

FINAL RESEARCH PAPER

Assessment of Gaps and Needs for Environmental and Sustainability Standards for the Canadian Mining Sector

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Mining activity accounts for approximately 20% of the total value of Canadian export goods and contributes nearly $100 billion to our national Gross Domestic Product (GDP) [2]

1 Introduction

The Canadian mining sector plays an integral role in meeting the global need for minerals and metals. The industry currently extracts more than 60 minerals and metals, and Canada is positioned among the top five countries in worldwide production of 16 major commodities, including gold, nickel, cobalt, and diamonds [1], [2]. Canadian financial institutions consistently rank among the leading global providers of mining finance [1]. Taken together, our mineral reserves represent significant natural resource wealth, with recent data demonstrating that mining activity accounts for approximately 20% of the total value of Canadian export goods and contributes nearly $100 billion to our national Gross Domestic Product (GDP) [2].

Domestically, the industry directly employs more than 426 000 workers in extraction, smelting, fabrication, and manufacturing operations, and indirectly employs an additional 200 000 people in related activities such as mining supply and support services [3]. In so doing, it helps to support the economic and cultural vitality of Canadian communities, many of which are northern, rural, or otherwise remote. With more than 450 active agreements in place between mining companies and Indigenous communities, mining companies are both major employers of Indigenous peoples and customers of Indigenous-owned businesses [4].

Canadian mining has taken important steps to reduce its environmental impacts and meet the broader challenges of sustainability. Environmental and social issues are consistently listed among the top challenges and risks facing the mining sector globally and in Canada [1], [3], [5]. Specific challenges include the social license to operate (encompassing a range of environmental and socio-economic concerns raised by mining-affected communities and the broader public), the need to shift to different and less carbon-intensive forms of energy, improving tailings and water management, and responding to responsible sourcing demands that include those associated with minerals and metals for the clean energy economy. Meanwhile, digital technologies and data present both significant risks and opportunities for the sector and have important implications for environmental and sustainability performance, including technologies that could dramatically reduce mine waste. In particular, there are strong pressures for the mining sector to innovate to address stakeholder expectations and to maintain returns on investment while operating in new realities (e.g., lower ore grades, operating in increasingly remote and challenging physical and social environments).

The environmental impacts of climate change are well known, and include the effects of new temperature extremes, changes in precipitation, and biodiversity loss. The material risks to the mining sector are now recognized to include impacts related to climate change and the further exacerbation of social and environmental

pressures. Where companies fail to meet the requirements for improved performance in these areas at all stages of operation (i.e., from exploration through to mine closure), mining projects are susceptible to financial losses and project delays, and, in the extreme, could become stranded assets.

1.1 The Role and Value of Standards

Standards are rules, minimum specifications, performance levels, and technical specifications pertaining to a topic area (see text box below). The adoption of standards in Canada's mining sector, both voluntary and mandatory, can enable mining companies to improve their environmental and sustainability management practices and performance. Standards can also help Canada's mining industry build resilience to the challenges of more responsible corporate governance and environmental risk management. Standards initially developed and adopted for use in Canada may also be implemented by Canadian companies abroad and adopted by other jurisdictions, leading to reputational benefits for Canada's mining sector and enhancement of the Canada brand in general.

A range of standards, guidelines, and protocols related to environmental protection and other sustainability issues are currently used by the Canadian mining sector. These include standards developed through the International Organization for Standardization (ISO) and through CSA Group; protocols and guidelines developed by industry (e.g., the Towards Sustainable Mining protocols developed by the Mining Association of Canada); regulations and guidance developed by federal, provincial, and territorial levels of government; and other standards and guidelines developed by Canadian and international non-governmental organizations such as the Canadian Dam Association (CDA). This report presents the results of research on standardization gaps, needs, and opportunities related to environmental protection and sustainability in the mining sector in Canada. Based on a landscape scan and a series of key informant interviews, this research explored gaps in the existing ecosystem of standards and guidelines to identify potential areas where new standards – developed through a multistakeholder and consensus-based process – could benefit industry, regulators, and other sector stakeholders. Benefits include those where standards support the commercialization, uptake, and acceptance of emerging technologies that could enhance environmental and sustainability performance.

What Are Standards?

In Canada, under the accreditation of the Standards Council of Canada (SCC), accredited standards are developed by a balanced matrix of stakeholder groups that work together to reach consensus on rules, minimum specifications, performance levels, and technical specifications pertaining to a topic area. They are based on a respective field's collective knowledge and, in this way, foster its development through dissemination of evaluative benchmarks that reflect best practice, best available technology, and so on. Generally, standards are recognized to have far-reaching societal benefits, particularly those pertaining to health and safety, environmental protection, the promotion of innovation, and new product development. Many standards are referenced in regulations.

Standards differ from guidance in that the latter are largely informative in content, describing good or best practices and suggested approaches, without prescriptive requirements, performance criteria, or specifications.

1.2 Objectives and Intended Audience

The research has two broad objectives:

1. To identify and characterize needs and gaps related to expectations and requirements for mining in Canada in the areas of environmental protection and management, mining innovation, and sustainability.
2. To provide recommendations on where standards development could address those gaps and needs, with a focus on material issues and specific priorities for industry and regulators.

This report should be of interest to the Canadian mining industry, including companies and industry associations, mining sector regulators and policy-makers, mining-affected communities, and other sector stakeholders, including service providers and non-governmental organizations, working on environmental and sustainability issues.

2 Methodology

2.1 Scoping

The scope of this research focuses on identified needs, gaps, and opportunities related to mineral and metal exploration and mining activity in Canadian provinces and territories. While the research approach and results are not commodity-specific, the research did not include consideration of the following commodities: oil sands, uranium, sand and gravel, and natural stone.

Certain issue areas, including autonomous mining and mine electrification, were not included in the scope of this research because these topic areas are covered by existing standard development initiatives.

The research was structured according to the list of key sustainability issues (environmental, social, and economic) shown in Table 1, which was informed by a review of a sample of mining company sustainability reports, mining trend reports, and other documents [6] [7] [8] [9] [10] [11] [12]. Most of the issues listed in Table 1 appear frequently in these documents and reflect a range of inclusion criteria:

- Issues that are considered material to mining companies operating in Canada. Note that the Global Reporting Initiative (GRI) defines "material" as "aspects that reflect the organization's significant economic, environmental and social impacts; or substantively influence the assessments and decisions of stakeholders" [13].
- Alignment with the United Nations' Sustainable Development Goals (SDGs) [14] to which many corporations are aligning their sustainability objectives and indicators to meet growing expectations from governments and communities, especially for social and economic benefits.

***Table 1**: Key Material Issues Facing the Mining Sector within Canada*

Environmental	Social and Economic
Land and Biodiversity	Stakeholder Engagement
Water	Indigenous Relations and Reconciliation
Climate Change Adaptation	Governance and Accountability
Energy and GHG Emissions	Business Ethics and Anti-Corruption
Air and Other Emissions	Community Development
Environmental Liabilities, Closure, and Reclamation	Local Economic Impact / Sustainable Benefits
Tailings and Mine Waste	Social Closure
Waste	Capacity Building, Certification, and Training
	Disclosure / Public Reporting

- Emerging market and investor expectations and requirements, including disclosure expectations [8]. The list of issues identified through the document review was further modified by the authors (exclusions, issue labels) based on the following methodological considerations:
- Providing sufficient disaggregation of issues (e.g., separating Climate Change Adaptation from Energy and GHG emissions) to distinguish between current and emerging issues and other aspects where there may be distinctions in gaps and opportunities.
- Excluding certain issues (e.g., child labour) deemed less relevant to the mining context within Canada.
- Excluding certain issues where standards, guidelines, and regulatory requirements are well established within Canada (e.g., health and safety) and/or less mining-sector specific.

The scope of the research also considered innovation in terms of emerging technologies related to the above-cited issues and the associated need for standards to support commercialization, uptake, and acceptance.

2.2 Information Sources

Information was collected through a landscape scan (based on a document review) and then through key informant interviews, organized according to the list of material issues.

2.2.1 Landscape Scan

The landscape scan involved identifying existing standards and related literature (e.g., guidelines and protocols) pertaining to the list of material issues. The scan included the following sources:

- Standards produced by the ISO and the CSA Group.[1]
- Frameworks, protocols, guidance, and other related documents produced by the Mining Association of Canada (MAC), which represents most of Canada's production of base and precious metals, uranium, diamonds, metallurgical coal, and industrial minerals.
- Principles, guidance, and toolkits produced by the Prospectors and Developers Association of Canada (PDAC), which is the leading voice of the mineral exploration and development community in Canada. PDAC has no sustainability-related requirements for its members.
- Principles, position statements, guidance, and other related documents produced by the International Council for Mining and Metals (ICMM), which represents 26 global mining and metals companies and 35 regional commodities associations.[2] ICMM members are required to follow the ICMM's principles and position statements.
- International voluntary standards that Canadian mining companies adhere to as listed in MAC's Towards Sustainable Mining (TSM) Progress Report, which outlines MAC's member companies' practices of application of international standards.
- Other international voluntary standards and guidance identified through interviews and the authors' experiences.

The research scope did not include a comprehensive review of laws and regulations applicable to the Canadian mining industry, given the complexity of the regulatory regimes and the sheer volume of relevant requirements at the federal, provincial, and territorial levels.

Section 4 presents a high-level overview of the results of the landscape scan, with more detail provided in Appendix C.

[1] Canada, through a "harmonized" Canadian Standards Council (SCC) mirror committee / CSA technical committee, is leading a number of ISO mining-related programs and specific standards at ISO. This includes leading a standards development program on "Advanced Automated Mining Systems" and a specific international standard on "Mine Closure and Reclamation Planning".

[2] At the time of this report, two ICMM member companies are Canadian, MAC is an association member, and several non-Canadian members operate mines and/or have mineral rights in Canada (e.g., Rio Tinto, Glencore, MMG, Vale).

