

# Development of international standards for mine reclamation management

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## Abstract

*A new international standards work program is underway through the International Organization for Standardization (ISO) to develop a series of international standards that will provide requirements and recommendations for mine reclamation management, with a focus on reducing the environmental risks, associated financial liabilities and environmental impacts of mining. Nine countries are actively participating in the standards development program, including all of the most significant mining countries in the world. CSA Group has helped organise a committee of Canadian stakeholders and experts from the Canadian mining industry, relevant government authorities, service providers, and academic researchers with the mandate to provide Canadian leadership and input into this international standards program.*

*This article explains the international standards being developed for mine reclamation management with a focus on an international work item and international standard that Canada has proposed on the topic of mine reclamation management planning. The standard is intended as a crucial overarching document that will provide requirements or recommendations on the topic of mine reclamation management planning. The document will also help guide the development of related standards for the mine reclamation management process.*

*The work item follows a lifecycle approach to mine reclamation management planning and recognises that planning for mine reclamation must take place throughout the lifecycle of the mine and not just at closure. This paper covers the main decision points and procedures that need to be considered in planning for mine reclamation, organised around the following topic areas: approaches to reclamation, reclamation technologies, reclamation activities, reclamation monitoring, financial provisions, and documentation and reporting. The objective is that the ensuing standard will help ensure consistency and completeness in terms of the mine reclamation planning process.*

## 1 Introduction

In 2013, a proposal was brought forward to establish an international standards development program focused on mine reclamation. This was brought forward through an International Organization for Standardization (ISO) technical committee focused on mining (ISO TC 82); the committee decided to form a subcommittee (SC) focused specifically on mine reclamation management. Nine countries are actively participating in the standards development program, including all of the most significant mining countries in the world.

The purpose of this article is to provide an overview of this new international standards development program, with a specific focus on a new work item being proposed on mine reclamation management planning. This new work item is intended to provide a framework not only for mine reclamation management and any standards developed for this, but also for the planning of mine reclamation across the lifecycle of a mine, from inception to closure.

This article is organised as follows: To explain the ISO context, the article first reviews the general process for developing international standards through ISO, including how the widest breadth of stakeholders is consulted and how consensus is sought. Section 3 describes the need for standards focused specifically on mine reclamation, and Section 4 provides an overview of the mine reclamation standards development

program, including Canada's contribution to this. Section 5 focuses on the mine reclamation management planning standard, including its need and purpose, scope, and international leadership. Section 6 provides a summary.

## **2 International standards development and the mining sector**

### **2.1 A staged approach to standards development**

The development of international standards through ISO follows a systematic process based on distinct stages of development. There are six separate stages, which involve different activities at both the working group (WG) level and the level of the committee to which the working group reports. These six stages are as follows:

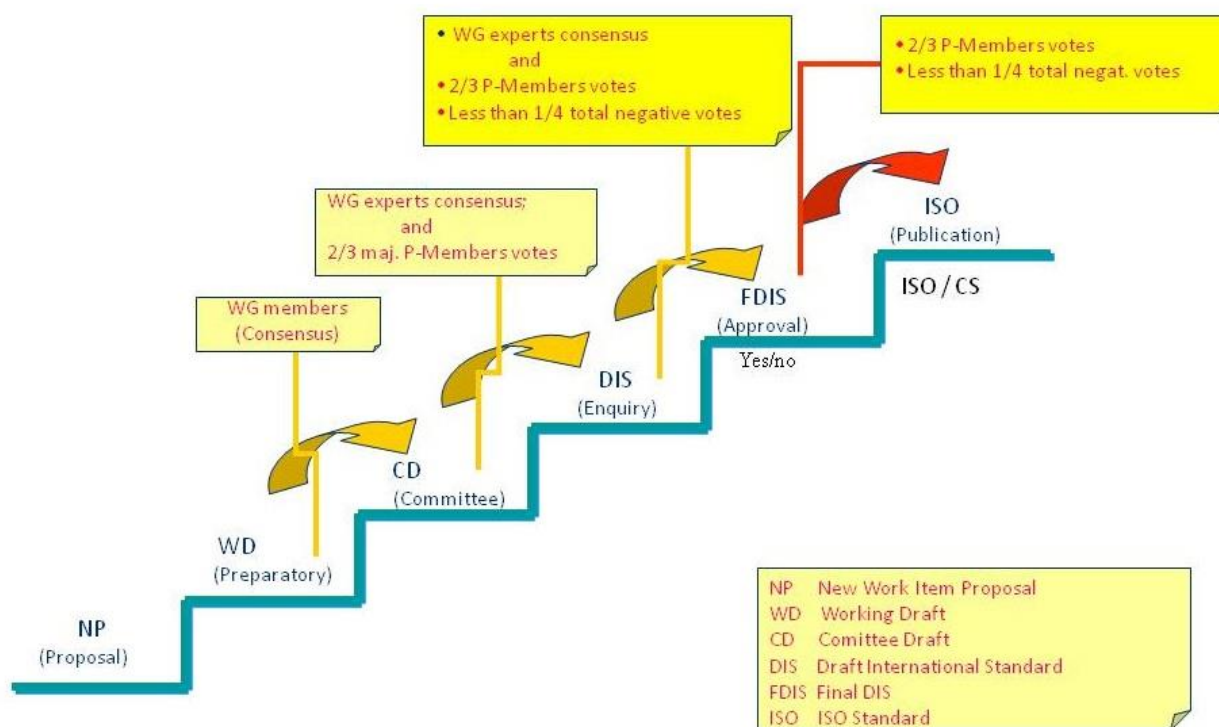
- Proposal
- Preparation
- Committee
- Enquiry
- Approval
- Publication

