments have historically been excluded from environmental and impact assessment processes in Canada. This has meant that "Indigenous culture, traditional activities, rights, and title have by and large not been taken into comprehensive (or even meaningful) account in the Crown-led and proponent-driven Canadian environmental assessment processes," or decisions about how environmental risks are managed (Gibson et al. 2018). However, a combination of evolving case law (e.g., Tsilhqot'in Nation vs. British Columbia), international laws and norms (e.g., the United Nations Declaration on the Rights of Indigenous Peoples), and the development of modern treaties and land claims are giving Indigenous communities more direct input in these decision-making processes. Some communities and governments are starting to conduct their own "Indigenous-led impact assessments outside or alongside the formal system that more closely match their priorities, worldviews, and legal customs"(Gibson et al. 2018).

The second way to mitigate environmental risk is through voluntary sustainability initiatives (VSIs), which transcend the patchwork of national and subnational mining laws. At their best, VSIs can complement and strengthen existing laws governing extraction by including stringent and on-the-ground independent third-party scrutiny of operations. At their weakest, VSIs can act as a vehicle for industry self-regulation, designed to ensure that regulatory burden and requirements for operational transparency remain low.

The intent of this section is not to grade VSIs, but rather to showcase where they offer a leading edge for reducing environmental risks. This paper examines examples where VSIs go beyond regulatory requirements, offering guidelines and science-based benchmarks that promote sustainable resource extraction and community engagement. For context, the table below presents an over-

view of key VSIs in the mining industry active in Canada. An industry steering group is currently exploring converging multiple standards into a common standard, but updates are not expected before 2026 (The Consolidated Mining Standard, n.d.).

Several VSIs are being implemented by mining companies such as the Initiative for Responsible Mining Assurance (IRMA) and Towards Sustainable Mining (TSM). Compliance with VSIs can create value for mines. For example, as of January 2025, 27 purchasers of metals, including automobile manufacturers and electronics manufacturers, were members of IRMA, and they can call on their metal suppliers to undergo IRMA audits.

Exploring both approaches—government regulation and VSIs—offers important and complementary insights on how to effectively address the three environmental challenges we've identified: mine closure, tailings management, and biodiversity impacts mitigation.

TABLE 1:
Voluntary Sustainability Initiatives (VSIs) active in Canada

Initiative	Description	Governance	Assessment framework	Uptake
Initiative for Responsible Mining Assurance (IRMA)	Established in 2006, IRMA is a globally recognized standard for its focus on mining governance and transparency. It evaluates individual mines against hundreds of Environmental Social and Governance (ESG) requirements through third-party on-site auditing. IRMA released a draft of the second version of its standard, which extends to exploration (IRMA 2023). IRMA 2.0 is expected to be finalized by the end of 2025.	Governed through consensus of six equal houses: affected communities, downstream purchasers, investment and finance, mining industry, NGOs, and organized labour.	Process begins with self-assessment, followed by independent third-party review (incl. on-site visit). Companies can decide whether to make their preliminary IRMA participation public or keep confidential; final rating indicates the degree to which the mine meets IRMA standard requirements, e.g., a rating of 75 means that the mine met all critical requirements, and at least 75 per cent of all 200-plus requirements. Re-assessment occurs within three years.	By the end of 2024, IRMA had engaged 99 mining companies across 34 countries, representing 118 sites. Currently, 68 sites are in the self-assessment phase (IRMA 2024a). Major companies like ArcelorMittal, Eramet, and Anglo American have committed to assessing multiple mines against the IRMA Standard. In Canada, at least three Quebec mines in early stages of the IRMA process., as well as a single B.C. exploration company. No Canadian mine has to date completed the independent evaluations.
Towards Sustainable Mining (TSM)	Established in 2004, TSM is a Canadian industry-led VSI mandating mine-level commitments and reporting for Mining Association of Canada (MAC) members. (Mining Association of Canada n.d.). Together with the International Council on Mining and Metals, Copper Mark and the World Gold Council, TSM is working towards the creation of a consolidated industry-led mining VSI (ICMM 2023).	Governed by the Mining Association of Canada, its Board of Directors includes executives from major global mining companies and is advised by a Community of Interest (COI) panel that makes decisions with the MAC board.	Companies self-assess their sites against best practices as determined by the MAC board, using grades from AAA to C. Every three years, the self-grading must be verified by an external, independent party, with limited company and auditor reports posted to the MAC website.	As of 2024, all Mining Association of Canada members, consisting of 32 companies, are required to adhere to TSM. The standard has also spread beyond Canada and is currently being adopted by at least 11 national mining associations outside of Canada.

13. Unlike roads or transmission lines, solar panels can be moved and installed in other locations.

Initiative	Description	Governance	Assessment framework	Uptake
International Council on Mining and Metals (ICMM) Mining Principles	In 2020, ICMM launched the Mining Principles which set out "good practice" environmental, social and governance requirements of company members through a comprehensive set of 39 Performance Expectations and nine related position statements. The ICMM Principles incorporate site-level validation of performance expectations and assurance of members' corporate sustainability reports. ICMM is currently working with TSM, Copper Mark, and the World Gold Council towards the creation of a consolidated industry-led mining VSI.	The ICMM Mining Principles are overseen by the ICMM Council, composed of global mining and metals CEOs, providing strategic direction. The ICMM Management Team, comprising senior industry representatives, manages daily operations and develops Principles and guidance through stakeholder consultation, and best practice training/capacity-building workshops.	Site-level assessment against performance indicators for each Principle. Three-tier grading system: "Meets," "Partially Meets," or "Does Not Meet" for each indicator. Independent third-party validation is required for all assets. Validation typically occurs every three years. Companies must have a process for self-assessment against the Performance Expectations.	As of 2025, ICMM has 24 member mining companies worldwide, including major players like Teck, BHP, Glencore, Rio Tinto, and Vale, with 12 having Canadian ties such as Barrick and Teck. ICMM's membership also encompasses 45 industry associations globally, including prominent Canadian bodies like the Mining Association of Canada, Prospectors & Developers Association of Canada, and the Canadian Institute of Metallurgy, Mining and Petroleum.
The Copper Mark	Established in 2019, The Copper Mark is a global assurance framework designed to foster responsible production and stewardship within the copper mining sector and has since expanded to include zinc, nickel, and molybdenum. The Copper Mark calls for site-level compliance with 33 ESG criteria through independent assessments. The Copper Mark is part of the industry consortium working on a consolidated mining VSI.	Governed by a Board of Directors and an Advisory Council. The Board, comprising industry and non-industry members with voting power, oversees strategic decisions. The Advisory Council, representing diverse sectors, provides recommendations to the Board.	Sites are evaluated against each criterion and receive a grade: "meets", "partially meets", or "does not meet". Companies develop and externally validate site-specific improvement plans together with certified assessors. Implementation timelines are set, with quarterly check-ins to monitor progress. Failure to meet each criteria expectation under a two-year period results in suspension or removal of the The Copper Mark, with extensions granted under exceptional circumstances. Reevaluation every three years is needed for all sites.	As of 2025, 70 sites globally hold The Copper Mark or related marks. In Canada, only three sites have obtained Marks under the program, with Teck Resources operating two sites covering zinc and copper mining to refining, and Nexans' Montreal-East Plant. (The Copper Mark n.d.) These sites are currently implementing improvement plans to fully meet The Copper Mark and The Zinc Mark, respectively.