2.2.2 Key Informant Interviews

Twenty-three interviews were conducted with key informants from industry (companies, industry associations), government (federal, provincial, and territorial; regulatory and policy), consulting firms, academia, and non-governmental organizations working on sustainability issues and innovation in the mining sector (see Appendix A for list of participating organizations). Key informants were selected to achieve coverage across the range of material issues, geographic regions within Canada (including Canada's North), and the mining life cycle (exploration, operation, closure).

A standard interview guide was used (the specific interview questions are provided in Appendix B) to gather perspectives on emerging expectations, key challenges and priorities facing the mining industry, and the extent to which these are currently addressed by existing standards, related instruments, and/or relevant regulations. These lines of inquiry aimed to elicit perceptions on potential opportunities for standards to address gaps, advance harmonization, and/or support innovation.

2.3 Analysis

Key informant perspectives on emerging expectations and key challenges facing the mining sector (see Section 3) were drawn from their responses to the first two questions of the interview and are presented in Section 3.

The data and information collected during the landscape scan and key informant interviews were further analyzed to identify gaps in the environmental and sustainability issues, characterize those gaps, and characterize the opportunities to address those gaps, including through the development of standards. The results of this analysis are presented in Sections 4.1 to 4.3.

A discussion of the prioritization of gaps and associated opportunities for standard development is presented in Section 4.4. A priority rating was assigned to each of the identified gaps and opportunities (Low, Moderate, or High) based on consideration of the following factors:

- Frequency of mention by key informants (rated on a 3-point scale: *Low* (1 or 2 mentions), *Moderate* (3 or 4 mentions), *High* (5 or more mentions).[3]
- Potential magnitude of benefits to industry and regulators through further standardization in this area.
- Urgency to address the topic, including relevance to identified key challenges and emerging expectations (Section 3).
- Feasibility and other considerations for standard development.

3 Emerging Expectations and Key Challenges

At the beginning of each interview, key informants were asked to identify their top emerging expectations and current key challenges for the Canadian mining sector – quite apart from any gaps or needs related to standardization. As shown in Table 2, their comments touched on and cut across many of the material issues identified in Table 1.

In terms of environmental issues, expectations and challenges related to climate change, mine closure, and tailings were the most prominent. References to land and biodiversity, air emissions, and non-tailings waste were notably absent – these issues are shown in grey in Table 2. In terms of social and economic issues, expectations and challenges related to consultation and engagement (with both Indigenous peoples and other stakeholders) were frequently mentioned, as were those related to the provision of socio-economic benefits. There was minimal mention of disclosure and reporting, and no mention of governance and accountability, nor of business ethics and anti-corruption.

[3] Given the relatively small number of interviews, the range of issues discussed, and variations in the range of expertise for each interviewee, the frequency of mention should be viewed as an indicative qualitative measure and not as a statistically significant result.

***Table 2**: Emerging Expectations and Key Challenges*

Environmental

Material Issue	Emerging Expectations and Key Challenges
Water	▪ There are growing expectations and restrictions concerning use of water resources (quantity and quality), which can be exacerbated by climate change and associated impacts on water balances and flows.
Climate Change Adaptation **Energy and GHG Emissions**	▪ Three key dimensions of climate change were identified as particular needs and challenges for the sector: 1. Reducing the carbon footprint of mining through electrification and the use of clean energy sources (and energy storage technologies) 2. Understanding and adapting to the impacts of climate change on mine operations, particularly in mine closure planning and design, and particularly for northern regions, and 3. Defining and capitalizing on mining's role in supporting the low-carbon economy, including renewable energy and other clean tech. ▪ Understanding climate change predictions and the potential impacts of climate change on critical mine infrastructure is a challenge for regulators. There are also concerns about the impacts of climate change on the stability of existing abandoned mines (of which there are thousands). ▪ Key informants recognized the impacts of climate change on other issue areas, including water management and community impacts.
Environmental Liabilities, Closure, and Reclamation	▪ Issues related to closure and reclamation are linked to other challenges identified by key informants, including broadening the scope of closure to include "social closure", managing the impacts of climate in closure planning and design, and reducing the footprint and liability associated with tailings and mine waste. Individual key informants also identified the following challenges: ▪ Canada has fallen behind other major mining jurisdictions (such as Australia and South Africa) in closure management. ▪ Approaches and requirements for long-term closure are still not adequately defined
Tailings and Mine Waste	▪ Recent tailings dam failures in Brazil (Brumadinho Samarco) and Canada (Mount Polley) have put the safety of mine tailings storage facilities in the spotlight again for governments, companies, and society in general. These events triggered several independent reviews and a strengthening of industry standards (e.g., TSM, ICMM). The majority of key informants identified this as an ongoing challenge for the mining sector. ▪ There is a lower risk tolerance associated with tailings and mine waste, and increased scrutiny, if not rejection, of "wet tailings" storage and "storage in perpetuity". Beyond ensuring the safe and long-term integrity of tailings and mine waste facilities, there are growing expectations for mines to reduce their land footprint and reduce the amount of mine waste overall, and an interest by mining companies to reduce closure liability and associated bonding requirements. ▪ The above factors are expected to drive research, innovation, and deployment of technologies to reduce the amount of mine waste produced (low-waste or no-waste mining) and reprocess mine waste (which is more common outside of Canada). ▪ Some key informants commented on governance and culture change as key aspects to address this issue.

***Table 2**: Emerging Expectations and Key Challenges cont'd*

Social and Economic

Material Issue	Emerging Expectations and Key Challenges
Stakeholder Engagement **Indigenous Relations and Reconciliation**	▪ The requirements and expectations for consultation (a legal duty of the Crown) and engagement (industry best practice) with Indigenous peoples are growing, meaning that different parties have different (and constantly changing) expectations and understandings of fairness. This dynamic often creates additional uncertainty, delay, and costs in the regulatory process (for both mining-affected communities and industry). ▪ The legal duty to consult is a legal minimum. Increasingly, mining companies, Indigenous communities, and international standards reference the concept of Free Prior Informed Consent (FPIC) and the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), but the application of these concepts and commitments remains a challenge. ▪ Interviewees noted that more time and effort is required to develop relationships at all phases of the mine life cycle. ▪ There is a need to build community capacity and awareness related to exploration and mining (i.e., mineral literacy). ▪ Consultation and engagement costs feel more significant at the exploration stage since the project is not yet generating revenue. ▪ Expectations for company-community agreements (commonly referred to as Impact Benefit Agreements or IBAs) vary greatly. Informants expect further evolution in the approach to and content of agreements.
Community Development **Local Economic Impact / Sustainable Benefits** **Social Closure** **Capacity Building, Certification, and Training**	▪ A dimension of Indigenous reconciliation is addressing economic disparities between non-Indigenous and Indigenous peoples. There are growing expectations around economic reconciliation and how this will be done (e.g., resource revenue sharing, equity stake, compensation, other forms of economic participation). ▪ Social closure refers to the steps taken to address the socio-economic impacts of mine closure on workers and the community. The expected closure of multiple mines in Canada around 2020 will create socio-economic challenges. Measures of success and roles in social closure (for communities and companies) need to be defined. ▪ The mining industry is facing human resource challenges. Pre-emptive capacity building in communities and regions (especially in mining districts) needs to improve and should be a multi-party effort. At the same time, there are growing expectations to increase diversity in the mining workforce, including women, people with disabilities, visible minorities, and Indigenous peoples. ▪ New technologies, including in the areas of automation and artificial intelligence (AI), may present a risk for local employment opportunities and benefits. These implications need to be better understood and managed.
Disclosure / Public Reporting	▪ There are emerging requirements (performance and disclosure) related to responsible sourcing, climate-related risks and strategies, and the circular economy.

In addition to their perspectives on the material issues in Table 2 below, key informants identified the following emerging expectations and key challenges related to other cross-cutting issues:

- The erosion of the competitiveness and investment climate of the Canadian mining sector due to regulatory and taxation systems and evolving requirements, Indigenous engagement requirements, and a fragmented approach to innovation.
- Growing requirements and expectations to assess and manage regional and cumulative impacts, as well as challenges associated with balancing interests between regional stakeholders and rights holders.

4 Gaps and Potential Opportunities for Standards Development

4.1 Standards Landscape Scan

The landscape scan focused on mining-specific standards, guidelines, and tools currently being applied within Canada, in order to demonstrate the extent to which environmental and sustainability issues are covered. Appendix C presents the detailed results of the scan.

Key findings of the landscape scan include:

- All issues are touched on by an existing standard, guideline, or tool. However, the depth and specificity of coverage vary significantly across the issues and across the different standards, tools, and guidelines.
- Of the environmental issues, tailings management, water stewardship, and energy and greenhouse gas management receive the greatest coverage. Note that standards and guidelines related to energy and greenhouse gas management and water stewardship include both mining-specific standards and guidelines, and more general, non-sector-specific standards and guidelines.[4]
- Of the social issues, stakeholder engagement and disclosure/public reporting are the issues most widely covered. In recent years, substantial efforts have been made to provide more consistent guidance on best practices and expectations related to community development and local economic development/sustainability benefits.
- Generally speaking, areas that cut across multiple issues are less well covered than stand-alone material issues. For example, social closure would include elements of mine closure, biodiversity, stakeholder engagement, and local economic development/sustainable benefits. While there are standards or guidelines that focus on each of these material issues, there is a significant gap in standards that define good social closure practices.

Sections 4.3 and 4.4. incorporate the issue-specific results of the landscape scan to assess current coverage of those areas identified as potential gaps or opportunities for standards development.

4.2 Applicable Laws and Regulations

The presence or absence of regulation can be a driver for standards development [15]. A standard can provide detail and guidance on how to meet a regulatory requirement, or it can address a regulatory gap by setting out requirements to meet a need or expectation of the market or stakeholders.

Within Canada, environmental, social, and economic issues are covered by legislation and regulation at the federal, provincial, and territorial levels. Indeed, certain issues (such as water effluent and dust) may also be covered by municipal bylaws. While this research did not include a comprehensive scan of the current laws and regulations that apply to the mining sector with respect to the list of material issues, we can offer the following observations:

- Legislation and regulations exist related to all of the environmental issues, with the exception of climate change adaptation.