Several documents are generated through this process:

- Proposal (NP)
- Working draft (WD)
- Committee draft (CD)
- Draft international standard (DIS)
- Final international standard (FDIS)
- ISO standard (ISO)

This process is illustrated in Figure 1 and discussed in more detail in the paragraphs that follow.

The first stage is initiated by a proposal for a new work item (NP), which involves either a new piece of work based on as little as a table of contents or the adoption of an existing document that can be used to seed the international standard. New international standards are proposed through a specific parent committee with a scope that includes the topic area of the standard. These parent technical committees are made up of members from individual countries that can either have voting privileges (termed participating or P-members) or act as observing countries to the process (O-members). Countries who have voting privileges on a committee can propose new work items; in doing so, they are also responsible for appointing an international convenor who will act to lead the working group responsible for developing the technical content of the standard. New work items are voted upon in terms of their market demand and the relevance of the standard on a global scale.



**Figure 1 Stages of the ISO standards process**

Another important element of this phase is the creation of a working group (WG), which will be composed of international experts and will develop and vet the actual content of the standard. Depending on the size of the parent committee, the WG will be made up of experts from a minimum of four or five different countries.

The preparatory stage involves the preparation of a working draft (WD) of the international standard. This work is done largely within the relevant ISO working group.

After the WG is satisfied on the technical merits of the working draft, this document is put forward to the working group's parent committee for comment and vote. There are three voting stages, and this is the first one. This stage, which is termed the committee stage of the development process, is where each P-member country registers its official comments and votes on the WD: a yes vote means that the working draft meets the requirements to move on to the next phase. Successive committee drafts may be considered until consensus, which is reached when at least two-thirds of the P-members register a yes vote. Once agreed upon, the text is finalised for submission as a draft international standard (DIS).

