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Adaptation Platform Mining Working Group

State of Play Report

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Adaptation Platform Mining Working Group

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Table of Contents

1	Introduction	1
1.1	<i>Rationale of the Adaptation Platform Mining Working Group</i>	<i>1</i>
1.2	<i>Objectives of the State of Play Report</i>	<i>1</i>
2	Canadian Mining ‘Outlook’	2
2.1	<i>National and global importance.....</i>	<i>2</i>
2.2	<i>Stakeholder roles and responsibilities</i>	<i>4</i>
2.3	<i>Mining sector in context.....</i>	<i>5</i>
3	Projected changes in climate.....	6
4	Importance of adaptation for the mining sector	7
4.1	<i>Impacts on core operations</i>	<i>8</i>
4.2	<i>Value chain impacts.....</i>	<i>8</i>
4.3	<i>Supply chain impacts</i>	<i>9</i>
4.4	<i>Other risks</i>	<i>9</i>
5	Adaptation initiatives.....	11
5.1	<i>Awareness and Engagement</i>	<i>11</i>
5.2	<i>Assessment of risks and opportunities</i>	<i>14</i>
5.3	<i>Adaptation planning.....</i>	<i>18</i>
5.4	<i>Adaptation related actions (policies, design, etc).....</i>	<i>18</i>
5.5	<i>Measures of effectiveness and reporting</i>	<i>19</i>
6	Gaps and needs	20
	Bibliography	22

1 Introduction

Across Canada and the world, climate change is already having an impact on the communities we live in, the environment that surrounds us, and our economy. Climate change creates both risks and opportunities for Canada’s regions and key resource sectors. All sectors, regardless of geographic location and economic value, may be faced with direct and indirect impacts from climate change.

Successfully planning for and managing the impacts of climate change entails more than an assessment of the risks and opportunities created by a changing climate; it requires information sharing and collaborative action involving stakeholders in the private sector, non-governmental organizations, and all levels of government. This State of Play report aims to help the recently-convened Adaptation Platform Mining Working Group develop a common understanding of the imperative for climate change adaptation for the mining sector¹, as well as a snapshot of the work that is already underway within the mining sector on adaptation. It will be followed by a strategic Program of Work document, to be developed in close consultation with the Working Group.

1.1 Rationale of the Adaptation Platform Mining Working Group

By working together, businesses, professional and industry organizations, and governments can often deliver more effective climate adaptation than they could by working in isolation. By pooling resources and sharing information, partners can collaborate on adaptation responses that help meet common objectives and targets, and can also avoid constraining adaptation options of partners in future. Collaborative working between business and government on adaptation can help to create consensus on priority actions, identify the most effective solutions, and ideally will generate greater private and public returns. The Adaptation Platform Mining Working Group includes members from national industry associations, national professional organizations, representatives from federal, provincial and territorial governments, as well as other relevant organizations to address shared adaptation priorities. Working within the wider structure of Natural Resources Canada’s new Adaptation Platform, Working Group participants can share knowledge, capacity and financial resources to produce and share information and tools to understand and adapt to the effects of a changing climate.

1.2 Objectives of the State of Play Report

The State of Play report aims to ensure that the Working Group moves forward with an agreed vision and goals, by providing a shared understanding of:

1. Current information on climate change impacts on the Canadian mining sector;
2. Adaptation planning and actions undertaken by the mining sector in Canada to date.

Section 2 of this report provides an overview and outlook for the mining sector in Canada, including current non-climate challenges and opportunities faced by the industry. The term “mining sector” is meant to encompass both businesses and governments. Section 4

¹ ‘Mining sector’, in the context of this report, refers to the entire mining cycle, from exploration and development, to processing and beneficiation, to closure and post-closure reclamation. We will also reflect on the importance of adaptation for some external mining sector stakeholders, including lenders, insurers, and investors.

demonstrates the importance of climate change adaptation, by describing projected future climatic changes, their impacts on the industry, and external drivers for adaptation. Section 5 outlines the wide range of adaptation actions undertaken to date within the mining sector, while Section 6 highlights strengths and gaps.

2 Canadian Mining ‘Outlook’

2.1 National and global importance

The mining industry is an economic pillar of our economy. According to Natural Resources Canada’s Mineral and Mining Statistics Division, the industry contributed \$36.2bn to the national GDP in 2011, \$8.6bn of which was derived from mineral extraction, while \$27.6bn was a result of mineral processing and manufacturing. The mining industry produced 23% of the value of all exported Canadian goods in 2011, made up chiefly of aluminum, copper, gold, iron and steel, iron ore, nickel, silver, uranium, zinc, diamonds, potash and coal. The Canadian mining industry is also a significant global player, with Canadian mining companies managing over 350 operations in other countries. As one of the world’s largest producers of minerals and metals, Canada ranks as one of the world’s leading mining countries.

Tax revenues from the mining industry represent important sources of income for the federal, provincial and territorial governments. The industry paid \$8.4bn in taxes and royalties in 2010. The mining industry employed over 320,000 people in 2011, providing approximately one in 55 jobs in Canada.

The relative size and geographic distribution of mining and quarrying establishments (a breakdown that excludes quarrying activity is not available) is shown in Exhibit 1. Mining activity is concentrated in Quebec, British Columbia, Ontario and Alberta. The bulk (64%) of employer establishments in this sector is considered small, employing between 5 and 99 people. Large employers, those with more than five hundred persons on payroll, accounted for just 2% of the total establishments in the mining and quarrying subsector.

Exhibit 1 Size and geographic distribution of mining and quarrying establishments in Canada.

Number of Employer Establishments in Canada By Employment Size Category and Region: December 2010 Mining and Quarrying (except Oil and Gas) (NAICS 212)				
Province or Territory	Employment Size Category (Number of employees)			
	Micro 1-4	Small 5-99	Medium 100-499	Large 500+
Alberta	39	85	3	2
British Columbia	55	91	10	4
Manitoba	12	18	2	1
New Brunswick	6	31	2	1
Newfoundland and Labrador	3	14	3	1
Northwest Territories	0	2	2	1
Nova Scotia	8	26	5	0
Nunavut	0	0	0	0
Ontario	52	175	24	6
Prince Edward Island	0	1	0	0
Quebec	68	190	17	3
Saskatchewan	21	42	11	2
Yukon Territory	17	13	1	0
CANADA	281	688	80	21
Percent Distribution	26.3%	64.3%	7.5%	2.0%

Source: Statistics Canada, Canadian Business Patterns Database, December 2010.