[4] In 2018, the International Institute for Sustainable Development (IISD) published a detailed analysis of prominent voluntary sustainability initiatives (VSIs), including TSM and ICMM, used in the international extractive sector. Their analysis examines four elements – coverage, assurance, responsiveness, and engagement – and provides a content and level of obligation score for each VSI [15].

- The social and economic material issues examined are less well covered by legislation and regulations, with the exception of stakeholder engagement, Indigenous relations and reconciliation, and business ethics and anti-corruption. Legislation and regulations establish minimum requirements for stakeholder engagement and consultation with Indigenous peoples. Many of the voluntary standards and guidelines reviewed build upon these minimum requirements to identify good or best engagement practices.
- Depending on the location of the mining project or operation, a combination of federal, provincial, and territorial legislation will usually apply. Provincial and territorial requirements can vary significantly across jurisdictions [16].
- There is no overarching federal law regarding corporate social responsibility (CSR), though various federal, provincial, and territorial laws insert CSR principles into areas such as health and safety, environmental protection, and environmental assessment [16]. The new Impact Assessment Act will require consideration of a broader set of project effects (including sustainability) to determine if a project is in the public interest [16].

Where potential gaps or opportunities for standards development were identified, interviewees were asked to provide their assessment of regulatory coverage based on their knowledge and experience within the Canadian context (see text box 2 for a high-level overview of key federal laws and regulations). These observations are included within the description and analysis of potential gaps and opportunities in Sections 4.3 and 4.4.

Key Federal Laws and Regulations

The focused document review identified the following key federal laws and regulations, several of which were under examination at the time of writing, with new bills pending government approval [16], [17]:

- Canadian Environmental Protection Act, including the Chemicals Management Plan and Interprovincial Movement of Hazardous Waste Regulations
- Canadian Environmental Assessment Act (CEAA 2012)
  - Bill C-69 proposes a new Impact Assessment Act, which requires consideration of a broader range of effects, including the project's contributions to sustainability, the impact on indigenous peoples, and community knowledge
  - In Northern Canada, where the federal environmental assessment law generally does not apply, environmental assessments are regulated by local laws in each territory
- Fisheries Act
  - Bill C-68 proposes significant changes to the Fisheries Act
- Navigation Protection Act
  - Bill C-69 proposes enlarging protections for navigable water and renaming the Canadian Navigable Waters Protection Act
- Canadian Metal and Diamond Mining Effluent Regulations (formerly Metal Mining Effluent Regulations)
- Species at Risk Act
- Migratory Birds Convention Act
- Transportation of Dangerous Goods Act

4.3 Issue-Specific Gaps and Opportunities

Key informants identified 13 gap and opportunity areas related to standardization for specific material sustainability issues, as shown in Table 3. While some gaps and opportunities may relate to more than one issue, they have been aligned with the issue with which they correlate most closely. In comparison to Table 1, the issues listed in Table 3 have been slightly modified to capture certain gaps and opportunity areas: *eco-efficiency* has been added to the environmental category, and big data and new sensors has been added within a new innovation category.

***Table 3**: Summary of Gap and Opportunity Areas by Material Issue*

Material Issue	Gap and Opportunity Areas
Environmental	
Climate Change Adaptation	1 Assessing Climate Change Impacts and Guiding Adaptation Actions
Energy and GHG Emissions	2. Comprehensive GHG Measurement 3. Testing Energy Technologies for Use at Northern Mines
Air and Other Emissions	4. Dust Suppression Technology Testing and Monitoring
Environmental Liabilities, Closure, and Reclamation	5. Estimation of Closure Bonds 6. Closure and Reclamation Requirements
Tailings and Mine Waste	7. Tailings Reprocessing and Reuse
Eco-efficiency	8. Eco-efficiency Indicators for Mining
Social and Economic	
Indigenous Relations and Reconciliation	9. Engagement to Support Impact Benefit Agreements 10. Integrating Traditional Ecological Knowledge
Local Economic Impact / Sustainable Benefits **Social Closure**	11. Social Closure Requirements
Disclosure / Public Reporting	12. Demonstrating Effective Resource Governance
Innovation	
Big Data and New Sensors	13. Integrating Environmental Monitoring Data and New Monitoring Technology



Addressing climate change was identified as a key challenge for the sector, including understanding and adapting to the physical impacts of climate change on mining operations.

For certain issues, there are no gap and opportunity areas. In some cases, such as governance and accountability, the issue was not discussed by key informants. In other cases, such as for water and land and biodiversity, key informants did not identify gaps specific to that issue that could potentially be addressed through improved standards or guidance. Since many of the issues in Table 3 are interconnected and overlapping, some of the standardization opportunities may impact issues other than the ones with which they are aligned (e.g., a standard for eco-efficiency indicators may address water use).

The following sections describe the gaps and opportunities in more detail, organized under headings corresponding to the issue categories (environmental, social and economic, innovation) and issues shown in Table 3. For each issue where a gap and opportunity area was identified, there is description of current standards coverage and any significant current efforts related to standardization and guidance development.

4.3.1 Environment

A. Climate Change Adaptation

Addressing climate change was identified as a key challenge for the sector, including understanding and adapting to the physical impacts of climate change on mining operations. Globally, the expectations for assessing and disclosing risks from these physical impacts are driven by initiatives such as the recommendations of the Task Force on Climate-Related Financial Disclosure (TCFD), which seeks to establish and encourage more consistent corporate disclosure of climate-related financial risks.

In 2016, MAC received an advisory statement on climate change from its multi-stakeholder Community of Interest Advisory Panel (COI Panel), which proposed specific ideas and actions to assist MAC and its members in making further progress in addressing climate change [17]. MAC is undertaking a number of actions to respond to the COI Panel statement [18], including the development of guidance on best practices for climate change risk and adaptation for the mining sector in the Canadian context. This project is funded by Natural Resources Canada's Climate Change Adaptation Program and is scheduled to be completed in 2020.

At the territorial level, the Yukon government's Department of Energy Mines and Resources (Minerals Resources Branch) is developing a guidance document for Yukon quartz mining projects, in order to more effectively assess and manage climate change risks in mine infrastructure design and maintenance. The guidance will be addressed to mining proponents and regulators. This initiative is also being funded by Natural Resources Canada's Climate Change Adaptation Platform and is scheduled to be completed in 2020 [19].

Existing mining sector guidance in this area includes ICMM's 2013 report *Adapting to a Changing Climate: Implications for the Mining and Metals Industry*, a guide to the incorporation of climate change impacts in practices of mine waste characterization, closure, and reclamation planning [20].

Gap and Opportunity 1: Assessing Climate Change Impacts and Guiding Adaptation Actions

Despite the range of existing voluntary standards and guidance documents, key informants identified several areas they believe are not adequately covered for the Canadian mining sector. Most prominently, the evolving requirements for assessing and adapting to the impacts of climate change on mine operations, particularly in mine closure planning and design, vary across and within jurisdictions. For example, one key informant mentioned receiving different directions from two federal agencies. At present there are no recognized and accepted risk thresholds that companies and regulators can use in combination with public engagement to demonstrate adequate consideration of potential climate change impacts. Companies face challenges in selecting appropriate climate change projections (i.e., selection of scenario / Representative Concentration Pathway), assessing risks to their operation, and planning and implementing adaptive measures for the highest risks.

Mining-specific standards or guidance on addressing these challenges and requirements could be useful for both companies and regulators. Specific gaps and opportunities raised by key informants include:

- Addressing the long-term safety of tailing dams in a changing climate due to shifts in expected rainfall.
- More mining-specific guidance within the CSA Group's PLUS 4013 [21] on intensity-duration-frequency (IDF), including appropriate approaches to downscaling models and specific guidance on addressing uncertainties.
- Adaptation guidance on how to monitor climate and implement necessary changes at the appropriate time (i.e., documenting triggers and actions that have to be taken), and where to implement such approaches (e.g., in OMS and other frameworks).

B. Energy and GHG Emissions

Reducing energy use and GHG emissions was identified as a key challenge for the sector. Key informants also see significant opportunities for mining to support the transition to the low-carbon economy by supplying clean-energy minerals.

Mining sector standards in this area include MAC's "TSM Energy and GHG Emissions Management Protocol" and the *IRMA Standard for Responsible Mining* ("Greenhouse Gas Emissions" chapter).

In response to the 2016 advisory statement on climate change from its multi-stakeholder COI Panel, MAC is undertaking a range of actions to assist its members in making further progress in addressing climate change [17], including an examination of the criteria in its above-noted "TSM Energy and GHG Emissions Management Protocol" in 2020.

There are also several non-sector specific standards and guidance documents for the quantification and management of greenhouse gas emissions across the natural resource and energy fields. These include the GHG Protocol from the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) [22], the CDP (formerly the Carbon Disclosure Project), and the ISO 50001 Energy Management Systems Standard [23]. Beyond 50001, ISO has a family of standards to help organizations quantify and communicate their greenhouse gas emissions, including ISO 14064 and ISO 14065 [24].

Gap and Opportunity 2: Comprehensive GHG Measurement

A few key informants stated that there is a need for more comprehensive and sophisticated measurement of GHG footprints, in order for mining operations to address requirements and opportunities related to:

- Expanded regulatory requirements associated with climate change impacts (e.g., sustainability requirements in Bill C-69)
- Increased electrification of mines and use of renewable energy
- More sophisticated disclosure and certification requirements (e.g., Climate Smart Mining [25]), and
- Carbon markets (e.g., offset markets)

Key informants suggested that additional mining-specific standards or guidance in the following areas could be useful:

- More detailed and comparable measurements of the GHG footprint of a mine and its products (this need is linked to Gap and Opportunity 8: Eco-Efficiency Indicators).
- Practical approaches for exploration companies to quantify GHG emissions.
- The application of life-cycle analysis (LCA) and other forms of systems analysis to quantify GHG emissions to inform, among other things, the optimization of trade-offs to improve environmental performance (e.g., increased energy use and GHG emissions resulting from additional water treatment).
- The development, measurement, and reporting of GHG offsets.