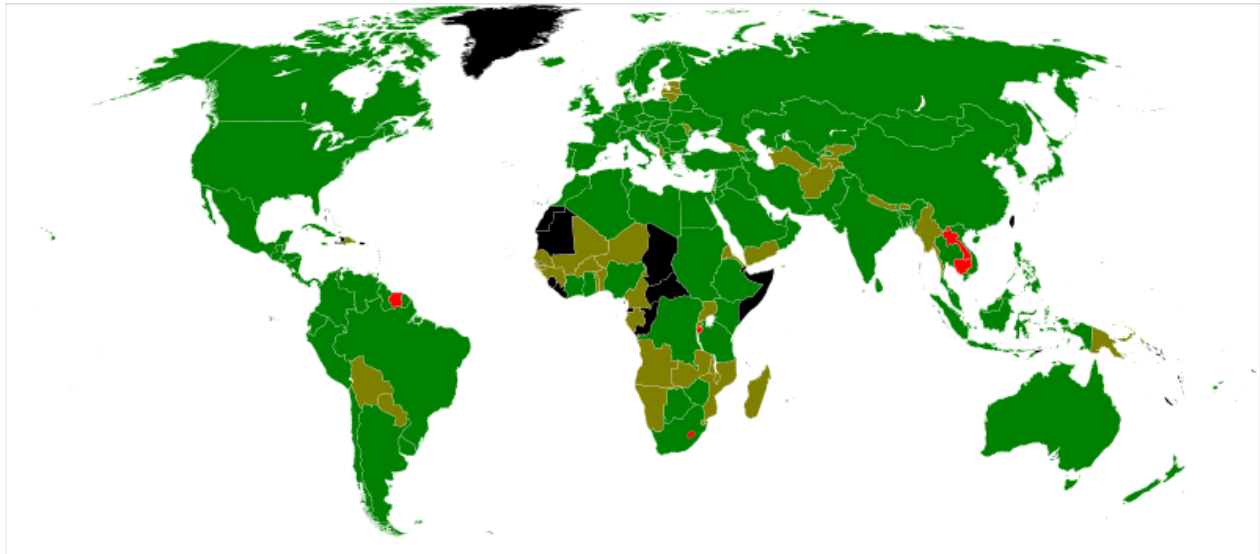
The fourth stage, or the enquiry stage, involves the DIS being circulated by ISO to all of the member countries of ISO for voting and comment over a three-month period. This is the second voting stage. The member countries, in turn, are encouraged to make the DIS text available to the widest range of national stakeholders possible in order to obtain the national vote of each member body. The text is approved if two-thirds of the P-members of the committee under which the work item falls vote in favour and if not more than one-quarter of the total votes cast are negative. The fifth stage of development is the approval stage. This involves the final draft international standard being circulated to all ISO member bodies for a final two-month yes or no vote. The text is approved for the final stage, the publication stage, using the same criteria as for the enquiry stage. The final document is published by ISO as an official ISO international standard.

## 2.2 A consultation approach to standards development

The ISO standards development process has been structured in order to allow for, and ultimately encourage, the widest possible participation and consultation of experts and stakeholders involved with the subject at

hand. From the starting point, an international working group is comprised of individuals with expertise on the subject, who each represent their own expertise. This is meant to encourage unfettered input of technical content as a starting point for the standard.

The successive review and commenting stages are also structured to encourage a progressively widening consultation process. The broadest of these stages is at the enquiry stage, when the ISO document under development is made available to all member bodies of ISO. ISO is made up of 119 member countries that have the ability to vote on ISO standards. This means that 119 countries will ultimately be given access to the standard and encouraged to seek the input of stakeholders in these countries to inform their national position. The map in Figure 2 shows ISO member groups in green and illustrates the wide scope of countries involved.



**Figure 1 ISO member countries (full member countries represented by green)**

Another mechanism that further encourages consultation during the development of ISO standards is the possibility for liaisons between committees and between organisations and the committee at hand. Such liaisons provide a number of privileges and opportunities to those in liaison, including the ability to observe, to contribute technical content during meetings, and to make comments on drafts. Liaisons can also be established at the working group level; these involve organisations that make a technical contribution to and participate actively in the work of a working group.

### **2.3 A consensus-based approach to standards development**

International standards developed through ISO are developed following a consensus-based approach, whereby consensus amongst member countries is sought at multiple stages. This process of consensus building helps ensure unbiased content and technical integrity of the standard being developed.

Consensus building starts at the very beginning of the ISO standards development process, where new work items being proposed will only pass if a majority of the voting countries of the particular committee approves the work item. At the working group level, consensus building is focused on developing the technical content of the work item and does not involve voting; during the committee stages of review, consensus is sought through reviewing, commenting, and voting on the document. This occurs at up to three distinct stages, namely, at the committee, enquiry, and approval stages, as discussed above.