The closely connected upstream supply sector of the mining industry, which provides construction services, manufacturing, wholesale and retail trade, as well as technical, scientific and professional services, employs even more Canadians and provides significant additional benefit to the economy. It is difficult to estimate the economic impact the supply side of the mining sector, because industry statistics rarely separate mining-specific activities from the total activity of supply-side businesses. However, an industry study shows that a 'representative mine' in Ontario which directly employs about 480 people will generate approximately 1100 additional supply side jobs, with a further 700 jobs supported by the spending power of those direct and indirect workers in the wider economy (Dungan and Murphy, 2007).

The mining sector has important ties to other industries, in particular the transportation sector. Approximately 50% of all Canadian rail-freight volume revenues are generated by the mining industry, and many modes of transport are dependent on the mining industry as an important customer that provides significant tonnage income. The reverse is also true: Canada's transportation sector is critically important to the mining industry, as secure, reliable, and cost effective means of getting goods to market are vital to the industry's success.

There is clearly a very strong interest in minerals exploration in Canada's North, but spending on exploration is also spread across other regions of the country. In terms of global investment, Canada receives the largest share of investment in exploration, followed by Australia, the US and Mexico.

The mining industry is deeply interconnected with the Canadian economy, and the everyday life of Canadians. The end products of mining activity are used to construct communication and transportation networks, consumer electronics, vehicles, buildings, and many other items essential to modern life.

2.2 Stakeholder roles and responsibilities

Canadian mineral rights are government-owned and must be leased – rather than purchased – by individuals or companies. The regulation of mining activities is primarily a provincial responsibility, although there are key exceptions which are described below. As such, separate mining rights legislation exists for all thirteen Canadian jurisdictions except for Nunavut. Exploration and mining activities in Nunavut are currently regulated by the Department of Aboriginal Affairs and Northern Development, although mineral rights for about 10% of the territory's area have been turned over to the Inuit community, which has developed its own rules and regulations for those areas outside of federal jurisdiction (Natural Resources Canada, 2011).

Provincial governments manage and regulate mineral exploration and extraction, as well as construction, development and decommissioning of mine sites within their borders. In the Yukon, Alberta, Saskatchewan, PEI, and Newfoundland and Labrador, companies and individuals can conduct prospecting or exploration activities without a license, however they must hold a license to acquire mineral rights or "stake claims" to protect new mineral discoveries. In the Northwest Territories, British Columbia, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia, individuals and companies must hold a prospector's license before engaging in exploration for minerals.

Federal government responsibilities in mineral exploration and extraction are limited to mineral activities offshore, on Crown lands, related to Crown corporations, or the mining of uranium as part of the nuclear fuel cycle. Through the Department of Aboriginal Affairs and Northern Development, the federal government is responsible for mining activities in the North, though it has committed to a diminishing role through devolution of jurisdictional mining responsibilities to territorial governments.

Other federal regulations relevant to mining's environmental impact are primarily concerned with mine effluent and its impact on ecosystems. Key pieces of federal environmental legislation that govern mining include the Canadian Environmental Protection Act (CEPA), the Canadian Environmental Assessment Act (CEAA), the Transportation of Dangerous Goods Act (TDGA), the Fisheries Act, the Canadian Shipping Act, the Marine Liability Act, the Navigable Waters Protection Act (NWP), the Species at Risk Act (SARA), and the Migratory Birds Convention Act (MBCA). Recent changes to environmental regulation are aimed at reducing overlap, speeding up and 'modernizing' the process for large new projects, including mines. Revisions to the Canadian Environmental Assessment Act, for example, allow for the shift of responsibility for environmental assessments to the provinces. Proposed revisions to the Fisheries Act may introduce further changes to the mining industry's obligations in achieving regulatory compliance. Finally, a collaborative effort between federal, provincial and territorial governments has developed guidance for incorporating consideration of climate change into the environmental assessment (EA) of projects. Though this guidance is currently followed at the discretion of jurisdictions and regulatory authorities, its development is still evolving and consideration of climate change is likely to continue to be part of the EA processes. Each province has its own environmental legislation, as well as individual mine operating and closure criteria and requirements. Clearly, wider federal policies also have an indirect influence on the Canadian mining sector. These include international trade and investment policy, taxation, and environmental protection legislation.

To avoid duplication of effort in shared jurisdictions, and to take account of the broad range of stakeholder interests in the mining sector, the federal, provincial and territorial governments

work consultatively in partnership with business, NGOs, and other bodies to sustainably and competitively manage mining and metals activities in Canada. The Intergovernmental Working Group (IGWG) on the Mineral Industry facilitates federal-provincial-territorial collaboration on a wide variety of issues.

The leading national Canadian mining institutions include the Canadian Institute of Mining, Metallurgy and Petroleum (CIM), the Prospectors and Developers Association of Canada (PDAC), and the Mining Association of Canada (MAC). Region-specific mining associations are also active in most provinces. These organizations have the potential to significantly advance thinking on mining sector adaptation, given their role in facilitating exchange of knowledge and technology, promoting and recognizing excellence in a number of areas (including corporate social responsibility), and advocating on behalf of the mining industry to foster international competitiveness. Finally, climate-related impacts on the mining sector are an active area of research, and the climate change research community will play an important role in helping the mining sector understand and manage climate risks. The Adaptation Platform Mining Working Group represents an important step towards addressing climate change adaptation in partnership within the mining sector.

2.3 Mining sector in context

The mining industry, both in Canada and abroad, is exposed to high levels of risk and opportunity, and as a consequence the industry has developed significant expertise and skill in assessing and managing risks. Some of the risks faced by the mining sector are heightened by a changing climate; these are described in more detail in Section **Error! Reference source not found.** In some cases these risks underline the importance of climate change adaptation as a normal part of planning for the future. In other cases these risks may constrain the sector's ability to adapt.

The mining sector relies on large, long-lived fixed assets, some of which may not perform as intended over their lifetime unless they are designed with climate change in mind. Mine sites and associated infrastructure are often located in areas with challenging climates, and any change in these climatic conditions is likely to have operational impacts which will need to be managed. For example, any reduction in seasonal precipitation in an already water-stressed location may well put additional pressure on treatment systems for recirculated water currently working at or near capacity. In 'frontier' locations, recovery from any operational disruption (including climate-related interruption from storms or floods) is more difficult at isolated sites with limited transportation access.