Gap and Opportunity 3: Testing Energy Technologies for Use at Northern Mines

Many mines in northern and remote locations of Canada currently rely on diesel for energy (mobile equipment and electricity production) and are looking for alternative energy sources to reduce fuel costs, reduce risks (e.g., spills, supply interruptions), and address the relatively large GHG contributions of mining operations to territorial emissions. Many equipment and service providers are looking to test and demonstrate the viability of their technology in the North.

A standard could help define requirements and/or testing approaches and would support regulators as they review mining applications that include alternative and innovative energy sources.

C. Air and Other Emissions

Mining sector standards that address air emissions include Section 7 of PDAC's *e3 Plus Framework for Responsible Exploration*; Environment Canada's *Environmental Code of Practice for Metal Mines*; the *IRMA Standard for Responsible Mining* ("Air Quality" chapter), and the International Financial Corporation's "Environmental, Health, and Safety Guidelines". Currently, air emissions (not including GHG emissions) are not the focus of any MAC or ICMM standards. Steps have been taken to harmonize air quality requirements across Canada, given the transboundary nature of ambient air pollution and its impacts on public health. In 2012, federal, provincial, and territorial ministers of the environment (not including Quebec) agreed to implement an Air Quality Management System (AQMS), which is a comprehensive and collaborative approach by governments to reduce the emissions and ambient concentrations of various pollutants of concern [26].

Gap and Opportunity 4: Dust Suppression Technology Testing and Monitoring

Dust generation is a long-standing and common issue of concern for communities located near mines. Key informants stated that there are currently no standards for particulates or dust control across the North, no established acceptable limits for dust generation, and no testing standards for the effectiveness of dust suppressants. The Nunavut Impact Review Board (NIRB), for example, relies on the claims and guidance from dust suppressant suppliers when reviewing the dust management measures in regulatory applications. Standards related to dust are tied to human health and do not account for environmental contamination.

A standard for the testing of dust suppressants and for dust monitoring programs (e.g., guidance on the number of monitoring stations, distance from the mine) could help regulators review dust suppression measures and help both regulators and companies assess dust impacts and the effectiveness of measures and monitoring programs.

D. Environmental Liabilities, Closure, and Reclamation

Mine closure and reclamation are identified as key challenges for the mining sector and are linked to other environmental challenges, including the storage of tailings and other mining wastes, as well as the vulnerability of closed mine sites to the impacts of climate change. Currently, the provinces and territories set requirements for mine closure and reclamation, which generally include the preparation and submission of a mine closure plan before production can begin, as well as the provision of a financial guarantee to the government to cover the costs

of closure [16]. In some cases, a federal environmental assessment may be required for abandoned mine site remediation projects [16].

Globally, ICMM has issued good practice guidance on integrated mine closure, and MAC has developed a parallel framework that outlines high level commitments in the area. The Initiative for Responsible Mining Assurance (IRMA) and the Asia-Pacific Economic Cooperation (APEC) Secretariat have also recently published standards and checklists for mine closure and reclamation [27], [28].

Recognizing a gap related to the consistency and quality of closure planning across international jurisdictions, a new ISO standard on mine closure and reclamation planning that is applicable to new and operating mines is currently being developed through ISO. This standard will emphasize early and ongoing planning of mine closure (following the principle of "design for closure and reclamation") and is not intended for abandoned mines, although the development of a separate standard for abandoned mine sites has been initiated through ISO. It is notable that none of the existing standards deal comprehensively with the social dimensions of mine closure, which we discuss later in Section 4.3.2.

Gap and Opportunity 5: Estimation of Closure Bonds

Based on the reports of key informants, while there are requirements across Canadian jurisdictions to provide financial guarantees for closure costs (also known as closure bonds or reclamation security), aspects of these can vary substantially, including how costs are estimated, as well as the degree of transparency and disclosure of bond amounts. When mines are abandoned, there continue to be situations where the closure bond is insufficient to complete the required work, leaving governments with the outstanding liability and responsibility to remediate the site.

Many of the stakeholders consulted advised that a standard approach (e.g., common principles, scope, structure, and/or estimation tools) could help protect governments from new abandoned mine liabilities and create a level playing field nationally, while providing companies with more clarity and certainty.

Gap and Opportunity 6: Closure and Reclamation Requirements

The requirements for closure and reclamation, including design criteria, vary widely across the country. One key informant stated that guidance from the Northwest Territories and Nunavut is considered leading, suggesting that there is room for improvement in the provinces. Under the umbrella of closure and reclamation, key informants identified a range of subtopics where there may be an opportunity for standards and/or guidelines to define good practice and achieve greater consistency, including:

- Design timeframes for closure
- Revegetation of closed sites
- Long-term durability of natural materials used in dams, rock drains, and other structures, and associated testing approaches and design frameworks
- Operation, monitoring, and surveillance (OMS) requirements specifically for closed sites

A few key informants emphasized that the management of old and recently abandoned mine sites is a long-standing and ongoing challenge for government. As with closure bonds, a clearer and more consistent approach across jurisdictions would provide more certainty to companies. An approach that better defines site design criteria for meeting the government's expectations for reclamation and for the integrity of long-term infrastructure would help ensure that closure and reclamation objectives are met and that government does not inherit new liabilities associated with closed sites.

E. Tailings and Mine Waste

The management of tailings is a key challenge for the mining sector and a concern for stakeholders. As stated as part of the landscape scan, the recent failure of tailings dams in Brazil and Canada have triggered several independent reviews and efforts to strengthen standards in this area.

Mining sector standards with relevance for Canada include MAC's "TSM: Tailings Management Protocol"



Tailings reprocessing is currently relatively uncommon in Canada, but is being explored more extensively in other mining jurisdictions, such as South Africa.

and associated guidance documents, ICMM's Tailings Governance Position Statement, Section 12 of PDAC's *e3 Plus Framework for Responsible Exploration, Environment Canada's Environmental Code of Practice for Metal Mines, and the IRMA Standard for Responsible Mining* ("Waste and Materials Management" chapter). Specific requirements for tailings dams are provided in the Canadian Dam Association's *Dam Safety Guidelines 2007* and its 2014 *Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams*.

The aforementioned documents are among an even larger number of international mine tailings standards. A 2019 study by the Global Mining Guidelines Group characterizes approximately 30 guidance documents, project initiatives, and standards related to mine tailings. International organizations such as the International Commission on Large Dams (ICOLD) and the International Network for Acid Prevention (INAP) also have standards, guidelines, and tools applicable to mine tailings and waste. These standards and guidelines address various dimensions of tailings and mine waste management that include (but are not limited to) the physical stability of tailings storage facilities, prediction and containment of acid mine drainage and metal leaching, and management and governance of tailings by owners and qualified professionals.

A number of debates around appropriate levels of risk tolerance for tailings storage facilities have persisted, with some stakeholders advocating for more categorical/prescriptive approaches, such as banning the long-term wet storage of tailings. Overall, there is a strong focus on approaches and strategies to reduce the overall tailings and mine waste footprint of mining by reducing the production of tailings through reprocessing and reuse, and other innovations.

Gap and Opportunity 7: Tailings Reprocessing and Reuse

Tailings reprocessing is currently relatively uncommon in Canada, but is being explored more extensively in other mining jurisdictions, such as South Africa. While several key informants suggested that this could be an area for standardization, no specific suggestions were made on the nature of standards or guidelines required. New policy and legal frameworks may also be required to address other barriers to reprocessing.

Several key informants stated that there is renewed interest in tailings reprocessing in Canada, driven by the need for smaller mine footprints, reduced closure liability, reduced tailings risk (all of which may facilitate permitting), and circular economy opportunities (i.e., to extract additional materials of value). Technological innovation that allows more cost-effective reprocessing could also drive increased interest, such as biological approaches (e.g., bioprocessing or biorecovery). One informant suggested that standard development could also support the reuse of tailings, such as a testing standard to identify tailings materials that could be used as cement or paste fill amendments. New mines are doing more to segregate waste rock, which can enable differentiated management approaches such as the reuse of "clean waste rock".

D. Eco-efficiency

The term eco-efficiency refers to the concept of creating greater value while using fewer resources and creating fewer adverse environmental impacts.

There are a number of mining standards and guidelines related to the quantification of various environmental indicators. These include TSM protocols that address biodiversity, energy and GHG emissions, and water; and IRMA standards related to waste and materials, water, air quality, GHGs, biodiversity, and reagents (e.g., cyanide, mercury). Such standards may support the determination of eco-efficiency indicators, which are normalized measures of resource use (e.g., use of energy, land, water, material resources relative to production or relative to tonnes of ore moved), but may not be designed to provide indicators that enable comparisons between companies.

Certain standards, such as the Mineral Council of Australia's "Water Accounting Framework for the Minerals Industry," provide specific metrics that are more clearly defined for mining and can be used to benchmark performance [29]. The Global Reporting Initiative's (GRI) "Sustainability Reporting Guidelines" also provide a set of relevant eco-efficiency indicators [30].

As a basis for comparison, investor-focused sustainability rating systems (conducted by socially responsible investment firms or SRIs), responsible sourcing certification schemes, and regulatory requirements are helping to drive the uptake of eco-efficiency indicators on the part of companies, in order to make comparisons to a benchmark or to gauge year-over-year improvements.

Gap and Opportunity 8: Eco-efficiency Indicators for Mining

Unlike manufacturing plants and other industrial operations, mining operations encounter challenges when reporting normalized indicators because the methodologies do not allow them to reflect significant changes in operating conditions (e.g., deepening the mine over time which requires greater energy use, declining ore grades over time which requires processing of more ore). Going forward, the expectations around responsible materials sourcing and the circular economy may require more mining-specific and standardized eco-efficiency indicators.