**Table 1 ISO committees of relevance to the mining sector**

<b>ISO technical committee</b>	<b>Scope of committee</b>
ISO/TC 82 (Mining)	Standardisation of specifications relating to specialised mining machinery and equipment used in open-pit mines (e.g., conveyors, high-wall equipment, rock drill rigs, and continuous surface mining equipment) and all underground mining machinery and equipment for the extraction of solid mineral substances, but excluding the preparation and processing of the minerals; recommended practice in the presentation of plans and drawings used in mine surveying; methods of calculation of mineral reserves; mine reclamation management; and design of structures for the mining industry
ISO/TC 127 (Earth-moving machinery)	Standardisation of nomenclature, equipment use classification, ratings, technical requirements, and test methods; safety requirements, operation, and maintenance manual format for earth-moving and related machinery
ISO/TC 147 (Water quality)	Standardisation in the field of water quality, including definition of terms, sampling of waters, measurement, and reporting of water characteristics
ISO/TC 207 (Environmental management)	Standardisation in the field of environmental management systems and tools in support of sustainable development
ISO/TC 282 (Water re-use)	Standardisation of water re-use of any kind and for any purpose: this covers centralised and decentralised or on-site water re-uses, direct and indirect water uses, intentional and unintentional water uses, and technical, economic, environmental, and societal aspects of water re-use. Water re-use comprises a sequence of the stages and operations involved in uptake, conveyance, processing, storage, distribution, consumption, drainage, and other handling of wastewater, including water re-use in repeated, cascaded and recycled ways.
ISO/TC 262 (Risk management)	Standardisation in the field of risk management
ISO/PC 283 (Occupational health and safety management systems)	Development of a standard on occupational health and safety management systems: "Requirements with guidance for use"

## 2.4 Use of international standards in the mining sector

There are a number of broad uses of standards in the mining sector. Beyond the general objectives of helping to mainstream best practices that help improve the safety and performance of operations, promote the safe use of equipment, or improve the sustainability of mining itself, standards can be referenced in regulations or can help mining companies demonstrate that they have met certain performance and operational criteria.

Although regulations usually stipulate what is required from a mine, they do not necessarily provide guidance on how these requirements can be achieved. The development and implementation of international standards therefore can assist mines to meet the requirements of such regulations as they provide key guidance on the actions that should be undertaken. Regulations may also directly reference standards in terms to help establish performance requirements (i.e., regulation by reference).

Another key use of international standards in the mining sector and by industry generally, is that these can allow companies and practitioners to demonstrate conformance to the requirements set forth in international standards. Prime examples include the use of the ISO 9000 family of standards, which sets forth

requirements for various aspects of quality management. This in turn can benefit companies through marketing and improved public credibility.

There are two ISO technical committees (TC) focused specifically on mining — ISO/TC 82 (Mining) and ISO/TC 127 (Earth-moving machinery) — while there are many others developing complementary standards often used within the mining sector. This latter group includes committees focused on topics such as water quality (ISO/TC 147), environmental management (ISO/TC 207), and water re-use (ISO/TC 282); other TCs are involved with developing standards for mining-related operations such as risk management (ISO/TC 262) or occupational health and safety (ISO/PC 283). The scopes of these various committees are provided in Table 1.

### **3 Standards for mine reclamation management**

#### **3.1 Need for mine reclamation standards**

Mining is a sector that has long faced heightened public scrutiny and attention from both local communities and other industry observers and stakeholders in terms of its overall lifecycle environmental impact (Jenkins and Yakovleva, 2006). This is especially true when considering the potential impacts of mining on immediate and surrounding environments. Due to the requirements for extraction; the use of heavy equipment, chemicals and other inputs during production and processing; and the large amount of disturbance to land, mining can and often is viewed to have a potentially large environmental impact that can extend far beyond the immediate surface disturbance and involve significant financial liability for the host country.

Over the last several decades, the topic of mine reclamation has therefore become increasingly intertwined with the sustainability of mining itself. Here, it is important to emphasise that mine reclamation involves planning and actions to reclaim the mining site and reduce its environmental impacts across the entire lifecycle of the mine, from mine inception through its operational phase, as well as at mine closure and decommissioning. As an activity, mine reclamation has emerged as a critical component of a project not only for minimising the impacts of mining on the environment and protecting the environmental services local communities often depend upon, but also for helping mining companies secure the social license they need to operate (Slocombe, 2012).

Many different jurisdictions have now also made mine reclamation planning a key component in the approval of new mines or the expansion of existing mines (Otto, 2010). This is especially the case across many of the more developed economies of the world, although in lesser developed regions there are often lower environmental requirements and safeguards in place (Cao, 2007; Dearden, 1998). Nonetheless, with the advance of social networking, the rise of green consumerism, and ever increasing attention being placed on the mining sector, companies operating throughout the world face a heightened impetus to manage the environmental impacts of their operations even if they are not facing regulatory requirements (Jenkins and Yakovleva, 2006).