The mining industry also operates globally, and is exposed to climate impacts worldwide through long and complex supply chains. Disruption to supply chains has consequences for commodity prices, supply of processing inputs, and delivery of finished products. Within Canada, limited investment in transport infrastructure has created supply and distribution bottlenecks for the industry. In many cases remote mining operations are served by a single freight rail company, leaving the customer with no competitive option. As access to transport infrastructure is already constrained, any additional stress on this network, including climate-related disruption, will heighten this business risk. Climate change will make it more critical to plan and manage the risks associated with supply chain disruption.

Maintaining a social license to operate is critical for the mining industry. In order to gain and maintain the support of the communities within which it operates, the industry must take account

of its impact on biodiversity, water abstraction rights, soil contamination, economic growth and development, social equity, and a host of other environmental, economic, social and cultural issues, both now and in the future. In traditional territories of Aboriginal communities, mining companies should also take account of potential climate risks to traditional lifestyles, values and culture. The skills shortage and human resource challenge in the Canadian mining industry highlights the importance of social license to operate, as companies attempting to build a workforce near mine sites must consider the long-term impact of climate change on the community as well as on operations. In some regions work is underway to help communities to adapt. For example, through the Climate Change Adaptation Program (CCAP), Aboriginal Affairs and Northern Development Canada is supporting Aboriginal and northern communities to address risks and challenges posed by climate change impacts and to become more resilient. Climate change has the potential to exacerbate many other risks associated with social license to operate, particularly with regard to competition for climate-sensitive resources like energy and water. As a heavily scrutinized and regulated industry that is very conscious of corporate responsibility, managing these evolving risks will be critical.

The mining industry is highly sensitive to global demand for products, and is often dependent on project financing for new developments. Recent moves to mainstream assessment of climate risks within investment and lending decision-making will add weight to the importance of planning for adaptation. Requests for climate risk disclosure by investors will further strengthen the argument for adaptation.

Clearly there is great variation in capacity in the mining industry. Whereas some operators are large enough to demonstrate leadership by devoting dedicated efforts to adaptation, smaller mining companies often do not have the capacity to integrate new innovative decision-making and practices.

3 Projected changes in climate

In its last assessment report, published in 2007, the Intergovernmental Panel on Climate Change (IPCC) confirmed that warming of the climate system is clear and indisputable, and that higher land and ocean temperatures, rising average sea levels, and reduced snow and ice cover are already observable on a global scale².

In Canada, higher temperatures and changing patterns of precipitation have been observed in climate records across most of the country. The report *From Impacts to Adaptation: Canada in a Changing Climate* (Lemmen et. al., 2008) describes projected climate changes for Canada over the coming century. Canada is projected to continue to experience rising temperatures, though the magnitude of warming will vary across the country. Temperature rise will be particularly acute in the North in the winter months, with seasonal average temperature changes exceeding the long-term historical average by 4.5°C by the middle of this century (based on the median projection of a seven member multi-model ensemble). Decreases in snow cover, as well as widespread increases in thaw depth over permafrost regions, are also projected to occur in response to warming over the next century. The IPCC ensemble of model results suggests a wide range in the potential reduction of Arctic sea ice over this century, with some models projecting the complete disappearance of summer sea ice cover in a high emissions future by the end of this century.

² IPCC. (2007). Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

Climate model ensembles project a general increase in the annual amount of precipitation over Canada as a whole, with greater consensus among models for winter precipitation increases in the north and a decrease in summer rainfall in the south (i.e. during the growing season). Despite the projected increase in annual precipitation, higher rates of evapotranspiration by plants in some regions are expected to offset this, resulting in greater aridity. More frequent intense precipitation events are also projected for Canada.

Warming during this century will also contribute to sea level rise, which is projected to occur for many hundreds of years because of the long lag time between greenhouse gas emissions and thermal expansion of the ocean. The IPCC projections of sea level rise show a range of 18-59cm by 2100, although analyses completed after the last IPCC assessment report indicate that a rise in global mean sea level rise of up to 120cm by 2100 for high emissions futures – double the maximum IPCC projections – is more likely³.

Because local sea level rise depends on ocean density, salinity and circulation, it is not possible to generalize about the amount of sea level rise along Canada's coastline. Vertical movement of land due to post-glacial rebound must also be considered in combination with mean sea level rise to determine the potential for localized coastal inundation.

Clearly, the effects of climate change will not be uniform from region to region, and assessments and adaptation initiatives will need to take account of local variability. Certain changes in climate may be more important for decision making than others, because of their associated impacts and the extent to which these can be managed.

4 Importance of adaptation for the mining sector

A changing climate may pose significant physical risks for mining operations; it may also create indirect impacts for social, economic, and environmental systems. There is regional variability in the type, and level of exposure to, climate risks. Canada's North is projected to experience particularly acute changes: while rapid warming and degradation of permafrost may pose challenges for asset design and access to resources, a shorter sea ice season may offer greater opportunities for shipping materials year-round. Rainfall is more important as a hazard to mine operations in British Columbia, where mountainous topography can make mining operations vulnerable to mud and debris flows triggered by intense rainfall, and transport routes are at risk of wash out, particularly during the spring melting season⁴. Mining operations in the Prairies are more likely to be affected by flooding and drought, and to experience challenges related to competition for water. There is also variability in vulnerability of communities and ecosystems to climate change, and in their capacity to adapt.

Globally, mining companies are already experiencing a range of climate-related disruptions. They are keen to assess the potential impact of climate change, so that they can plan to mitigate risks and capitalize on opportunities. Governments also want to ensure that the mining sector is able to operate competitively in a future climate, without compromising health and safety, environmental protection and community well-being.

³ Rahmstorf, S. (2007). A semi-empirical approach to projecting future sea-level rise. *Science*, 315, 368-370.

⁴ David Suzuki Foundation. (2009). *Climate Change and Canadian Mining: Opportunities for Adaptation*.

4.1 Impacts on core operations

Climate change has the potential to affect operations across the mining cycle. Opportunities for exploration and discovery in the North could be significantly improved by a longer ice-free sea lane season and warmer arctic and subarctic temperatures, although the reduced capacity of permafrost to support roads and other infrastructure may lower the efficiency (or increase the cost) of resource extraction. In areas that are currently water stressed, future exploitation may be constrained by regulation that seeks to limit climatic impacts on biodiversity or ecological systems.