National standards for eco-efficiency indicators could help companies and the industry respond to these requirements, attract investors, and access certain markets.

4.3.2 Social and Economic

A. Indigenous Relations and Reconciliation

Mining sector standards identified in the landscape scan include MAC's "TSM protocol on Indigenous and community relationships (which is currently undergoing a major revision, to have been released in late 2019), a range of ICMM documents and toolkits, PDAC's *e3 Plus Framework for Responsible Exploration* ("Guides on Engagement" chapter), the Devonshire Initiative's *Beyond Zero Harm Framework*, and the *IRMA Standard for Responsible Mining* (notably the chapters "Community and Stakeholder Engagement," "Complaints and Grievance Mechanism," and "Access to Remedy"). Other relevant standards include ISO 26000 and the OECD's *Due Diligence Guidance for Meaningful Stakeholder Engagement in the Extractive Sector*. Some of these standards and guidance documents address both engagement and community development-related issues.

Gap and Opportunity 9: Engagement to Support Impact Benefit Agreements

Despite numerous standards and guidance documents, key informants described challenges around meeting growing and dynamic requirements and expectations for engaging meaningfully with Indigenous peoples and stakeholders. Key informants had mixed views about whether these challenges are best addressed through new standards and guidance or through other actions.

Key informants identified the following challenges and gaps related to engagement, particularly with Indigenous communities, and in relation to the development of impact benefit agreements (IBAs) or other agreements:

- Beginning discussions/negotiations on IBAs with lawyers without community involvement can set up a conflict situation and disconnect between the needs of the community and the objectives pursued by the negotiators.

- Engaging communities in visioning (their objectives for the project) should occur early on.
- Current engagement standards may not be sufficiently oriented towards building more collaborative and participatory arrangements between proponents and communities.

Some key informants saw an opportunity for a standard or guidance to help communities and companies negotiate agreements for socio-economic benefits and establish more collaborative arrangements. A standard that supports broader engagement of communities in IBA negotiations and helps establish more collaborative arrangements could benefit all parties involved throughout the project's life cycle. It would be important to have one or more Indigenous organizations lead or co-lead any standard development efforts. Any new standard or guideline should recognize and complement the policies, protocols, and direction of the Indigenous community where it is being applied. Existing standards and experiences and lessons learned from Canadian mining projects (including in the North) could inform the development of the standard.

Gap and Opportunity 10: Integrating Traditional Ecological Knowledge

There is increasing recognition across regulators, companies, and Indigenous communities that Traditional Ecological Knowledge (TEK), also referred to as Indigenous Knowledge (IK), and Western knowledge should both be harnessed to inform Environmental Impact Assessments and environmental monitoring programs. To date, uptake of these knowledge forms has been uneven, with limited guidance available. One example is the Mackenzie Valley Environmental Impact Review Board's 2005 publication *Guidelines for Incorporating Traditional Knowledge* [31]. Encouragingly, these Guidelines are now being used by the BC Environmental Assessment Office. Many First Nations have also published TEK policies and research protocols that might be useful to a wider audience. There would be a benefit to compiling and disseminating good practices and case studies in order to support regulators, companies, and communities in their approach to incorporating TEK. Further investigation would be required to determine what work is currently underway in this area.

This remains an evolving practice area, and proponents could benefit from guidance on principles and approaches for incorporating TEK into assessments, monitoring, and decision-making by co-creating knowledge and blending knowledge sets. Another potential opportunity is to develop a standard or guideline on the management and use of TEK data, which would need to address considerations of intellectual property and ownership. Standards in this area could benefit companies and regulators, addressing knowledge gaps for the assessment of projects (e.g., gaps in baseline data, uncertainty in modelling), informing better decisions, and building trust between companies and communities. Key informants also stated that effectively incorporating TEK can also lay the foundation for meeting *duty-to-consult* requirements and for *Free, Prior and Informed Consent* (FPIC).

B. Local Economic Impact/Sustainable Benefits and Social Closure

There are a number of standards and guidance documents currently being used by mining companies to help them define, measure, and manage local economic benefits. These include the *IRMA Standard for Responsible Mining* ("Obtaining Community Support and Delivering Benefits"; "Artisanal and Small-Scale Mining"; "Community Health and Safety"; "Resettlement"; "Planning and Financing Reclamation and Closure" chapters), the ICMM's "Community Development Toolkit", PDAC's *e3 Plus Framework for Responsible Exploration* ("Community Development" and "Social Wellbeing" sections), the Social & Human Capital Coalition's "The Social Capital Protocol," and Mining Shared Value's "Mining Local Procurement Reporting Mechanism" (LPRM)."

Most of these standards have been developed by international organizations. While there may be a more acute need for such guidance and standards in developing countries, many mines in Canada are located near Indigenous communities that historically have not benefited from resource extraction and/or near communities where benefits from mining may be limited or short lived due to a relatively short mine life

and lack of other significant economic opportunities. As a result, the United Nations' Sustainable Development Goals (SDGs), which focus on and target broad-based wellness and quality of life improvements, are now informing expectations for the sector.

Gap and Opportunity 11: Social Closure Requirements

The practice of managing closure-related social impacts is known in the mining industry as "social closure". Social closure in mining is part of a broader practice of managing community transitions, which applies to any situation where a community experiences a socio-economic disruption. Several emerging factors and trends, including automation and the transition to a low-carbon economy, are further contributing or giving rise to community transitions.

The area of social closure is not well addressed within existing standards or guidelines. While there has been some movement in this area (for example, ICMM has recently updated its closure guidance to include more social elements, and some governments have general guidance on community transitions), there remains a need for clearly defined and articulated expectations for good practice in social closure. This would provide clarity for companies in terms of what is expected, and enable regulators to assess the quality of social closure planning. Ultimately, improving practice in this area must support community wellness and resilience.

Some key informants saw value in creating a standard or guideline on social closure planning for mining companies. A standard or guideline in this area could address questions such as:

- What is social closure?
- What should be included in a social closure plan, including partial and full closure?
- How do you measure success?
- What are the roles for the company, community, governments, and other businesses in planning and implementing for social closure?

In addition, key informants recommended that any standard or guidance be informed by an examination of Canadian case studies such as the Polaris, Nanisivik, Sullivan, and Thompson mines.

C. Disclosure / Public Reporting

Several key informants identified responsible sourcing as an important emerging expectation for the sector that will affect the sector's disclosure and public reporting requirements. A number of responsible sourcing standards have been developed in recent years, some of which are commodity specific, and others that apply across a range of commodities (e.g., the OECD's guidelines on responsible sourcing [32]). Several downstream companies, such as electronics and automotive manufacturers, have also established their own standards for component materials. This is putting pressure on mining companies to demonstrate that they meet these standards. Eco-efficiency indicators (discussed above) can have a role in reporting against environmental criteria in these standards.

Gap and Opportunity 12: Demonstrating Effective Resource Governance

A component of responsible sourcing is demonstrating sourcing from jurisdictions with good resource governance, including comprehensive and effective environmental, health and safety, and labour laws and regulations.

Given that responsible sourcing initiatives and standards are developed for international application, there are some issue areas that may be of lower risk within Canada because they are highly regulated or where there are few incidences (e.g., labour rights, child labour, forced labour, freedom of association). There may be an opportunity for a standard or a guideline to support the demonstration of good resource governance at a subnational level (i.e., province or territory). Unlike other opportunities identified in this report, such a standard would apply to governments or jurisdictions rather than to companies or facilities. This type of standard or guideline could provide market assurance that a particular set of requirements is met for all companies operating within key mining jurisdictions in Canada.

4.3.3 Innovation

A. Big Data and New Sensors

Innovation in the mining sector is needed to address key environmental and other sustainability challenges, including those related to climate change, waste reduction, and achieving community benefits. Gaps and opportunities have been identified in a number of issue areas, described elsewhere in this report, where innovation may play a role, such as greater application of tailings reprocessing. Several of the areas where key informants identified opportunities for standards to support innovation and the deployment of new technologies involve technologies with cross-sectoral application.

Gap and Opportunity 13: Integrating Environmental Monitoring Data and New Monitoring Technology

Regulations, limitations in the availability of data, and inconsistent data formats can be barriers to the application of new environmental monitoring technology and data. Currently, environmental data formats (including formats for data under various regulatory requirements) are not sufficiently standardized to facilitate consolidation within databases or for other "big data" applications. The accuracy and reproducibility of environmental monitoring is important for the integrity of the regulatory system and public confidence. This can make regulators resistant to accepting new monitoring technologies.

Advancements in so-called big data, GIS, field sensors, and genomics create new opportunities to advance environmental monitoring. This is driven by a need for more, and more sophisticated, environmental monitoring data to support the assessment of regional and cumulative effects assessment, and by opportunities to reduce the cost and waiting times associated with conventional laboratory analysis. Key informants identified two opportunities for standard development in the area: (1) standardizing of environmental data format (e.g., water quality data), and (2) standard requirements for testing and use of new environmental monitoring/testing technology.

4.4 Analysis of Standardization Opportunities

The gaps and opportunities identified by key informants were analyzed to determine priorities for further exploration of standardization potential and scoping. Table 4 presents a priority rating of low, medium, or high for each gap and opportunity area, along with the rationale for these ratings. In assigning this priority rating, the authors considered the following factors:

- Frequency of mention by key informants (rated on a 3-point scale: Low (1 or 2 mentions), Moderate (3 or 4 mentions), High (5 or more mentions).[5]
- Potential magnitude of benefits to industry and regulators through further standardization in this area.
- Urgency to address the topic, including relevance to key challenges and emerging expectations described in Section 3.
- Feasibility and other considerations for standard development.

[5]Given the relatively small number of interviews, the range of issues discussed, and variations in the range of expertise for each interviewee, the frequency of mention should be viewed as an indicative qualitative measure and not as a statistically significant result.