3.1 Mine closure and reclamation

Multiple voluntary sustainability initiatives share a common vision when it comes to mine closure: planning must happen proactively, long before an ore body is exhausted. From the moment exploration begins—with impacts like road-building, bulk sampling, and drilling to demystify the geology of a site—planning needs to be in place for how the site will be returned to as natural a state as possible.

All Canadian jurisdictions now require some level of financial assurance for cleanup costs, but not all are equally effective

On the regulatory front, over the past century, Canada has witnessed a sea-change in how governments require mining companies to plan for the future. Financial assurance requirements for mine operators—proactive, upfront payments by companies in advance of closure to cover costs of eventual cleanup—now exist in some form in all Canadian provinces and territories (Innes et al. 2020). This is the primary fix for the historical problem of some companies declaring bankruptcy and leaving mine closure and remediation costs to the public. It also addresses the still-common global practice of relatively small, unsophisticated companies buying up near-end-of-life mines—which by this point have tailings dams, waste rock dumps, and other liabilities—and proceeding to exhaust the last remnants of ore before abandoning communities and cleanup costs.

Quebec's example also shows that stringent rules around financial assurance and a thriving mining sector can coexist.

That said, financial assurance policies are implemented differently across Canada. Quebec stands out as a leader when it comes to approaching mine closure responsibly. There were 346 abandoned mining sites under the responsibility of the Quebec government as of March 2024 (Government of Quebec 2024b). Quebec revamped its Mining Act in 2013 to make it mandatory for mining companies to post hard and liquid surety—assets like cash—for future closure (Boulanger, Stone, and Hudon 2013). Financial guarantee obligations apply to mining exploration as well (Government of Quebec 2024a). Before mining can even start, a mining company in Quebec must put down 50 per cent of estimated restoration costs upfront, and the province retains this money in case of bankruptcy. After one year, another 25 per cent of that total cost must be put down, and on the second anniversary of operations, the remainder must be provided (Government of Quebec n.d.).

Additional rules added in 2024 include the prohibition of any transfer of a mining lease or concession in the event of failure to pay the required financial guaran-

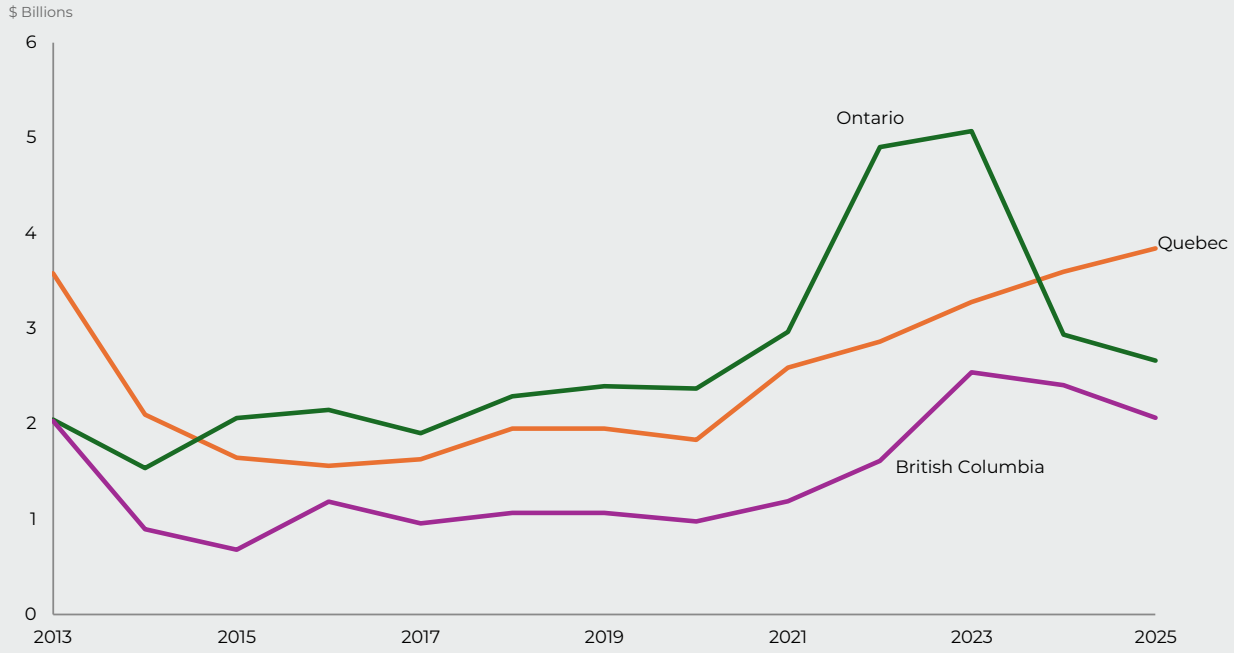
tee, and the requirement that holders of mining leases or concessions on public lands hold civil liability insurance (National Assembly of Québec 2024).