The risk of flooding associated with intense seasonal rainfall or rising sea levels may degrade and lower the value of physical assets. If assets are compromised, operations will be disrupted, with associated costs. Heavier rains and erosion can also affect slope stability, with consequences for infrastructure integrity. Intense precipitation events can require temporary changes to waste water treatment regimes. Increased rainfall exacerbates the risk of overflow of tailings and waste storage facilities, reservoirs, and contaminant holding ponds, while permafrost degradation could cause loss of integrity of containment over time. If released into the surrounding environment, contaminants can pollute soils, plants and surface and groundwater supplies.

In dry areas and seasons, hotter temperatures may increase the risk of wildfires that can affect access to operations, damage communications and power infrastructure and, in extreme cases, can pose a risk to the safety of workers. If water for processing and beneficiation is temporarily in short supply, operations can be disrupted and costs for post-use treatment can increase. Rising temperatures will also heighten demand for energy for cooling; it can also compromise the supply of energy by lowering the capacity of transmission networks. During very hot weather, impacts on the supply of (and demand for) energy have the potential to lower the efficiency of production or disrupt mining operations.

Post-closure obligations often extend for several decades, meaning that closure design now needs to ensure that climate risks on mining operations are minimized until at least the middle of this century and beyond. Re-vegetation and reclamation plans ought to be developed in the context of future climate, with considerations for future biodiversity and vegetation. Post-closure obligations also have significant implications for the potential of failure of tailings dams on permafrost soils, discharge of contaminated water into surrounding areas, accompanying remediation costs, and increases in liability and reputational damage.

4.2 Value chain impacts

The mining industry is characterized by water- and energy-intensive operations. The availability and affordability of these two climate-sensitive resources is critical, and any climate-related impacts on their supply or cost may have implications for the viability of some mining operations. Water is used throughout the mining cycle, mainly for dust suppression, drilling rock, and processing ore. Mining companies can manage water use by tailoring the source and quality of water inputs to the requirements of mining operations. In areas of low water availability, mining operations may have opportunities to source water from lower quality sources, such as saline or brackish water, rather than using high quality fresh water inputs from sources such as aquifers.

Affordable and reliable energy supplies are also critical for mining operations. During hot weather, when river flows are low and waters are warm, thermal power plants are occasionally forced to shut down because of a lack of cooling water⁵. This impact has occurred recently in the southern US and in Europe. With hotter, drier summers projected for central Canada, this is a potential risk for operations reliant on thermal power stations. The environmental impact of discharging cooling water at elevated temperatures into streams and rivers that have reduced capacity to absorb heat (because they are already at low flow) is another concern. During very hot, dry weather, power stations may need to curtail production or risk regulatory non-compliance on discharge limits. Extreme events (e.g. floods and storms) can also damage energy infrastructure. Finally, some operations are powered by hydroelectricity, which will be affected by any changes in precipitation patterns.

Rising temperatures, flooding, and storms can all affect employee health and safety, either by increasing the likelihood of heat-related or vector-borne illnesses, or by increasing the risk of injury and accidents. Flooding can also prevent workers from accessing operations. Mining companies are often heavily dependent on the communities in which they operate (and vice versa), and therefore any climate-related impacts on these communities will have consequences for mining companies.

4.3 Supply chain impacts

A changing climate has the potential to severely disrupt supply chains which are critically important to the mining industry. Transportation infrastructure can be damaged as a result of extreme sea levels, storms, or excessively hot weather, causing expensive delays moving ore to processing facilities or shipping finished products to market. When spring flooding affected major ports on the Mississippi and Ohio rivers in 2011, for example, the aluminum industry experienced significant disruption in getting alumina to smelters.

Climate impacts on transport infrastructure are particularly acute in the North, where the ice road season has already shortened considerably and is projected to contract further, although for the time-being, technological changes in ice road operations have largely offset recent climate impacts. Finally, sea level rise, flooding and storm surges may affect port operations. Climate change presents opportunities for this sector as well: a longer ice-free season in Northern sea lanes may increase the viability of Northern operations. Even when infrastructure is not damaged as a result of extreme climate events, the incremental changes in climate averages may necessitate greater maintenance and upkeep of transportation infrastructure.

4.4 Other risks

While the sections above describe the various ways that a changing climate may directly affect mining operations, the industry is also concerned about indirect risks to the financial, environmental and social performance of mining operations. If these risks are not managed, they have the potential to lead to reputational damage, regulatory non-compliance, and legal liability. Mining companies are also experiencing pressure to adapt to a changing climate as a

⁵ Ebinger, J. and Vergara, W. (2011). Climate Impacts on Energy Systems: Key Issues for Energy Sector Adaptation. A World Bank Study.

result of changing perceptions and expectations of external mining industry stakeholders, including communities, investors, insurers, regulators and banks.

Investors are increasingly putting pressure on companies to develop adaptation plans and minimize the risks to sustainability and profitability associated with a changing climate. Through influential initiatives like the Carbon Disclosure Project, institutional investors are able to gauge the climate readiness of the companies in which they invest. Other initiatives, like the Climate Registry and the Global Reporting Initiative, provide monitoring and tracking of voluntary and state-mandated disclosures regarding climate related risks. Calls from investors for more information on how the companies in which they invest are managing climate risks have led to individual shareholder resolutions requesting disclosure about climate-related risks from specific companies. Materiality for investors can certainly change over time, and this has implications for future disclosures. Both the Canadian Securities Administrators (CSA) and the U.S. Securities & Exchange Commission have issued formal guidance on climate change-related disclosure that companies must provide to investors in their financial filings.

Many international financial institutions (IFIs) are beginning to take account of climate risks as part of project finance decisions. In its last Performance Standards review, the International Finance Corporation (IFC) stated that it “believes that the private sector needs to implement risk-appropriate climate adaptation measures” to ensure the financial, social and environmental sustainability of its investments in the face of potential climate impacts⁶. Several development banks have adopted climate risk management and adaptation strategies that guide project lending decisions. These project lending criteria are more likely to affect Canadian operations overseas more than domestic operations, though they could affect access to capital if climate risk-related lending criteria are adopted more widely.

Social and environmental sustainability could be affected by climate change. This is particularly true in communities and ecosystems that are already sensitive or vulnerable, and that have reduced capacity to adapt. Changing temperatures, patterns of precipitation, and rising sea levels could affect vulnerable communities and environments disproportionately. There will be challenges in managing the cumulative impacts of climate change and resource development in climate sensitive areas. Unless the mining sector takes a holistic approach to adapting communities and mining operations, it may unknowingly exacerbate community climate change impacts, or constrain the ability of the surrounding community to adapt to a changing climate in future, with negative consequences for social license to operate.