***Table 4**: Emerging Expectations and Key Challenges*

Gap and Opportunity Area	Factors Informing Prioritization		Priority Rating
	Frequency of Mention by Key Informants	Other Considerations (urgency, benefits for industry and government, feasibility)	
Environmental			
Climate Change Adaptation			
1. Assessing Climate Change Impacts and Guiding Adaptation Actions	high	With climate change impacts already becoming more apparent and severe, there is an urgency to identify, assess, and treat risks associated with the impacts on mining operations. Guidance and/or standards could benefit regulators by more clearly articulating what is required to demonstrate that climate change risks have been adequately considered and to enable consistent and informed reviews of proponents' regulatory submissions. Benefits to industry include greater clarity and certainty on what is required to meet regulatory requirements, improved risk management (and associated loss reduction), and ability to address growing disclosure requirements. Further standard development in this area should be informed by the scope and content of emerging guidance being developed at the time of writing by MAC and the Yukon Government (both of which are expected to be completed in 2020).	MODERATE
Energy and GHG Emissions			
2. Comprehensive GHG Measurement	moderate	Transitioning to lower carbon technologies and processes is an imperative for all sectors, including mining, and standards that support this work will be relevant. However, assessment of this opportunity would benefit from a better understanding of the key drivers for more comprehensive and sophisticated GHG measurement at Canadian mines. RESOLVE (a non-profit organization) is currently developing a Climate Smart Mining Emissions Widget "… to bring alignment and consistency across mining-related standards and initiatives on climate reporting and … move the needle forward for mining companies and companies using minerals in their products to help achieve greenhouse gas reduction goals". They expect to release the Widget in 2019. While this will not address all of the needs associated with this issue, any further work in the area should take RESOLVE's into consideration.	LOW
3. Testing Energy Technologies for Use in Northern Mines	low	The deployment of renewable energy and clean tech in the North is important to a number of sectors and stakeholders and, as such, any standards or guidelines to support successful deployment would have cross-sectoral application. Assessment of this opportunity would benefit from a more specific assessment of current standards related to energy technology and cold-weather performance (e.g., for wind turbines, solar panels)	LOW
Air and Other Emissions			
4. Dust Suppression Technology Testing and Monitoring	moderate	Air emissions was not identified as a key challenge for the sector by key informants and dust is not a mining-specific issue. However, dust is viewed as a long-standing and perennial issue for communities and stakeholders located close to mine infrastructures, including in Canada's North. Dust management is a mature issue and, therefore, expertise and best practices should be available to inform standard development.	MODERATE

Gap and Opportunity Area	Factors Informing Prioritization		Priority Rating
	Frequency of Mention by Key Informants	Other Considerations (urgency, benefits for industry and government, feasibility)	
Environmental Liabilities, Closure, and Reclamation			
5. Estimation of Closure Bonds	high	A clear and more consistent approach across jurisdictions to the estimation of closure bonds would benefit companies active in the sector. In turn, an approach that is more accurate (i.e., closer to the actual cost of closure, including in different scenarios), would be beneficial to government by reducing the likelihood of taking on abandoned site liability. In addition to existing standards and tools, key informants reported that Crown Indigenous Relations, Northern Affairs Canada (CIRNAC) and the Ontario Ministry of Energy, Northern Development and Mines (in partnership with the Ontario Mining Association) have plans to advance policy and/or guidance for this issue. Investment climate / competitiveness considerations and different risk tolerances may pose challenges for developing a common approach across jurisdictions. While greater clarity/ certainty is needed, some companies may not find a standard beneficial if it leads to an overall increase in closure bond estimates.	HIGH
6. Closure and Reclamation Requirements	moderate	The imminent publication of the new ISO standard for mine closure and reclamation and the initiation of an ISO standard for abandoned mines point to the need and urgency for standards in this area. The scope and content of these standards, once published, and the response to them from the Canadian mining sector, will provide more insight into any remaining gaps and needs that might be addressed through the development of additional standards particularly for mining in Canada. Specifically, there may be areas in the ISO standard for which there are guidelines but no requirements, and for which an additional Canadian standard would be appropriate.	MODERATE
Tailings and Mine Waste			
7. Tailings Reprocessing and Reuse	high	Reprocessing has potentially widespread benefits, including the reduction of closed mine site liability and the recovery of previously unrecoverable or undervalued minerals. However, economic and technical feasibility may be greatest when considered at the early design and planning stage of new mines. Furthermore, current policies and regulations can be a disincentive for companies to reprocess tailings if this involves assuming associated liability. Standard development in this area may require significant engagement and information gathering given that Canada is not a leader in this area (i.e., it would require engagement with international jurisdictions), and due to the diversity of mine site conditions, tailings compositions, and processing technologies. Key informants provide little information on the specific needs to be addressed by standardization. A review of (i) policy and regulatory gaps or barriers to reprocessing within Canada, and (ii) technical and economic feasibility of reprocessing of different types of waste rock would be useful to understand the need for, and the scope of, a standard in this area.	MODERATE

Gap and Opportunity Area	Factors Informing Prioritization		Priority Rating
	Frequency of Mention by Key Informants	Other Considerations (urgency, benefits for industry and government, feasibility)	
Eco-efficiency			
8. Eco-efficiency Indicators for Mining	low	Improving eco-efficiency indicators through standardization may benefit environmental and financial performance management, including defining baselines and target setting. National standards on eco-efficiency indicators may also benefit government through enhanced environmental monitoring, the results of which could be used to inform environmental and industrial policy. However, regulator interest may remain focused on absolute indicators from an environmental impact perspective. The extent to which current approaches to measuring eco-efficiency are overly burdensome, expensive, or are limiting access to certain investment streams is unclear. As such, this may not be viewed as a high priority. Standards development would likely involve engaging with and examining a wide variety of mining operations (i.e., different technologies and contexts), which increases complexity.	LOW
Social and Economic			
Indigenous Relations and Reconciliation			
9. Engagement to Support Impact Benefits Agreements	moderate	While stakeholder engagement is a mature area, expectations are evolving rapidly, including expectations for more participatory and collaborative arrangements between communities and companies, and specific requirements to fulfill the duty to consult and demonstrate FPIC. Furthermore, under the proposed federal Impact Assessment Act, projects will be assessed for their effects on the public interest, including factors such as sustainability, impacts on Indigenous peoples, and community knowledge. Differences between communities and their expectations and protocols regarding engagement may present a challenge for standard development.	MODERATE
10. Integrating Traditional Ecological Knowledge (TEK)	moderate	Integrating TEK in natural resource management decisions is becoming a norm in Canada and there is strong interest in understanding good practices. Given differences between communities, nations, and cultures, standardization related to TEK cannot be viewed as a "one size fits all" approach and must be scoped appropriately and collaboratively, working with Indigenous organizations as leads or co-leads. The approach to developing the standard or guidance should itself model good process on bringing traditional and Western approaches together. Any new standard or guideline should not be too prescriptive and should complement or defer to the policies, protocols, and direction of the Indigenous communities where it is being applied.	HIGH

Gap and Opportunity Area	Factors Informing Prioritization		Priority Rating
	Frequency of Mention by Key Informants	Other Considerations (urgency, benefits for industry and government, feasibility)	
Local Economic Impact/Sustainable Benefits and Social Closure			
11. Social Closure Requirements	high	There are growing challenges in the natural resource sectors associated with community transitions. Regulatory changes in Canada (e.g., Bill C-69) bring broader sustainability considerations into decision making. Expanding mine closure planning to more formally include social and economic impacts on communities is part of this trend. Doing this well improves the credibility of the value proposition for mining – which is of interest to regulators and the industry. Social closure is an inherently multi-stakeholder process, and the range of stakeholders involved in social closure planning at the community/ regional level should be represented within the development of any standard or guideline. Trends such as automation and advancements in other types of mining innovation are anticipated to reduce the number of jobs in the sector. This may reduce the social impacts of closure and place more emphasis on the negotiation of socio-economic benefits at the beginning of mine life.	HIGH
Disclosure/Public Reporting			
12. Demonstrating Effective Resource Governance	low	Development of a standard would require engagement with one or more jurisdictions, potentially to develop and pilot test an approach. Notably, British Columbia may currently be looking at this. If international adoption is ultimately a requirement for such a standard to be useful then it may be more appropriate for an international standard development process (e.g., through ISO).	MODERATE
Innovation			
Disclosure/Public Reporting			
13. Integrating Environmental Monitoring Data and New Monitoring Technology	high	There may be limitations in the use of certain existing data, but standardization for newly collected data could be a significant opportunity in terms of cost savings and could enable creation of comprehensive and regional data sets by consolidating data from different parties. Assessment of this opportunity will likely require broader engagement with data experts and regulators. Certain new technologies, such as eDNA, may or may not be at a stage of readiness where standardization is the next step to facilitate deployment. Assessment of this opportunity will likely require engagement with experts in these technologies.	MODERATE

The analysis identified a frequently cited need to improve coordination and interoperability between existing standards. This suggests that strong engagement with the sector and regulators, and demonstration of sound knowledge of the range of standards already in use will be important when exploring and advancing new standardization opportunities.

Several of the gaps and opportunities identified in Table 4, such as those related to dust suppression and environmental data, could be applicable to sectors beyond mining. In these instances, further engagement could involve representatives from multiple industry sectors.



The Canadian mining sector plays an integral role in meeting the global need for minerals and metals. The industry currently extracts more than 60 minerals and metals, and Canada is positioned among the top five countries in worldwide production of 16 major commodities, including gold, nickel, cobalt, and diamonds.

5 Conclusions

The Canadian mining sector is facing emerging expectations, needs, and key challenges in a number of areas, including:

- More stringent requirements and lower risk tolerance related to tailings and mine waste.
- Evolving requirements related to Indigenous relations and reconciliation and stakeholder relations.
- Growing expectations to deliver substantial socio-economic benefits to local communities.
- Pressures to improve greenhouse gas emissions disclosure and to demonstrate understanding and adaptation of climate change impacts on mine operations.
- Need to improve closure planning and management practices.