This makes Quebec a world leader in financial assurance—and a jurisdiction that can be emulated by other Canadian jurisdictions (see Section 4). Quebec's example also shows that stringent rules around financial assurance and a thriving mining sector can coexist.

An important caveat, however: these measures only apply to mines that have applied to the government for permitting since 2013, which means that most of Quebec's 29 existing mines as of this writing are operating under less stringent rules.

Quebec introduced some of Canada's most stringent regulations for mine closure assurance in 2013. Figure 1 compares the trends of capital investments in the mining sector between Quebec, Ontario, and British Columbia, the key critical mineral mining regions in Canada. It shows that investment in Quebec's mining industry continues to thrive compared to other mining provinces despite the extra financial burden for companies.

Figure 1 - Mining investment in Quebec continues to grow despite more stringent environmental regulations



Source: Statistics Canada. Table 34-10-0035-01 Capital and repair expenditures, non-residential tangible assets, by industry and geography

Publicly available and regularly updated reclamation and closure plans are key to reducing end-of-life risks

Of the different VSIs, the Initiative for Responsible Mining Assurance (IRMA) stands out in setting a high bar for how it approaches mine closure. In certain areas, IRMA rises above Canadian provincial/territorial mining laws: under IRMA, the operator must develop a reclamation and closure plan "compatible with protection of human health and the environment…" before mine construction can begin, and all exploration and operational impacts must be addressed at the end of a mine's life (IRMA 2024b). The plan, which is required to be made public, must demonstrate how affected areas will be returned to a stable landscape with an agreed post-mining end use.

Another IRMA standout is that in order to meet its requirements, monitoring and sampling must happen for at least 25 years after a mine officially closes (IRMA 2023). In Brazil at Barro Alto, Anglo American complied with this approach as a requirement of IRMA (IRMA 2024b) (see Box 5).

BOX 5 - IRMA in action at the Barro Alto nickel mine (Goiás State, Brazil)

The independently audited Barro Alto mine is one of only seven mines in the world to have achieved an IRMA 75 rating as of January 2025. (Three have earned the lesser IRMA 50 rating to date.) The mine, which commenced production in 2011, had four open pits at the time of its IRMA audit, as well as waste rock disposal areas, on-site power generation, and a containment basin. The mine underwent the IRMA assessment process between 2019 and 2022 , including a third-party independent audit, achieving a rating of IRMA 75 in February 2024. This rating means the mine has substantially or fully met all 40 critical requirements and at least 75 per cent overall in each of the four Principle areas of the Standard (IRMA 2022; IRMA 2024b). As part of the independent audit, IRMA published a Mine Site Assessment report that includes detailed disclosure of where the company succeeded and failed (IRMA 2024b). For the company to maintain its IRMA 75 status, it must not only deliver on publicly disclosed corrective actions, but re-submit its operations to new, on-the-ground audits every three years. The public Mine Assessment Report reads like an open book about the mine's operations, and includes a link to the current Mine Closure Plan, which must be updated at least every five years (IRMA 2024b; Anglo American Nickel Brazil 2024).

3.2 Tailings management

The need to manage and store mine tailings over vast periods of time is modern mining's greatest environmental liability and long-term expense (Pollon 2023). It's also a significant concern moving forward, as production ramps up for critical minerals. Many new, increasingly large tailings dams will be required, both in Canada and globally. Recent high-profile disasters have focused global mining companies on tailings dam safety as never before. The necessity of regular inspections of operating tailings dams, and the need to have contractors or staff on the ground who assume legal responsibility for safety and integrity of tailings dams, are now firmly entrenched in the practice of many large global mining companies.

While data availability is limited, a public database of tailings facilities suggests that Canada currently has 122 active tailings facilities, 28 of which have an extreme or high risk ranking (Global Tailings Portal 2025).

Global investor pressure to increase safety of tailings dams is growing

To date, only four countries in the world (Brazil, Chile, Peru, and Ecuador) have banned upstream dams—the cheapest and most accident-prone design (Franks et al. 2021; see also Appendix 1). The ICMM, representing the world's biggest industrial miners, does not support a "blanket ban" on upstream dams. They maintain that this design is safe if it is done with due care and attention to detail (Pollon 2024).

Technical solutions to minimize the risk of tailings breaches are promising, including so-called dry stack tailings—a process for dewatering mine waste that avoids wet storage altogether. Drains can also, in some cases, be installed beneath conventional tailings impoundments (this has been done in the Northwest Territories and Thailand), which continue to drain away liquid after operation of the facility ends. This has the effect of unsaturating a large portion of the tailings and preventing the risk of disasters.

Investor pressure has spurred change in tailings management practices. In the wake of the deadly 2019 tailings disaster in Brumadinho, Brazil, and with B.C.'s 2014 Mount Polley tailings disaster still fresh in memory, investors representing $14 trillion in assets, led by the Church of England Pensions Board, vowed to take serious new action to mitigate the risk of failure (Pollon 2024). Together with the ICMM and the United Nations, the group created a new system of rules to better manage the thousands of tailings dams scattered across the globe. In 2020 the Global Industry Standard for Tailings Management (GISTM)

was launched: a standard that has since been integrated with both Copper Mark and ICMM's Principles. It is now expected that this new tailings scheme will be adopted by the new industry-consolidated standard to govern tailings management (see Box 6) (ICMM et al. 2020).

BOX 6 - The Global Industry Standard for Tailings Management (GISTM)

As of this writing, about half of all public mining companies on earth have either implemented or are committed to adopting the GISTM (e.g., Anglo American) (Anglo American n.d.). Twenty-four ICMM companies committed to conforming to the standard by August 2023 for tailings dams considered at "extreme" and "very high" consequence in the event of a failure—about 240 sites in all (although not all companies met this deadline) (Pollon 2024).