Mining companies may be held responsible for perceived impacts on local communities and environments, particularly if mining operations have exacerbated climate-related risks in any way. As an example, in water-stressed regions and seasons, mining operations may be held responsible if the downstream community suffers a decrease in freshwater quantity or quality, even though operational water use is held constant – if the potential for reduced availability of freshwater resources downstream is not understood and planned for this can have significant consequences for reputation, brand, and social license to operate. This will pose a challenge beyond the mining industry, as other stakeholders will also be planning for and adapting to these cumulative effects and competing interests for resources. On the other hand, protecting and adapting infrastructure not owned by the mining company (e.g. roads, bridges, rail, telecommunications) will enhance the resilience of the surrounding community. Mining companies may want to explore opportunities to increase the adaptive capacity of the communities in which they operate, as part of planning for climate risks at the mine site.

⁶ IFC. (2010). Review and Update of IFC's Sustainability Framework: Overview of Key Issues.

Mining operations are also responsible for protecting and maintaining local environments, even though this may be more challenging in a changing climate. Not only is the local ecosystem disturbed by mining operations, it is also vulnerable to invasive species, pests and diseases brought on by climate change. Closure obligations to rehabilitate mine sites to original habitats may be more difficult if the ecosystem is also changing as a result of climate change.

Awareness of climate change impacts is growing across all areas of government, business and society, and this is increasing the number of driving forces for adaptation. Insurers are increasingly concerned about losses from climate impacts. The insurance industry is acutely aware of potential climate change impacts on industry sectors, and has already borne the cost of events driven by climate change. Many major insurers, industry associations, and reinsurers such as Swiss Re and Munich Re have been at the forefront of raising the profile of climate change as a business risk rather than an environmental issue. Left unmanaged, these risks may cause insurers to raise premiums or withdraw cover in particularly vulnerable locations. Governments are also planning for climate change. As government mainstreams adaptation into existing legislation, regulations and authorizations, mining operations may find it more challenging to achieve regulatory compliance.

Depending on how external stakeholders (e.g. communities, indigenous peoples, environmental organizations, shareholders, insurers, and project financiers) respond to climate change, the mining sector also faces potential impacts associated with litigation, brand and reputation.

5 Adaptation initiatives

This section will present a current snapshot of efforts to build adaptive capacity and take adaptation actions in the mining sector. Section 5.1 describes efforts to raise awareness, and encourage engagement and collaboration by stakeholders on adaptation issues. It includes any survey results about the level of awareness as well as activities to raise awareness. Section 5.2 describes efforts to assess the risks, vulnerabilities and opportunities that a changing climate presents, while Section 5.3 lists initiatives to incorporate adaptation into planning decisions. Section 5.4 outlines the various concrete actions that have been taken to adapt, including policy mechanisms and design standards. Finally, Section 5.5 describes efforts to monitor, measure, and report the effectiveness of adaptation.

5.1 Awareness and Engagement

Although awareness of climate change impacts is growing within the mining sector, and a number of mining companies and associations are increasingly engaged on this issue, there is no benchmark for the level of awareness among industry and governments.

International Council on Mining and Metals (ICMM) Land use change and adaptation to the impacts of climate change.

The ICMM was established in 2001 to improve sustainable development performance in the mining and metals industry. Its members include 22 mining and metals companies (many of which have significant operations in Canada) as well as 34 national and regional mining associations and global commodity associations.

Building on its 2009 Policy on Climate Change (described in the next section), ICMM formally launched its climate change program in May 2011. The program has three areas of focus: national policies and competitiveness; land use and adaptation to the impacts of climate change; and measurement, reporting and verification of net greenhouse gas reduction activities.

Through a newly-launched 'land use change and adaptation to the impacts of climate change project', ICMM aims to help its members to better understand:

- the relationship between land use, adaptation and broader sustainable development objectives, taking into account different types of mining and the associated differences in the scale and mine life of these operations;
- the added value of incorporating climate change considerations (both adaptation and mitigation) into land and water management;
- different examples of good practice from within the mining and metals industry; and
- policy and fiscal drivers to encourage the uptake and support of these good practices.

These issues were identified as of high importance to the mining and metals industry by the CEOs of ICMM's member companies. Project results will be delivered in October 2012.

Managing Climate-related Business Risks in the Mining Industry.

This briefing session provided an overview of the global mining industry's growing need to manage the business risks which result from climate change. It included a discussion of the developing legal, regulatory and financial drivers for climate change adaptation for global mining companies, the significant climate-related risks to global mining operations, how mining companies and their stakeholders can manage these risks by building climate resilience, and adaptation options to manage these risks in future. The briefing covered a broad range of issues, including:

- Potential for climate risks and opportunities to be felt across all areas (e.g. social, environmental, technical, financial) of business performance;
- Financial institutions' growing awareness of the implications of climate change, and recognition of climate risk in performance standards;
- Investor pressure for disclosure on climate risk management;
- Legal liability and 'reasonable foreseeability' of climate risks;
- Shifting policy landscape and regulatory changes;
- Reputational risk and potential for conflict with project stakeholders;
- Corporate examples of good practice in mainstreaming climate risk management at the strategic and operational levels;
- Global examples of practical adaptation methods for mine design and operation;

The briefing session was held in Toronto (the world's capital of mining finance) in January 2011, and was attended by approximately 40 representatives of major mining companies, insurers and lenders.

Workshop presentations are available via

http://www.bennettjones.com/uploadedFiles/News_and_Events/Seminars_and_Webinars/Minig%20Seminar.pdf

Weather Variability and Climate Change: Challenges and Solutions for the Mining Sector Mining and Climate Change workshop.

This one day workshop, held in February 2012 and hosted by the Centre for Excellence in Mining Innovation (CEMI) and the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) aimed to raise awareness of the impacts of weather variability and climate change on the mining sector in Canada by:

1. Communicating climate change science and impacts, as well as other drivers of adaptation planning;
2. Presenting methods to evaluate climate vulnerabilities and risks, and convey practical examples of the application of such tools; and
3. Facilitate knowledge exchange between mine operators and various experts in the field of climate change adaptation.

Workshop materials are available via the Centre for Excellence in Mining Innovation at <http://www.miningexcellence.ca/knowledge/reports/>

Climate Risk in BC's Mining Sector: Industry Dialogue on Challenges and Opportunities.