There are significant jurisdictional differences in terms of both the requirements for mine reclamation and what is included and practiced, and there is a need for consistency regarding how mine reclamation is planned and carried out. This is especially the case given that the mining sector is global in nature and many of the players involved with mineral and metal extraction and processing are vast corporate structures with operations in many different resource extraction regions around the world. This is the impetus behind developing mine reclamation standards.

#### **3.2 Existing best practices for mine reclamation**

There are a wide range of existing documents relevant to mine reclamation that will likely inform or, in some cases, form the basis for the international mine reclamation standards being developed. While some of these are international in scope, many are jurisdictionally specific, reflecting both the geographical realities of mining and also the different environmental and social public policy priorities of various regions.

The Planning for Integrated Mine Closure: Toolkit published by the International Council on Mining and Metals (International Council on Mining and Metals, 2008) is an example of a more generic document that is internationally applicable. The document is intended to promote a more disciplined approach to integrated closure and reclamation planning and to increase the uniformity of good practices across the mining sector. Thirteen tools provide practitioners with work processes, examples and contexts within which to apply the closure and reclamation planning discipline, ranging from stakeholder engagement to biodiversity management. Each tool provides key references for the user so that they can refer to existing best practices and provides general guidance on each topic area.

There are also many documents that are more specific to certain jurisdictional regions. In Canada, for example, with mining regulated provincially or territorially, many Canadian provinces and territories have developed guidance specific to their particular region. Examples include the Guide for Surface Coal Mine Reclamation Plans (Nova Scotia Environment, 2009) produced by the Government of Nova Scotia. As inferred by its title, this document is focused on surface coal mines, reflecting the historical importance of coal mining in that region. However, the document also contains valuable and useful information for mine reclamation more broadly, including, for example, principles of reclamation, landscape design, revegetation, etc. Another example from a different jurisdiction is the British Columbia Reclamation and Closure Code (contained within the Health, Safety and Reclamation Code for Mines in British Columbia) (British Columbia Ministry of Energy, Mines and Petroleum Resources, 2008). Again, although this is specific to British Columbia, it does contain a wide range of relevant information. Then there is the Mackenzie Valley Land and Water Board's document on mining and reclamation produced specifically for Canada's Northwest Territories (Mackenzie Valley Land and Water Board, 2013). Like the other documents highlighted, it is regional in nature but provides relevant information that can be more widely applied.

Another important issue that affects successful mine closure is the management of mine wastes to prevent metal leaching and acid mine drainage. There are several guidelines available, including the Global Acid Rock Drainage (GARD) Guide (International Network for Acid Prevention, 2012), and the Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (Price and Errington, 1998).

## **4 Mine reclamation management standards development program**

### **4.1 Scope of mine reclamation management standards program**

The scope of the mine reclamation management standards development is set forth as follows:

*Standardization of mine reclamation management to minimise mine hazards that occur during the lifecycle of resource development, such as during exploration, exploitation, suspension of operation, mine closure (restoration), and follow-up management.*

*However, it is expected that safety and health issues related to mining activity will be excluded from this context.*

*Mine closure planning shall be re-established at every stage for sustainable resource development and risk management. (International Organization for Standardization, 2013)*

The standardisation program therefore focuses on the environmental aspects of mine reclamation while also taking a lifecycle approach in terms of the framework being followed for the standards development program.

### **4.2 Countries involved**

There are currently nine participating (voting) member countries involved with ISO TC 82/SC 7 and six countries that are observing the process. These are listed in Table 2.

**Table 2 Countries participating in and observing ISO TC 82/SC 7 Mine reclamation management**

Participating countries (9)	Observing countries (6)
Australia	Czech Republic
Canada	Finland
Chile	Russian Federation
China	Sweden
France	United Kingdom
Germany	Zambia
Iran, Islamic Republic of	
Korea, Republic of	
South Africa	

It should also be noted that communication with the U.S. Technical Advisory Group (the equivalent of the Canadian Standards Mirror Committee) to ISO TC 82/SC 7 has indicated that the United States plans to submit an application to become a participating member on the mine reclamation management subcommittee.