The standard comprises six topic areas, 15 Principles, and 77 auditable requirements, and covers standards and practices over the entire tailings facility lifecycle (ICMM et al. 2020). This includes the following requirements:

- Develop a robust design that integrates the knowledge base and minimizes the risk of failure to people and the environment for all phases of the tailings facility lifecycle, including closure and post-closure.
- Appoint and empower an Engineer of Record.
- Publicly disclose and provide access to information about the tailings facility to support public accountability.

Yet the new standard remains a work in progress. One hundred and fifty environmental and civil society groups banded together shortly after the formation of the GISTM to launch a report called Safety First (Morrill et al. 2022). They highlighted how the new tailings standard failed to ban both upstream dam designs, and the disposal of tailings in oceans, rivers, and lakes (Morrill et al. 2022). The discharge of mine waste into lakes and other water bodies is currently regulated in Canada through the Metal and Diamond Mining Effluent Regulations under the federal Fisheries Act (ECCC 2024).

At the heart of the critique expressed in the Safety First report is the idea that the economic cost of ensuring tailings dam integrity should not trump safety for human life and the environment. Herein lies the fundamental tension regarding industry-led initiatives to prevent tailings dam failures: most mining companies rely on conventional accounting systems that dictate available choices made around the separate phases of dam design, construction, and maintenance. In each phase, choices are made under the imperative of

keeping costs low, which can be a barrier to implementing the best available technology. However, if a failure occurs, the associated costs for society—financial, social, and environmental—are typically much larger.

BOX 7 - A regulatory solution to the disaster-bankruptcy gap—tiered financial protection

A decade after the Mount Polley tailings disaster, the bankruptcy gap described in Section 2 remains: no financial assurance is required against the risk of mining disasters in British Columbia—or in any other Canadian jurisdiction. Even in B.C. and Quebec, where the legal principle of polluter pays is enshrined in law, bankruptcy remains a loophole in the case where a company cannot absorb unplanned disaster costs. (However, the 2019 Redwater legal case ensures that even in the event of a bankruptcy, regulators are "first ranked" regarding any assets as required to address environmental liabilities.)

Taking a tiered approach to financial disaster protection may be a solution to this risk (Canada's Ecofiscal Commission 2018). In such a scheme, depending on the scope of the incurred damages, costs are covered via different tiers of protection. For example, the first tier of protection—typically assurances provided to the government by the company in the form of hard sureties such as cash—will cover the first tranche of the costs. If the damages exceed these available assurances, the second tier kicks in, including, for instance, third party insurance. If damages are yet higher, third tier protections will cover the remaining costs, for example through an industry-wide pool of funds that all companies contribute to for this purpose.

While not applied for mining in any Canadian jurisdiction, such an approach is nothing new for the regulation of other disaster-prone industries. Provincial governments could emulate the example of multiple federally regulated industries—like offshore drilling, nuclear energy, pipelines, and rail. Regulations require these industries to not only price disaster risk at the firm/company level, but pool risk across the industry to ensure taxpayers do not get stuck with cleanup costs. Consider the example of railways: spurred into creation by the Lac-Mégantic disaster of 2015, the Safe and Accountable Rail Act was created to require oil-transporting rail and ship companies to pay into an industry fund designed to cover disaster costs that exceed an operator's insurance coverage and ability to pay (Canada's Ecofiscal Commission 2018; Ship and Rail Compensation Canada n.d.).

3.3 Biodiversity impacts

Biodiversity impacts of projects usually extend far beyond the mine sites typically covered by VSIs. A single operating mine covers a relatively tiny geographic area, but the network of roads, power lines, and other infrastructure required to support its operations can be huge. Once in operation, the reach of tailings and water pollution (or the prospects of a breach of containment), captured in precipitation and carried off-site, also enlarges the footprint of any single operation (Macklin et al 2023). The cascading or cumulative impacts on environment and biodiversity are higher in regions with multiple mines and/or industrial activity in other sectors, including agriculture and energy. An analysis by S&P Global found that 78 per cent of all critical minerals mines in Canada are in significant ecosystems (Whieldon et al. 2024).

Unlike with reclamation and tailings impacts, which primarily occur and are managed within the geographical boundaries of a mining project, biodiversity impacts of mining projects and associated infrastructure can be far-reaching within regional ecosystems. And because VSIs typically focus on managing on-site impacts only, they have a smaller application when it comes to managing biodiversity loss and cumulative impacts. Best practices here are focused more on direct regulation and policy, yet as this section explores, few jurisdictions in Canada are wielding the tools available.

Governments can, however, draw lessons from VSIs in terms of how to better manage biodiversity impacts of mining projects. VSIs generally agree on the importance of protecting biodiversity through all stages of the mining lifecycle, and in ways that are transparent to the public and measurable over time. TSM and Copper Mark's frameworks on biodiversity include the principle of "no net loss" in cases where it is unavoidable to destroy biodiversity. This principle requires that a company attempts to compensate for the loss of natural values in one location by creating new, comparable natural values at a different location (Mining Association of Canada 2020).

IRMA, again, leads the way: from the outset, the IRMA standard "requires consideration and mitigation of the impact of mining on biodiversity and ecosystem services, threatened and endangered species, and [pre-existing] protected areas" (Innes et al. 2020). Decisions made early in the mining process—especially during the exploration stages when the first road-building occurs—are critical to protecting biodiversity.

Assessment and management of cumulative effects require new policy frameworks

In Canada, as one expert consulted for this research observed, the law has historically been silent on the cumulative environmental impacts of mining infrastructure and activity: mines were typically evaluated on a site-by-site basis. Colonial-era free mining laws prioritize mining on most publicly owned lands. These laws are still in effect in provinces like British Columbia, despite recent changes to mineral staking rules prompted by court rulings. This has repeatedly led to staking rushes, such as those in B.C.'s Golden Triangle, where a surge of exploration activity occurs. During these rushes, permitting and approvals often fail to consider the cumulative impacts of multiple potential projects. British Columbia has made significant progress with the establishment of the Mineral Claims Consultation Framework (MCCF) which requires consultation with First Nations before mineral claims are registered (Government of British Columbia 2025b).