In March 2012 the Fraser Basin Council organized an industry dialogue session on climate change adaptation challenges and opportunities in the mining sector. The purpose of the session was to provide an opportunity for participants to learn about and discuss the need for climate adaptation in BC's mining sector. Presentations included examples of climate impacts and adaptation, and touched on the perceptions of climate change impacts at mine sites, the potential barriers to management of climate risks, and the business case for adaptation in the mining sector.

The session was attended by over 30 participants, the majority of whom were from the industry (or industry consultants). Participants at the session were invited to discuss the opportunities for mining companies with operations in BC (and elsewhere) to work together to advance progress on climate adaptation, as well as the areas where industry would benefit from increased collaboration with others. The Fraser Basin Council is in the process of writing a report which will include recommendations to Natural Resources Canada about mechanisms for efficiently engaging industry going forward.

Climate Change and Canadian Mining: Opportunities for Adaptation.

This report, published by the David Suzuki Foundation in 2009, documents and describes the vulnerability of the Canadian mining industry to climate change and highlights opportunities for adaptation. The report also investigates opportunities to reduce greenhouse gas emissions in the mining sector. With reference to climate change adaptation, the report:

- Characterizes how the Canadian mining sector is sensitive to climate change and assesses how climate change is perceived among different operators through a survey of 48 participants at a Prospectors and Developers Association of Canada conference;
- Documents strategies the sector has adopted to deal with changes in climate and assesses how these strategies differ across Canada; and
- Identifies what risks and/or opportunities the mining sector perceives future climate change will bring.

Climate Change Impacts on Mining Operations and Infrastructure.

In 2009, the Centre of Excellence in Mining Innovation (CEMI) conducted an overview of current knowledge about climate change and its impacts on mining-related operations and infrastructure, and proposed a set of research priorities to foster development of a niche research stream. The study focused on the North of Canada (regions north of the 60th parallel), where permafrost, extreme weather, and limited infrastructure present unique challenges for mining development.

The study concluded that mines in the North are most at risk because climate changes will be more pronounced in the North, some elements of mining infrastructure rely on permafrost to ensure structural stability, slope stability, and the containment of contaminants, and power and transportation infrastructure is more limited and therefore more vulnerable to warmer temperatures and extreme weather events. It recommends that research address innovative tailings management approaches and vulnerability of power and transport infrastructure as priorities.

Building Business Resilience to Inevitable Climate Change: Global Mining.

This report analyzes the responses of publicly owned mining companies to a request for climate risk disclosure as part of the Carbon Disclosure Project. It looks at the ways that mining companies are assessing and managing climate risks, while also exploring the increasing interest that investors and financial institutions are taking in the climate risk implications for their investments. Although the report's focus is global, many of the mining companies profiled are based in Canada or have significant Canadian operations.

5.2 Assessment of risks and opportunities

Many mining companies and some government departments have performed risk assessments that consider climate change impacts. Leaders in the private sector are starting to integrate climate risks into corporate risk management processes. Within these companies climate risks are taken into account at the project level (through a very detailed and rigorous technical risk assessment that takes local site conditions into account) or and at the strategic level (through a scan for broader, more strategic risks), or both. Unfortunately it is not possible to gauge how many companies have begun to mainstream climate risks.

Climate Change Impacts Assessment, Teck.

Teck, a Vancouver-based diversified resource company with business units focused on copper, zinc and coal, is working with climate modeling and forecasting experts to gain a better understanding of how climate change will affect company operations. Teck's main objectives are to more comprehensively understand the science and utility of climate modeling; to assess the impacts of future climate scenarios across the company's business model; and to evaluate the climate-related implications for mine and infrastructure design criteria and operating parameters. This project is focusing on Teck's operations in British Columbia, and is concentrating on a small number of key climate variables: precipitation, temperature, and water runoff.

Climate Change Sensitivity Framework, Rio Tinto Alcan.

Rio Tinto Alcan, based in Montréal, is one of the world's largest producers of bauxite, alumina and aluminum. The group operates large-scale, long-life assets on six continents, with a significant presence in Canada.

Rio Tinto Alcan has developed a climate change sensitivity framework to help the company assess the exposure of operations and associated infrastructures to climate change risks. This framework is intended to provide a strategic perspective on the exposure to climate change risks in any geography, by illustrating the exposure of potential new sites to current and future climate change impacts across the business model. It presents information about potential climate changes, and draws on the expert knowledge of company staff in a wide range of job functions, to identify a broad range of risks which include:

- Operational risks linked to project location and site – depending on geography, project sites could be exposed to higher temperatures resulting in increased drought risks, or low lying coastal areas at increased risk of flooding. Projects could also be located in pristine 'frontier' environments that are uniquely sensitive to changes in climate (e.g. permafrost zones);
- Vulnerability of land, sea and river transport systems, and knock-on risks for supply chains and logistics;
- Potential for increased maintenance requirements and degradation of assets that have been designed on the basis of historic climate data and a period of relatively stable weather.
- Changes in social performance because of increased competition with local communities for access to climate-sensitive natural resources and changes in socio-economic conditions;
- Changes in environment (through changes in habitats, flora and fauna, impacts of discharges and use of natural resources), with consequent risks of failing to meet environmental performance standards;
- Reduced brand and reputation, as a result of not demonstrably dealing with climate change impacts;
- Global political instability as a risk driven by climate change;
- Impacts on site remediation costs;
- Potential for downtime and disruption to operations from extreme weather events that exceed engineering or operational standards; and
- Changes in power generation capacity including variation of production related to increased weather changes.

The climate change sensitivity framework forms part of a wider program of climate change initiatives initiated by the company. Rio Tinto Alcan is also developing a methodology for taking account of detailed climate risks at the project design and engineering stage. Taken together, these initiatives help the group manage climate change as part of its robust risk management portfolio. In developing this climate change sensitivity framework, Rio Tinto Alcan benefits by realizing opportunities in new geographies, identifying new risk issues, and developing a competitive edge.

Climate Change Risk Assessments, Cameco Corporation.

Cameco is one of the world's largest uranium producers, accounting for 16% of world production, with significant assets and operations in Canada. Most of the climate risks faced by the company as a uranium producer stem from its mining activities, which are often undertaken in isolated environments with harsh and challenging climates.

The mandate of Cameco's Environmental Leadership team includes scanning and studying environmental challenges that have the potential to become company liabilities, so that they can be incorporated into the corporate risk assessment system if warranted.