This research has identified a number of outstanding gaps and opportunities within the existing ecosystem of standards and guidelines where standards could potentially add value by providing rules, minimum specifications, performance levels, or technical specifications developed through a multi-stakeholder and consensus-based process.

Table 5 summarizes the gaps and opportunities that need to be addressed and aligned with their respective material issues. They are listed in order of highest to lowest priority. Of the 13 areas identified, 3 are rated as *High* priority, 7 as *Moderate* priority, and 3 as *Low* priority.

Nonetheless, as discussed in this report, some gaps and needs may not yet be ready for standards development. For example, certain issues and related best practices may need to mature further through experience before a standard can be defined. On the other hand, while waiting for the issue to become more mature, practitioners may develop workarounds that may be difficult to undo later. Some new technologies need to advance further before a standard can be developed to facilitate pilot testing or deployment. However, some new technologies need standards to achieve commercialization or obtain acceptance from regulators and industry. In these cases, the lack of standards can hamper advancements. Therefore, the maturity of the issue and the need for workable solutions now are important considerations in determining readiness for standardization.

It is recommended that opportunities for standard development related to Indigenous relations and reconciliation be pursued with the involvement of one or more Indigenous organizations as a lead or co-lead.

***Table 5**: Summary of Gaps or Opportunities that Could Be Potentially Addressed through Standards*

Suggested Priority Rating	Material Use	Gap or Opportunity to Be Addressed
Environmental		
High	Environmental Liabilities, Closure, and Reclamation	Estimation of Closure Bonds
Moderate	Environmental Liabilities, Closure, and Reclamation	Closure and Reclamation Requirements
Moderate	Climate Change Adaptation	Assessing Climate Change Impacts and Guiding Adaptation Actions
Moderate	Tailings and Mine waste	Tailings Reprocessing and Reuse
Moderate	Air and Other Emissions	Dust Suppression Technology Testing and Monitoring
Low	Energy and Greenhouse Gas Emissions	Comprehensive GHG Measurement (specific to the mining sector)
Low	Energy and Greenhouse Gas Emissions	Testing Energy Technologies for Use at Northern Mines
Low	Eco-efficiency	Eco-efficiency Indicators for Mining
Social and Economic		
High	Local Economic Impact / Sustainable Benefits	Social Closure
High	Indigenous Relations and Reconciliation	Integrating Traditional Ecological Knowledge
Moderate	Indigenous Relations and Reconciliation	Engagement to Support Impact Benefit Agreement
Moderate	Disclosure/Public Reporting	Demonstrating Effective Resource Governance
Innovation		
Moderate	Big Data and New Sensors	Integrating Environmental Monitoring Data and New Monitoring Technology

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9 Appendices

Appendix A: List of Interviewee Organizations

Category	Organization
Industry (Association)	Mining Association of Canada
Industry (Company)	Hudbay Minerals
Industry (Company)	Avalon Rare Metals Inc.
Industry (Company)	Sabina Gold and Silver Corp.
Government (Federal)	Natural Resources Canada
Government (Federal)	Natural Resources Canada – Canadian Minerals and Metals Plan
Government (Federal)	Crown-Indigenous Relations and Northern Affairs Canada – Northern Contaminated Site Program
Government (Provincial)	Ontario Ministry of Indigenous Relations & Reconciliation
Government (Provincial)	Ontario Ministry of Energy, Northern Development and Mines
Regulator	Nunavut Impact Review Board
Regulator	Mackenzie Valley Review Board
Academia	University of British Columbia – Norman B. Keevil Institute of Mining Engineering
Consulting	Firelight Group
Consulting	Hutchison Engineering Inc.
Consulting	Golder Associates Ltd.
Consulting	Trailmark Systems
Consulting	ERM
Non-Governmental Organization	Canada Mining Innovation Council (CMIC)
Non-Governmental Organization	International Institute for Sustainable Development (IISD)
Non-Governmental Organization	Resolve

Appendix B: Interview Questions

The following questions were asked in the interviews:

1. **Emerging Expectations**: What do you see as the key shifts and/or emerging expectations (societal, government, market) that will likely affect environment, sustainability, and innovation priorities and action within the Canadian mining industry over the next ten years?

2. **Key Challenges**: What are the top three to five environmental, sustainability, and innovation challenges / priorities / needs facing companies undertaking exploration and mining activity in Canada? (Appendix C provides a list of issue categories.)

3. **Role of Standards**: Of these top challenges / priorities / needs:

   a. To what extent are these issues currently addressed through government policy and regulation (federally, provincially, or territorially)? Is coverage significantly different across jurisdictions and where is this most problematic? Within these areas, are there specific gaps or grey areas where further guidance would be helpful, or where there are opportunities for harmonization?

   b. To what extent are these issues currently addressed through standards? If partially addressed, are there specific gaps that might be addressed through standards?

   c. Are there innovations (technologies, processes, procedures, etc.) whose deployment could be supported by standards or areas where there should be more consistency in practices or processes?

   d. Are there other priority issues / needs / opportunities where you think standards might add value?

4. **Standards Currently in Use**: Broadly speaking, what do you see as the most useful standards currently being applied in the mining sector related to environment, sustainability, or innovation? Why?

5. **Other**: Do you have any other comments or suggestions you'd like to share about:

   a. what new standards you would like to see?

   b. where you see standards providing benefit to industry?

   c. new processes and procedures that are not being used effectively?

Appendix C: Detailed Landscape Scan

The table below presents the results of the landscape scan, listing relevant standards and related literature (e.g., guidelines, protocols, principles) pertaining to the material issues identified. Issues considered out of scope include human rights (including security, child labour, and forced labour), cultural heritage, transparency of payments, crisis communications and emergency response planning, labour practices (including diversity and inclusion and employee relations), and responsible sourcing. Other standards that may be peripherally relevant to the material issues (but not those excluded from scope) are categorized as "other".

This assessment does not comment on the level of detail of each standard (i.e., How adequate is the coverage? Is it detailed or high level?); rather, this is addressed in Section 4 of the report where we consider coverage of specific subissues.

In cases where specific sections are referenced, the format used is "document title" – "relevant document section". Some documents are under development and these are indicated by "(under development)" after the title; the status of these documents will be updated in the final version of the report, as needed.

Synthesis of Material Issues	MAC	ICMM	CSA Group / ISO	PDAC	Voluntary Standards & Guidance
Environmental					
Land and Biodiversity	▪ Biodiversity Conservation Management Protocol [33] ▪ Mining and Biodiversity Conservation Management Framework [34]	▪ Principles 6, 7 [35] ▪ Position Statement on Mining and Protected Areas [36] ▪ Good Practice Guidance for Mining and Biodiversity [37]		▪ e3 Plus: A Framework for Responsible Exploration – Section 8 [38]	▪ Initiative for Responsible Mining Assurance (IRMA) – Biodiversity, Ecosystem Services and Protected Areas [27] ▪ CDP Forests Disclosure Insight Action [39] ▪ IFC – Performance Standards – Biodiversity Conservation and Sustainable Management of Living Natural Resources [40] ▪ IFC – EHS Guidelines – Mining: 1.1 Environmental – Land use and biodiversity [41] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42]
Water	▪ Water Stewardship Protocol [44] ▪ Water Stewardship Framework [44]	▪ Water Stewardship Position Statement [45] ▪ Mercury Risk Management Position Statement [46] ▪ A Practical Guide to Catchment-Based Water Management [47] ▪ A Practical Guide to Consistent Water Reporting [48]		▪ e3 Plus: Water Use and Conservation [49]	▪ IRMA – Water management; cyanide management; mercury management [27] ▪ AWS – International Water Stewardship Standard [50] ▪ CDP Water Disclosure Insight Action [51] ▪ IFC – Performance Standards – Resource Efficiency and Pollution Prevention [40] ▪ IFC – EHS Guidelines – 1.3 Wastewater and Ambient Water Quality; 1.4 Water Conservation; Mining: 1.1 Environmental – Water use and quality [41] ▪ Mineral Council of Australia, Water Accounting Framework [52] ▪ ICMI – The Cyanide Code [53] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42] ▪ DJSI CSA – Water-related risks [43]
Climate Change Adaptation	▪ Climate Change Risk and Adaptation Best Practices for the Mining Sector (under development) [17]	▪ Adapting to a Changing Climate: Implications for the Mining and Metals Industry [20]	▪ ISO 14091 Adaptation to Climate Change – Vulnerability, Impacts and Risk Assessment [54]		▪ UN Framework Convention on Climate Change [55] ▪ EPA – Development of a Climate Resilience Screening Index [56] ▪ CDP Climate Change Disclosure Insight Action [57] ▪ Business for Social Responsibility Adapting to Climate Change: A Guide for the Mining Industry [58] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42]