In recent years, however, provinces and territories across Canada have started to adopt pioneering measures to ensure that cumulative effects of development projects on biodiversity are better understood and reflected in decision-making. British Columbia has developed the Cumulative Effects Framework (CEF)—a set of policies, procedures, governance frameworks, and decision tools that enable the scrutiny of natural resource development at the landscape level, above and beyond the impacts of a single mine or development (Government of British Columbia 2024a). Viewing cumulative environmental impacts at this macro level, the framework can identify areas of impact that threaten biodiversity, informing land use planning, regulation, and overall management.

The B.C. Cumulative Effects Framework makes it possible to identify and assess risk to specific species and ecosystem types at both a landscape and provincial level, employing a consistent, standardized methodology. To date, the B.C. government assesses cumulative effects for both at the individual species level such as grizzly bear and moose, and at the ecosystem level such as forest biodiversity with indicators that are measured, reported and incorporated in decision-making (Government of British Columbia 2021). For example, indicators used by the Framework for grizzly bears include road density, mortality rate, and availability and quality of food. Indicators for aquatic ecosystems include multiple metrics involving roads (such as road density and number of stream crossings), the number of mines in the area, and water withdrawals (Government of British Columbia 2021). A mine proponent in the permitting stages, for example, can access relevant assessments already completed by the government, and use this data not only to ensure that their project minimizes biodiversity impacts, but to understand how this one additional project contributes to total past, present, and future impacts on important wildlife and ecosystems.

Indigenous land-use planning can help define zones where development is possible and where it is not

Indigenous governments are also leading by example in developing public policies that better integrate cumulative biodiversity effects into industrial development decision-making. The leadership role taken by the Gitanyow people of the Middle Nass and Upper Skeena watersheds, located on unceded territory in northwestern British Columbia, is a prime example (Marsden and Curran 2021). By initiating and conducting their own land use planning—negotiated between the Gitanyow Hereditary Chiefs and B.C. over 10 years, concluding in 2012—the Gitanyow have scanned their entire territory and mapped all the natural resources and biodiversity values (Gitanyow Hereditary Chiefs n.d.a). Based on this exercise, they have created management zones to indicate where development can occur, and where it cannot.

The Gitanyow, like other Indigenous Peoples in Canada, have also recently established Indigenous Protected Areas as a means to protect irreplaceable natural values. In 2021, the Gitanyow led the creation of the 54,000-hectare Wilp Wii Litsxw Meziadin Indigenous Protected Areas, which protects critical spawning habitat for Nass River sockeye, coho, spring/chinook salmon, and steelhead and bull trout (Gitanyow Hereditary Chiefs n.d.b). This Indigenous Protected Area exists in addition to the Northwest Territories' Thaidene Nëné—covering 26,000 square kilometres of pristine subarctic boreal forest and northern Manitoba's proposed Seal River Watershed protected area (Parks Canada 2024). The Seal River Watershed initiative, a partnership of four First Nations with support of Inuit neighbours, proposes the protection of 50,000 square kilometres of land holding almost two billion tonnes of carbon, and home to at least 22 known species at risk (Chang 2024). Then there is Ontario's Ring of Fire (see Section 2) where the Indigenous-led, proposed Mushkegowuk National Marine Conservation Area could one day protect the immense natural capital and biodiversity of the entire coastline of James and Hudson Bay (Talaga 2024). The future of protected areas and, by extension, biodiversity protection in Canada in a context of mining expansion, will to a large degree depend on what areas were historically designated as parks—and will be led by Indigenous Peoples.

Lastly, there is also a clear role for the federal government in promoting regulatory frameworks that better take into account cumulative effects of development projects on biodiversity. The federal Impact Assessment Act includes provisions on strategic and regional assessments. These tools are promising but remain underutilized. As of April 2025, the federal impact assessment registry has two regional assessments out of 38 active assessments (Impact Assessment Agency of Canada n.d.).

Regional and strategic assessments are under-used tools under the federal Impact Assessment Act

Created under the federal Impact Assessment Act, regional and strategic assessments can help Canada ramp up critical minerals production and prevent regulatory delay without compromising necessary impact scrutiny and protection of biodiversity on the ground. These assessments scrutinize cumulative environmental impacts above the mine-by-mine project level, by requiring impact assessments for a portfolio of projects. They assess policies and systemic issues rather than individual projects and thereby provide an avenue for regulators to incorporate landscape-level analysis in the assessment of individual projects (Trottier-Chi 2023). The federal government defines strategic assessments as a tool to evaluate existing or proposed federal policies, plans, or programs that cause or contribute to issues arising in the impact assessment of projects (Impact Assessment Agency of Canada 2024b). In such cases, "a strategic assessment can consider how those issues may be addressed in the development, refinement or implementation of the evaluated policies, plans or programs" (Impact Assessment Agency of Canada 2024b). For example, a strategic assessment of the Canadian Critical Mineral Strategy might help assess the full impacts on waterways and Indigenous governance, and develop methodology for systematically measuring and mitigating such adverse impacts. This would thereby standardize the approaches that future proponents use in project-specific impact assessments (Trottier-Chi 2023).

Created under the federal Impact Assessment Act, regional and strategic assessments can help Canada ramp up critical minerals production and prevent regulatory delay without compromising necessary impact scrutiny and protection of biodiversity on the ground.

Unlike project-level impact assessments, a regional assessment has a broader scope. It includes both the positive and adverse effects of past, existing and/or future activities within a specific region. A regional assessment was triggered for Ontario's Ring of Fire region in 2020 with a motivation to better understand how the many proposed projects in the region could together impact the landscape and communities that inhabit it (Regional Assessment Working Group n.d.). The assessment, however, was initiated after companies and individuals are holding thousands of mining claims, possibly underlining the limited precedence and complexity associated with carrying out these novel types of assessments. The complexity of producing comprehensive regional assessments is illustrated by the fact that it took five years to develop the assessment's Terms of Reference.

Launching assessments early and developing organizational expertise in carrying them out—and ensuring that affected Indigenous communities are actively participating in the process—could turn strategic and regional assessments into a major boon. Such assessments could foster a shared understanding of biodiversity impacts for a portfolio of projects happening in the same landscape, ensuring coherence and a better management of mining projects' cumulative impacts on local biodiversity.