Mitigation of, and adaptation to, climate change was a focus of the team from an early stage, because of its importance in public policy debates and its prominence in media reporting.

As a first step in managing the corporate risks of climate change, Cameco conducted an operations-wide climate change risk assessment by coordinating working group discussions with staff from different divisions of the company. This exercise included a number of targeted risk assessments for specific locations and company operations, including a high-grade uranium mill in Saskatchewan and a uranium refinery in Ontario. Four working groups considered a broad range of climate change risks and opportunities, including:

- The impacts of rising temperatures, projected to be particularly pronounced during the winter in the Far North, on access to resources using winter roads;
- Impacts of future changes in the seasonal distribution of precipitation on water-intensive mining and milling activities, particularly in locations where seasonal water scarcity is already a constraint;
- The potential for downtime and disruption of mining operations as a result of increased frequency and severity of extreme weather events (such as storms, droughts and flooding), with knock-on consequences for cost;
- The increased risk of forest fires in the Prairies due to hotter temperatures and reduced summer precipitation, particularly in remote locations that do not benefit from publicly-funded firefighting services (Cameco has since engaged with Saskatchewan Fire Services to conduct an independent audit of its mitigation controls and response measures for forest fires);
- The potential for complications in the safe, long-term decommissioning of assets, a process that is critical for the mining industry.

As a result of the climate risk assessment exercise, Cameco concluded that, overall, in the majority of its operations the benefits of climate change are likely to outweigh potential risks. These benefits include increased demand for uranium and nuclear energy due to greenhouse gas emission targets, as well as savings associated with reduced heating requirements.

Canada's First National Engineering Vulnerability Assessment of Public Infrastructure.

Engineers Canada has established a Public Infrastructure Engineering Vulnerability Committee, which brings together all three levels of government and non-governmental organizations, to look broadly and systematically at the vulnerability of infrastructure to climate change, from an engineering perspective. The Committee has produced the nation's First National Engineering Vulnerability Assessment, which examines vulnerability and 'adaptability' in four categories of public infrastructure: buildings; roads and associated structures; storm water and wastewater systems; and water resources.

The City of Greater Sudbury was selected as a case study in the roads category. Because the Sudbury region has major mines (Xstrata and Vale Inco), and transport corridors are vital to mining operations, this vulnerability assessment contributes to the understanding of climate risks facing the mining sector.

This case study did not characterize Greater Sudbury roads and associated structures as highly vulnerable to climate change. High temperatures and intense rain and snowfall events will, however, have an impact on road surfaces and could potentially cause overflow of the drainage

system and related infrastructure, including embankments. This could pose public health, emergency response and environmental risks, as well as increasing maintenance costs. The study notes that lack of data about specific climate variables limits a comprehensive assessment of infrastructure vulnerability. In future, it recommends development and enhanced availability of suitable data, which may lead to more information about potential vulnerabilities.

Case studies of roads in Northern Canada.

Because access to communities, mining operations, and other resource developments in northern Canada often relies on a single all-weather or winter road, climate change presents significant risks to road structures that overlie permafrost. Warming trends in recent years have put these indispensable access routes at risk by shortening the duration of winter roads built on ice or seasonally frozen ground.

This paper presents two case studies of two all-weather and winter roads in northern Canada: the Yellowknife Highway (NWT Highway 3) reconstruction, and the Tibbitt to Contwoyto Winter Road which serves diamond mine operations. The case studies describe the potential impacts of climate change and the adaptation strategies that have been or are being implemented to cope with the impacts.

Climate change and acid rock drainage: risks for the Canadian mining sector.

On behalf of the Mine Environment Neutral Drainage (MEND) program, the Mining Association of Canada commissioned this report to assess the impacts of climate change on acid rock drainage and metal leaching at Canadian mines. This assessment is a high-level risk analysis rather than a detailed technical study, which would require detailed knowledge of local conditions. Indicative estimates of costs were developed for some more likely impact scenarios. The study concludes by presenting key messages for mining operations and closure with respect to acid rock drainage risks in a changing climate. It notes that a greater number of adaptation options (and more effective options) are available earlier in the mine life. Adaptation measures are also less costly when developed and integrated at the planning and design phase.

Mine Waste Management in a Changing Climate.

As part of Natural Resources Canada's 'Enhancing Competitiveness in a Changing Climate' program, the Mining and Metals Sector (MMS) is conducting a project to investigate new challenges to various mining-related activities, especially mine waste management and effluent treatment in the North. The CANMET Mining and Mineral Sciences Laboratories (CANMET-MMSL) is assessing current mine waste management and effluent treatment practices in the North with respect to their ability to accommodate the impacts of extreme climatic events. The work focuses on northern mining vulnerability, examining operations, development and reclamation projects, as well as researching potential adaptation options.

Climate Change Vulnerability Assessment of the Mining Sector and Good Environmental Practices, Nunavut.

The Nunavut Regional Adaptation Collaborative has collected and compiled information to assess the vulnerability of Nunavut's mining industry to climate change and describe potential adaptation strategies. In order to determine how a changing climate will impact mining infrastructure, and identify adaptation measures that can be employed to minimize impacts, it

developed a ‘Vulnerability Assessment of the Mining Sector to Climate Change’. A second phase of this project builds upon the results of the vulnerability assessment to produce a ‘Good Environmental Practices for Northern Mining and Necessary Infrastructure’ report, which provides recommendations for best management practices to address climate change adaptation in northern mining.

5.3 Adaptation planning

Adaptation planning for the mining sector as a whole appears to be less advanced than initiatives to assess risks. Where there is evidence of adaptation planning, it is focused on a particular geographical region or specific to a single issue (i.e. tailings management), and there is no coordinating framework to tie this information together to make it more accessible and useful to decision-makers.

Understanding the Engineering Challenges for Tailings Management Facilities in Nunavut.

This study, also commissioned by the Nunavut Regional Adaptation Collaborative, outlines the engineering challenges for large scale infrastructure/tailings management facilities over the vast territory of Nunavut in light of projected climate changes. It includes technical recommendations for tailings disposal techniques to be used in future mining projects in Nunavut up to the year 2100, focusing mainly on the potential loss of integrity of frozen ground as a natural containment mechanism for safely storing waste material. The report also investigates alterations in precipitation and evaporation, so that mine water management design can be adequately designed to account for anticipated heavy rainfall events in future. Although the study does not define the specific types of mines or ores, it assumes that mines producing hazardous waste and high-volume production mines will be the most challenging.