Synthesis of Material Issues	MAC	ICMM	CSA Group / ISO	PDAC	Voluntary Standards & Guidance
Energy and GHG Emissions	▪ Towards Sustainable Mining: Energy and GHG Emissions Management Protocol [59]	▪ Principle 6 [35] ▪ Adapting to a Changing Climate: Implications for the Mining and Metals Industry [20] ▪ Principles for Climate Change Policy Design Position Statement [60]	▪ ISO 50001 Energy Management [23] ▪ ISO/TC207 Life Assessment Cycle [61] ▪ ISO 14064-1 GHG – Part 1 [62] ▪ ISO 14065 ▪ ISO 14080	PDAC Guidance and Tools [63]	▪ IRMA – Greenhouse Gas Emissions [27] ▪ World Resources Institute and World Business Council for Sustainable Development GHG Protocol [22] ▪ IFC – Performance Standards – Resource Efficiency and Pollution Prevention [40] ▪ IFC – EHS Guidelines – 1.2 Energy Conservation [41] ▪ ICAP and PMR Emissions Trading in Practice: Handbook on Design and Implementation [64] ▪ CPLC – Report of the High-Level Commission on Carbon Pricing and Competitiveness [65] ▪ DJSI CSA – Operational Eco-Efficiency; Electricity Generation [43] ▪ IFC – EHS Guidelines – Mining: 1.1 Environmental – Energy use [41] ▪ CDP Climate Change Disclosure Insight Action [57]
Air and Other Emissions				▪ E3 Plus: A Framework for Responsible Exploration – Section 7 [66]	▪ IRMA – Air Quality; Noise and Vibration [27]] ▪ IFC – EHS Guidelines – 1.1 Air Emissions and Ambient Air Quality; Mining: 1.1 Environmental – Air Quality [41] ▪ Canadian Air Quality Management System [67] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42]
Environmental Liabilities, Closure and Reclamation	▪ Mine Closure Framework [68]	▪ Principle 6 [35] ▪ Integrated Mine Closure – Good Practice Guide [69]	▪ Mine Closure and Reclamation Terminology (under development) [70] ▪ Mine Closure and Reclamation Planning (under development)	e3 Plus: A Framework for Responsible Exploration – Section 14 [71]	▪ IRMA – Planning and Financing Reclamation and Closure [27] ▪ US EPA – Guidance for Ecological Risk Assessment [72] ▪ IFC – EHS Guidelines – 1.5 Hazardous Materials Management; 1.8 Contaminated Land; 4. Construction and Decommissioning; Mining: 1.4 Mine Closure and Post-Closure [41] ▪ APEC – Mine Closure Checklist for Governments [28] ▪ Saskatchewan Ministry of Environment Northern – Mine Decommissioning and Reclamation Guidelines [73] ▪ INAC – Mine Site Reclamation Guidelines for the Northwest Territories [74] ▪ Government of the Northwest Territories ¬– RECLAIM 7.0 Model for Closure and Reclamation Cost Estimates [75]

Synthesis of Material Issues	MAC	ICMM	CSA Group / ISO	PDAC	Voluntary Standards & Guidance
Tailings and Mine Waste	▪ Tailings Management Protocol [76] ▪ A Guide to the Management of Tailings Facilities [77] ▪ Developing an Operations, Maintenance and Surveillance Manual for Tailings and Water Management Facilities [78]	▪ Principle 6 [35] ▪ Tailings Governance Position Statement [79] ▪ ICMM Review of the Management of Tailings Dams [80]		▪ e3 Plus: A Framework for Responsible Exploration – Section 12 [81]	▪ IRMA – Waste and Materials Management [27] ▪ International Commission on Large Dams [82] ▪ INAP – The Global Acid Rock Drainage Guide [83] ▪ IFC – EHS Guidelines – Mining: 1.1 Environmental – Wastes [41] ▪ CDA – Dam Safety Guidelines [84] ▪ CDA – Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams [85] ▪ Guidelines for Metal Leaching and Acid Rock Drainage at Mine sites in British Columbia [86] ▪ MEND – Guidance Documents [87] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42] ▪ ECCC – Guidance on the Reporting of Tailings and Waste Rock to the National Pollutant Release Inventory [88] ▪ GMGG – Mine Tailings – A Review of Guidelines, Initiatives and Standards [89]
Waste		▪ Principle 6 [35]		▪ e3 Plus: A Framework for Responsible Exploration – Section 12 [81]	▪ IRMA – Waste and Materials Management [27] ▪ IFC – EHS Guidelines – 1.6 Waste Management; Mining: 1.1 Environmental – Wastes, 1.1 Environmental – Hazardous Materials [41]
Other general environment-related standards/ guidance		▪ Principles 4, 6 [35] ▪ Metals Environmental Risk Assessment Guidance [90]	▪ ISO 14001 Environmental Management [91]	▪ e3 Plus – Protect the Environment [92]	▪ UNFCCC – Rio Declaration on Environment and Development [55] ▪ –UN GC – Principles 7, 8 and 9 [93] ▪ OECD – Guidelines for Multinational Enterprises – Environment [94] ▪ IFC – Performance Standards – Assessment and Management of Environmental and Social Risks and Impacts [40] ▪ IFC – Environmental, Health, and Safety (EHS) Guidelines – Mining: 1.1 Environmental [41] ▪ Dow Jones Sustainability Indices (DJSI) Corporate Sustainability Assessment (CSA) – Environmental Policy & Management [43] ▪ Jantzi Social Index [95] ▪ Environment Canada – Environmental Code of Practice for Metal Mines [42] ▪ DI – BZH Framework – Environment [96]

Synthesis of Material Issues	MAC	ICMM	CSA Group / ISO	PDAC	Voluntary Standards & Guidance
Social and Economic					
Stakeholder Engagement	▪ Indigenous and Community Relationships Protocol (under development – revised version of Aboriginal and Community Outreach Protocol) [97]	▪ Principles 9, 10 [35] ▪ Understanding Company-Community Relations Toolkit [91] ▪ Handling and Resolving Local Level Concerns and Grievances [98]		▪ e3 Plus – Engage Host Communities and Other Affected and Interested Parties [92] ▪ First Engagement: A Field Guide for Explorers [99]	▪ IRM – Community and Stakeholder Engagement; Complaints and Grievance Mechanism and Access to Remedy [27] ▪ OECD Due Diligence Guidance for Meaningful Stakeholder Engagement in the Extractive Sector [100] ▪ DI – BZH Framework – Civic Engagement [96] ▪ DJSI CSA – Stakeholder Engagement [43]
Indigenous Relations and Reconciliation	▪ Indigenous and Community Relationships Protocol (under development – revised version of Aboriginal and Community Outreach Protocol) [97][96]	▪ Good Practice Guide to Indigenous Peoples and Mining [101]			▪ IRMA – Free, Prior and Informed Consent [27] ▪ IFC – Performance Standards – Indigenous Peoples [40] ▪ Jantzi Social Index [95]
Community Development (including community wellbeing, health & safety)	▪ Indigenous and Community Relationships Protocol (under development – revised version of Aboriginal and Community Outreach Protocol) [97]	▪ Principle 9 [35] ▪ Position Statement on Mining Partnerships for Development [102] ▪ Community Development Toolkit [103] ▪ Mining: Partnerships for Development Toolkit [104]		▪ e3 Plus – Contribute to Community Development and Social Wellbeing [92]	▪ IRMA – Obtaining Community Support and Delivering Benefits; Community Health and Safety [27] ▪ Social & Human Capital Coalition – The Social Capital Protocol [105] ▪ IFC – Performance Standards – Community Health, Safety, and Security [40] ▪ IFC – EHS Guidelines – 3. Community Health and Safety [41] ▪ Jantzi Social Index [95] ▪ DJSI CSA – Health Outcome Contribution; Strategy to Improve Access to Drugs or Products [43] ▪ DI – BZH Framework – Health; Safety and Security [96]
Governance and Accountability		▪ Principles 1, 2 [35]		▪ e3 Plus – Adopt Responsible Governance and Management [92]	▪ Jantzi Social Index [95] ▪ AA1000 Accountability Principles [106] ▪ DJSI CSA – Corporate Governance; Customer Relationship Management [43] ▪ DI – BZH Framework – Governance [96]

Synthesis of Material Issues	MAC	ICMM	CSA Group / ISO	PDAC	Voluntary Standards & Guidance
Business Ethics and Anti-Corruption		▪ Principle 1 [35]		▪ e3 plus – Apply Ethical Business Practices [92]	▪ UN Convention Against Corruption [107] ▪ UN GC – Principle 10 [93] ▪ OECD Guidelines for MNE – Combating Bribery, Bribe Solicitation and Extortion [94]
Local Economic Impact/ Sustainable Benefits	▪ Indigenous and Community Relationships Protocol (under development – revised version of Aboriginal and Community ▪ Outreach Protocol) [97]	▪ Principle 9 [35] ▪ Community Development Toolkit [103]		▪ e3 Plus – Community Development and Social Wellbeing [92]	▪ IRMA – Obtaining Community Support and Delivering Benefits [27] ▪ Mapping Mining to the Sustainable Development Goals: An Atlas [108] ▪ SHCC – The Social Capital Protocol [105] ▪ DJSI CSA – Codes of Business Conduct [43] ▪ Mining Shared Value – Mining Local Procurement Reporting Mechanism [109] ▪ DI – BZH Framework – Infrastructure; Living Standards; Economy [96]
Social Closure		▪ Principle 9 [35] ▪ Integrated Mine Closure – Good Practice Guide [69]		▪ e3 Plus: A Framework for Responsible Exploration – Section 4 [110]	▪ IRMA – Planning and Financing Reclamation and Closure [27]
Disclosure/ Public Reporting	▪ TSM Facility-Level Reporting Requirements for Annual Reporting of all TSM Results	▪ Principle 10 [35] ▪ Member Reporting and Performance [111] ▪ GRI Mining and Metals Sector Supplement [112]		▪ e3 Plus: A Framework for Responsible Exploration – Section 1 [113]	▪ GRI – G4 Sustainability Reporting Guidelines [30] ▪ International Financial Reporting Standards [114] ▪ CDP – Disclosure Insight Action (All) [115] ▪ OECD Guidelines for MNE – Disclosure [94] ▪ DJSI CSA – Social Reporting [43] ▪ Mining Shared Value – Mining Local Procurement Reporting Mechanism [109] ▪ IFC – EHS Guidelines – Mining: 2.0 Performance Indicators and Monitoring [41]
Capacity Building, Certification and Training	▪ Indigenous and Community Relationships Protocol (under development – revised version of Aboriginal and Community Outreach Protocol) [97]	▪ Principles 3, 5 [35]			▪ DJSI CSA – Human Capital Development [43] ▪ DI – BZH Framework – Education [96]
Other General Social Standards/ Guidance		▪ Principles 4, 9 [35]	▪ ISO 26000 Social Responsibility [116]		

CSA Group Research

In order to encourage the use of consensus-based standards solutions to promote safety and encourage innovation, CSA Group supports and conducts research in areas that address new or emerging industries, as well as topics and issues that impact a broad base of current and potential stakeholders. The output of our research programs will support the development of future standards solutions, provide interim guidance to industries on the development and adoption of new technologies, and help to demonstrate our on-going commitment to building a better, safer, more sustainable world.

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