4. Moving forward: Policy options for Canadian governments

The Canadian policy landscape for managing environmental risks from mining—as illustrated by the discussion of best practices in Section 3—has evolved considerably over the past few decades. Mining companies and investors show a growing awareness of the costs associated with high environmental risks, and their increasing uptake of VSIs illustrates that they see value in establishing better norms and practices even if not mandatory under current regulations. At the same time, Canadian governments have started to fill some of the regulatory gaps that have contributed to the mining sector's legacy of environmental disasters in the past. Together, these developments illustrate that, in many cases, mitigation of environmental impacts is both technically feasible and critical to ensuring the industry's long-term competitiveness.

Despite this progress, Canada's systems for managing environmental risks from mining projects require further improvements to support the expected growth in critical mineral mining while mitigating environmental risks. Moreover, how the regulations evolved in Canada has resulted in an inconsistent patchwork of regulations across provinces and territories. Building and maintaining the trust of local communities and the general public in new mining operations requires a more ambitious and consistent approach to managing associated environmental risks.

Government regulation is the foundation for managing environmental risk from mining. While VSIs can help identify appropriate benchmarks for regulation, only governments can establish and enforce a mandatory baseline for the environmental performance of all projects. It is ultimately the public that bears the costs from poor environmental management practices, and it is incumbent upon governments to minimize these costs.

This section identifies concrete options for Canadian governments to improve the management of environmental risks from mining. Identified here are key areas for future progress across the three types of environmental risks

discussed in this paper: closure and reclamation, tailings management, and biodiversity impacts. Generally, our recommendations to Canadian governments fall into three categories:

- **IMPROVE ENFORCEMENT** of existing regulations by reducing excessive discretion in implementation;
- **STRENGTHEN REGULATIONS** to close loopholes and to align with more stringent VSIs where appropriate;
- **INTRODUCE NEW REGULATIONS** to complement existing provincial/territorial mining rules.

4.1 Requiring early planning—including financial planning—for mine closure and reclamation

Strengthening the regulatory requirements for mining companies around mine closures and reclamation should start with better enforcement of existing rules but can also include increasing their scope and even introducing new rules. These policy options include:

- **Reducing discretion in the enforcement of mine closure regulations:** For example, B.C. and Yukon have regulations that are stringent on paper but loosely enforced in practice (see the example of the Yukon government's case-by-case approach to setting financial sureties). Giving governments and civil servants too much discretion in enforcement can lead to inconsistencies, create loopholes for companies, and weaken the regulatory system by making companies seek exemptions.
- **Increasing the scope and stringency of financial surety and assurance regimes:** While all provinces and territories in Canada have legislation that requires mining companies to post upfront financial securities to cover mine cleanup costs, not all of them are equally effective. Creating more comprehensive financial surety and assurance regulations can strengthen the incentive for individual companies to improve environmental management over the mine's lifetime, and also find ways to reduce the overall cost and the likelihood that environmental cleanup costs will be borne by taxpayers. Governments should require mining operators to provide adequate liquid funds to pay for mine closure and reclamation—both in the case of bankruptcy, and/or at the end of life, including permanent water treatment if necessary. Here, provinces could emulate Quebec's approach to requiring hard surety.

- **Requiring that every new mine has detailed plans for closure that start at the beginning of a mine's life:**
  Proactive planning minimizes the risk of mines becoming future liabilities for the Canadian public. The beginning of mine life—at which point all mining companies submit some form of Mine Plan to the government—is the most critical moment in terms of getting the mine design right to reduce future environmental harms. For instance, decisions made at this stage will have a big impact on the effectiveness of measures such as minimizing pollution from acid rock drainage or the stability of tailings dams over time. While closure plans evolve over the life of a mine, it is critical for project operators to provide sufficient detail upfront to avoid underestimating closure costs.

  B.C. has strict requirements for project proponents to plan for reclamation right at the start of the mining operations. Other jurisdictions can follow their example.

  IRMA also requires that closure plans as well as financial assurance are updated when there is a significant change to the mine plan, or at least every five years. IRMA also requires that closure plans be made public, which increases transparency and public accountability. Engaging local communities in closure and post-closure monitoring through oversight and direct participation can help build trust and foster mutual benefits between project proponents and the community.

Proactive planning minimizes the risk of mines becoming future liabilities for the Canadian public.

- **Reducing the risk of "vulture" companies avoiding liabilities for mine closures:**
  Smaller mining companies may not have the financial capacity to adequately meet cleanup obligations, especially in cases where they purchase a mine that is close to its end of life. To reduce this risk, governments may explore legal options to prohibit or more closely scrutinize the sale of a mining asset where the operating company does not hold enough security to pay full costs of closure and remediation, including ongoing treatment and monitoring costs. For example, under the Investment Canada Act, the federal Canadian government can assess the purchases of Canadian assets through foreign buyers to determine whether the deal is likely to be of net benefit for Canada.

- **Considering alternative uses for closed mines while minimizing residual risks:**
  While the primary goal of a mine closure plan is to return the landscape to a healthy environment, there can be some cases where a mine site can be repurposed for other industrial, or recreational purposes, while minimizing

additional environmental and social risks. For example, the Tent Mountain coal mine in Alberta is being repurposed to be used as a pumped hydro project. An international example where active planning has started for post-mining land use options is the Latrobe Valley and Gippsland in Australia, where three coal mines are expected to stop operating by 2035[3] (CRC TiME n.d.). As for all new projects, proponents should plan such alternative uses with the direct participation of local communities. An added benefit of reusing old mining sites is that this practice can help prevent new projects on undisturbed lands and also enable use of existing rather than new infrastructure.