True North: Adapting Infrastructure to Climate Change in Northern Canada.

The National Round Table on the Environment and the Economy (NRTEE) conducted this study to highlight the risks to northern infrastructure, including critical mining infrastructure, posed by climate change and the opportunities presented by adaptation. It emphasizes the need to ensure that infrastructure is resilient over its lifespan, even as the climate changes. The report offers guidance on how to use existing risk management tools to reduce infrastructure vulnerabilities and adapt more effectively to climate change in Canada’s North.

The NRTEE recommends that we make climate change adaptation more of a ‘mainstream’ issue and build northern capacity to adapt to climate change, by focusing on four priorities:

1. Integrate climate risks into existing government policies, processes, and mechanisms;
2. Ensure northern interests are represented and implicated in the development of climate change adaptation solutions;
3. Strengthen the science capacity and information use in the North to support long-term adaptation efforts; and,
4. Build community capacity to address climate risk to northern infrastructure and take advantage of opportunities.

5.4 Adaptation related actions (policies, design, etc)

International Council on Mining and Metals (ICMM) Policy on Climate Change.

In its Policy on Climate Change, published in 2009, the ICMM recognizes that comprehensive and sustained global action is required to reduce the scale of human-induced climate change and to adapt to its impact. The global policy “promotes the development and dissemination of technologies that build the capacity to adapt to climate change, particularly in developing countries”. By endorsing the policy, individual members have also accepted their responsibility to:

- Develop appropriate, operations-specific adaptation strategies, and
- Contribute to the sustainable development of local communities and societies in adapting to the impacts of climate change.

<http://www.icmm.com/climate-change>

Northern Infrastructure Standardization Initiative (NISI)

The Standards Council of Canada (SCC) has formed a Northern Advisory Committee on Adaptation Codes and Standards that will guide the work of its Northern Infrastructure Standardization Initiative (NISI). The Northern Advisory Committee will be comprised of representatives from Northwest Territories, Nunavut, Yukon and Nunavik. In consultation with northern practitioners and regulators, committee members will decide on the climatic impacts and infrastructure categories requiring immediate attention. The Committee will also contribute to the selection of partners and technical experts that will develop and update northern standards and codes.

The Northern Infrastructure Standardization Initiative is a joint project being led by SCC with support from Aboriginal Affairs and Northern Development Canada (AANDC). This initiative is intended to adapt critical codes and standards to address the effects of climate change on new infrastructure, as well as retrofits, maintenance and repairs to existing infrastructure. The Standards Council of Canada (SCC) has been granted \$2.5 million over five years to implement this program.

5.5 Measures of effectiveness and reporting

Carbon Disclosure Project (CDP)

Section 5.1 described a handful of prominent Canadian companies' efforts to assess climate change risks and opportunities. These publicly available examples give an indication of the climate risk management activities currently underway within the broader private sector of the mining and metals industry, although it is not possible to determine how many mining companies are mainstreaming adaptation, nor how successfully. Given the capacity constraints within the mining sector, it is sensible to assume that smaller companies will have less capacity to consider climate risks than larger companies. While some efforts to identify business risks arising from a changing climate remain company-confidential, many risk assessments are documented through the Investor Carbon Disclosure Project (CDP). The CDP is a collaboration of the largest investors in the world, which requests disclosure of greenhouse gas emissions, climate change risk, and water strategies, of the public companies. It is important to note that CDP only engages larger, publicly traded companies. CDP holds the largest collection of self-reported climate change data in the world, all of which is freely accessible at <https://www.cdproject.net>.

6 Gaps and needs

Mining sector stakeholders are making important progress on climate change adaptation. In particular, significant collaborative efforts involving government, the private sector, and mining associations have made great strides in raising awareness of climate impacts and consequences for the mining industry, although no benchmark exists. It is clear from the growing number of workshops, conferences, and briefing sessions devoted to climate change impacts in the mining industry, as well as the number of popular and industry publications that have covered the issue (not reported here), that a steady momentum of awareness and engagement is developing. In order to advance this issue, communications expertise will be needed to ensure clarity in the discussion between different decision makers with varying objectives and appetites for risk. There is currently a limited amount of sharing between companies and stakeholders on the issue of climate change adaptation, and fora for collaboration will be essential.

Many organizations, most notably private sector companies, are also undertaking work to assess the risks and opportunities of climate change. This is not surprising given the mining sector's 'perfect storm' of exposure to climate risks: it depends on large, fixed assets with long design lifetimes; it makes decisions with long-term consequences; it operates globally and has long supply chains; it relies on climate-sensitive inputs (e.g. water and energy); it is heavily regulated; and finally it often operates in 'frontier' or isolated environments where recovery from climate-related hazards can be more difficult. In part because of these particular challenges, the mining sector is used to scrutiny, attuned to issues like corporate responsibility, and highly skilled at identifying and managing risks. It is likely that larger mining companies are devoting more effort to climate change impact assessment, but that this is 'mainstreamed' within corporate risk registers and processes, and not reported as a response to climate change per se.

Adaptation planning for the mining sector as a whole is less advanced, and not integrated. Many of these initiatives are specific to a particular geographical region or focus on a single issue (i.e. tailings management), and there is no coordinating framework to tie this information together to make it more accessible and useful to decision-makers. It is clear that some activities are suited to a more regional or issues-based approach than can be shared more broadly. It is possible that adaptation planning and actions are being implemented within the private sector, but not reported – either because these initiatives are completely embedded in standard risk management procedures, or because they reveal a competitive disadvantage. There are several opportunities for mainstreaming climate risk management into existing processes, one notable example being the Towards Sustainable Mining (TSM) initiative, which incorporates self-assessment, verification, and indicators across a broad range of performance areas.

None of the initiatives reported here included obvious measures of effectiveness and reporting. It will not be possible to gauge the success (or otherwise) of adaptation efforts without monitoring and evaluation, and this lack of adaptation indicators reveals a significant gap. Similarly, just one of the adaptation efforts appeared to assess financial consequences of climate change. This highlights the need for information on the costs, both of impacts and adaptation actions, in order to justify adaptation in the mining sector. Costs could be addressed both at the micro level (e.g. company business cases on how climate change affects operations) and at the macro level (e.g. the cost to the economy as a whole).

Climate services organizations will be very important to advancing adaptation in the mining sector. Adaptation initiatives identified above demonstrate the value of the research community

working directly with industry. Professional associations are also key, as they play an important role in advancing member practice.

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