4.2 Strengthening regulations for more effective tailings management

Robust tailings management is critical to ensuring the safety of communities and ecosystems in contact with mining operations. Many large mining companies have voluntarily committed to implementing standards that address tailings risks such as the Global Industry Standard on Tailings Management (GISTM) and Towards Sustainable Mining (TSM), which may go beyond current government regulations (see Box 6). Provincial governments can close the gap between the voluntary standards and regulations by adopting one or more of the following policy options:

- **Requiring financial assurance for disasters:**
  If a tailings dam disaster bankrupts a mining company today anywhere in Canada, taxpayers will be left to cover the cleanup costs. Closing this 'liability gap' by requiring companies to set aside more money to cover possible environmental liabilities not only prevents these costs falling on the public, but also incentivizes companies to step up safety practices over the mine's lifetime (Canada's Ecofiscal Commission 2018). Since the potential liabilities from mining disasters are very high, Canadian provinces and territories could emulate the examples of federally regulated industries—like railways and pipelines—which employ tiered levels of risk assurance to offset the massive potential costs of disasters (see Box 7). Such a tiered approach shares the risk coverage between companies, third-party providers of financial assurance (e.g., insurances), and industry-wide disaster funds. Enhanced financial assurance requirements will increase the cost of operating a mine and may deter new investment. Thorough risk assessment can help governments

3 Multiple stakeholders are actively working on a project called Collaborative Planning for Post-Mine Land Use where different scenarios of land uses are explored. No decision has been made on how the land will be used..

set assurance requirements (i.e. the 'price' of environmental risk) at a level that balances the need for mitigating environmental risks with the strategic priority of supplying the critical minerals for the clean energy transition (Canada's Ecofiscal Commission 2018).

- **Restricting or prohibiting upstream tailings dams:**
  This is typically the cheapest type of dam design to build and is also the one associated with some major tailings disasters (Franks et al. 2021). It was the kind that failed at the tailings disasters at the Brumadinho and Fundão mines in Brazil, in 2019 and 2015 respectively. Brazil has banned upstream tailings, and other jurisdictions followed (Parizot 2020).

  Publicly available data indicates that Canada has 122 active tailings facilities of which 28 are classified as upstream failings facilities with extreme or high consequences in case of failure (Global Tailings Portal 2025).

- **Promoting technical solutions to increase safety:**
  Technical solutions to minimize the risk of tailings breaches include dry stack tailings and drainage systems. Governments could consider either financially incentivizing the use of these technologies where appropriate, or make their use mandatory in certain settings.

- **Increasing fines for non-compliance with tailings safety regulations and enhancing accountability of corporate decision-makers:**
  Charges for environmental violations, if they happen at all, can take many years. In the case of Mount Polley the company was charged more than a decade after the disaster. Another spill charge for a mining company took nine years.[4] More timely enforcement of existing compliance regimes can help prevent non-compliance.

4.3 Safeguarding biodiversity

Canada has committed, under the UN-led Kunming-Montreal Global Biodiversity Framework, to conserve 30 per cent of its land, sea, and inland waters by 2030 (known as the 30 by 30 commitment). A ramp up of mining and the required infrastructure can place intact biodiversity regions at risk. Canada is home to large, globally-significant, intact ecosystems (Watson et al. 2018). To protect these ecosystems, governments must consider impacts of mines in the context of existing and planned industrial activity in the region, and they

4 Teck Coal Limited pleaded guilty in 2021 for releasing selenium and calcite into the upper Fording River in 2012. Teck was fined $60 under the Fisheries Act (Government of Canada 2021).

must assess the cumulative effects of both proposed mining projects and the supporting infrastructure.

Governments can consider the following policy options to promote such comprehensive assessments:

- **Adopting dedicated provincial frameworks for assessing and managing cumulative effects:**
  Nearly all mining jurisdictions in Canada consider cumulative impacts in their environmental assessment process to varying degrees. But so far, B.C. is the only province that has established a comprehensive framework for the evaluation of cumulative effects. Such frameworks can provide methodological guidance on how to value cumulative impacts, and they can be tailored to the jurisdiction's specific mining and ecological regions.

- **Developing robust systems for biodiversity offsets for new project approvals:**
  Essentially, making biodiversity offsets mandatory would require mining companies to make up for the loss in biodiversity caused by a new mining project by investing in biodiversity gains at a different site (Brownlee 2014). In fact, the ICMM Principles include the no net loss principle on biodiversity, and a draft policy for biodiversity offsets exists at the federal level (ICMM 2024; ICMM n.d.; ECCC 2020). Also, the federal government approved at least one mining project, the Rose Lithium-Tantalum Mining Project, under the federal Impact Assessment Act in 2021 with conditions that included wetland offsets (Impact Assessment Agency of Canada 2021). Provincial and territorial governments could consider adopting a similar principle in the regulatory approval of new mining projects, making a positive decision conditional on a company's conservation efforts. However, the effectiveness of such a regulatory change would significantly depend on the robustness of the underlying valuation and accounting framework. Lacking credible, scientifically supported metrics for valuing nature, biodiversity offsets can become a loophole for corporate greenwashing (Chandrasekhar 2023). Alternatively, governments could adopt the practice of considering new mining development at a regional level and in parallel with conservation planning. This approach can help protect ecosystems and biodiversity and strengthen Indigenous leadership in these decision-making processes.

- **Supporting Indigenous land use plans that identify Indigenous Protected Areas:**
  In cooperation with provincial governments, some Indigenous communities are engaging in the development of land use plans that integrate Indigenous knowledge with Western science to define where development

is generally acceptable and unacceptable (Indigenous Leadership Initiative n.d.; Gitanyow Hereditary Chiefs n.d.a). As mentioned earlier, the Gitanyow Hereditary Chiefs negotiated a land use plan with the government of B.C. This land use plan identifies various zones considering cultural sites and habitats to determine what kinds of development (if at all) may be permitted in each zone. A global review of 86 initiatives found that Indigenous Peoples' Protected and Conserved Areas created socio-cultural, political, and ecological benefits such as improving Indigenous livelihoods, and improving species populations and habitat protection (Tran et al. 2019). Canadian governments (both federal and provincial/territorial) can play a significant role in building the necessary capacities for Indigenous communities to produce land use plans. [5]

5 See the report *Critical Path: Securing Canada's place in the global critical minerals race* published by the Canadian Climate Institute.

5. Conclusion: Mitigating environmental risk as a precondition for long-term competitiveness

With substantial reserves of the critical minerals required for clean energy technologies, Canada has a major economic opportunity to become a global supplier of choice. Capitalizing on this opportunity will require a rapid ramp up of mining activities in an industry that is both capital-intense and associated with high environmental risks.

Yet the relationship between environmental regulations and investment is complex. While compliance will most likely increase the costs for mining companies in the short term (e.g. due to larger spending for financial assurance mechanisms and/or safer tailings storage technologies), in the long run compliance with more robust environmental standards will reduce operational, financial, and reputational risks. That is why both investors and clients (e.g., auto manufacturers) are increasingly pushing for change in mining practices (for example, see the Global Investor Commission on Mining 2030)[6], and why a large share of global mining companies are participating in one or more VSIs. According to Ernst & Young's survey of global mining and metals companies, environmental stewardship is ranked second among top 10 risks foreseen by the industry in 2025 (Mitchell 2024).

With substantial reserves of the critical minerals required for clean energy technologies, Canada has a major economic opportunity to become a global supplier of choice.

More importantly though, government actions to better manage the environmental risks of mining is a necessary condition for building Canada's long-term competitiveness in the sector: without the support of local communities, no new mines will be built, no matter the available capital. And while voluntary industry and investor commitments are essential in driving change by defining global best practices and complementing public policies, it is on Canadian governments to put regulations in place that make risk-reducing practices mandatory for all companies operating in Canada and thereby limit the risks for all communities.

6 Global Investor Commission on Mining 2030 n.d.

And yet it must also be clear that government regulations cannot fully eliminate risks—no mining activity will ever be completely risk-free. Canadian governments must recognize and be transparent about the trade-offs that come with pursuing the strategic objective of developing Canada's critical minerals reserves.

Finding the right balance between reducing environmental risks and encouraging investment will be a crucial task for Canadian governments. The long-term competitiveness of Canada's critical mineral mines will depend on it.[7]

7. *Critical Path: Securing Canada's place in the global critical minerals race*, a report published by the Canadian Climate Institute alongside this paper, assesses different policy options in greater detail and further discusses environmental risk management in the context of Canada's strategic objective to become a leading global supplier of critical minerals for clean technologies.

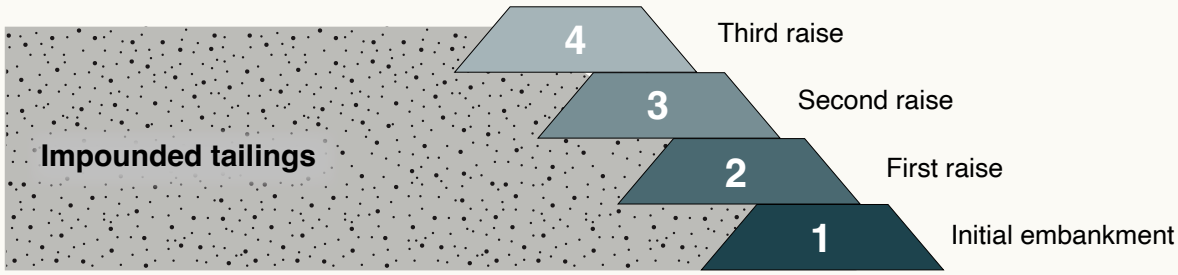
Appendix 1

Tailings storage construction methods

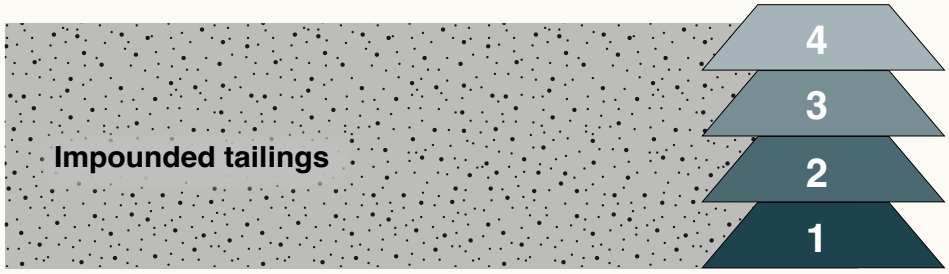
Raising Method	Description	Cost	Safety	Key considerations
Upstream	The dam is raised by placing new material on top of and inside the existing tailings.	Lowest	Generally least safe, higher risk of failure in poor drainage or seismic conditions (Franks et al. 2021).	• Relies on compacted tailings for stability. • Not suitable for regions with high rainfall or seismic activity. • Faster and cheaper to construct.
Centerline	The dam is raised vertically, aligning with the original crest, using compacted fill.	Moderate	Safer than upstream but less safe than downstream.	• Requires stable foundation and well-compacted tailings. • Balances cost and safety. • Commonly used where moderate risks and costs are acceptable.
Downstream	The dam is raised outward by placing material downstream of the existing dam.	Highest	Safest, with better stability against seismic and flood risks.	• Requires more land and material. • Suitable for high-risk regions (seismic or high rainfall). • Higher construction time and cost, but more reliable in the long term

Source: Vick 1990

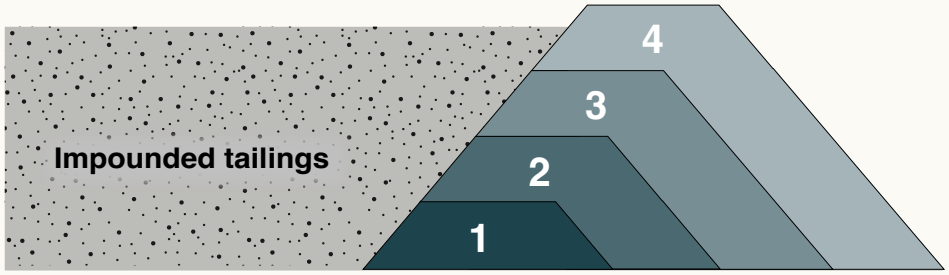
Tailings storage construction methods



Upstream construction method



Centreline construction method



Downstream construction method

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