**Table 3 Preliminary work items – mine reclamation standards program**

Potential title of preliminary work item	Potential scope	Proposing country and international leadership
Mine reclamation planning	This work item and subsequent standard will provide requirements and recommendations for the purposes of mine reclamation planning. This will cover the main decision points and procedures that must be considered in planning for mine reclamation. The objective is to help ensure consistency and completeness in terms of the mine reclamation planning process.	Proposing country: Canada Proposed work item leader: Professor Dirk van Zyl, University of British Columbia
Mine reclamation management – terminology	This document will help to maintain the required consistency of vocabularies within a group of standard documents in SC 7 (mine reclamation) and other related technical committees.	Proposing country: South Korea Proposed work item leader: Dr. Sang-il Hwang, Korean Agency for Technology and Standards
Guidance on survey of mine drainage in abandoned mines	Target process: survey and analysis Target area: abandoned mine area Sampling targets: adit water, drainage from open pit, leachate from mine tailings and waste rock, background water Additional item: collection of information required for the plan of water treatment facilities	Proposing country: South Korea Proposed work item leader: Mr. Sunbaek Bang, Mine Reclamation Corp.

### 4.3 Existing and future work items

With the mine reclamation standards program still in its infancy at the time of writing, there are not yet any official work items registered as part of the program. However, three work items are at the preliminary



proposal stage, where efforts are underway to put forward proposed new work items for review, comment, and ultimately voting for their passage into the international standards development process. These preliminary work items are presented in Table 3.

Additional work items can and will most certainly be proposed and added to the SC 7 standards program over time.

#### **4.4 Canadian involvement, representation and expertise**

Canada is not only putting forward the mine reclamation management planning standard as a new international work item (discussed in detail in Section 5), but it is also putting forth some of Canada's leading thinkers and practitioners involved with mine reclamation planning and practices to provide input and contributions to the entire mine reclamation management standards development program. Canada's involvement includes both contributions to the overall ISO mine reclamation management standards development program and also the possible adoption or adaptation of any of the resulting standards into Canada as National Standards of Canada.

The Canadian Standards Association has also established a Canadian standards mirror committee that parallels the ISO activities on mine reclamation. This committee has two overarching purposes: First, by bringing together Canadian experts and stakeholders involved with mine reclamation, this effort will help to ensure both that Canadian experts have the ability and opportunity to provide input into the international standards being developed through ISO/TC 82/SC 7 and also that Canada's national position is informed with respect to any decisions Canada puts forward. Second, the committee has the mandate and ability to adopt or adapt any of these standards into Canada as National Standards of Canada. This specific ability to adopt international standards into Canada comes about because the committee is officially recognised by the Standards Council of Canada (SCC), Canada's national regulator of the standards development landscape in Canada and Canada's national member body to ISO.

One of the basic requirements of any harmonised mirror committee is that it must be balanced in terms of representation across interest categories, i.e., the different groups that have varying interests on the topic. For the mine reclamation management committee, this includes five different interest categories: mine operators, government/regulatory authorities, mine service providers, equipment suppliers, and a general interest category that includes such groups as academic researchers and professionals. The rules of SCC are that no one interest category can outweigh the two smallest in terms of actual voting members. The Canadian harmonised standards mirror committee on mine reclamation is therefore populated by a cross-spectrum of participants from varying interest groups and stakeholders.

It is important to emphasise the depth of expertise and experience in terms of the membership base of the Canadian harmonised mirror committee. At the time of writing, the committee has about 45 members: representatives from some of Canada's leading mine companies, government, regulatory authorities from both the federal and key provincial governments, and mining service providers, and some of Canada's leading academic researchers involved with different aspects of mine reclamation. This includes, for example, members from industry who are directors of mine reclamation within their respective organisations; government regulators (current and recently retired), often with decades of direct experience with mine reclamation in Canada and internationally; many leading providers of mine reclamation-related consultancy services; and leading academic researchers who are internationally recognised for their expertise on different aspects of the topic. The committee also includes leaders from associations, such as the Mining Association of Canada, that represent both the mining industry in Canada and also stakeholders involved with land reclamation.

As a result of the breadth and depth of this membership, the mirror committee's intention is to put Canada's leadership, experience, and high requirements forward as the basis of this international standards development program.

## **5 The mine reclamation management work item**

### **5.1 Need and purpose**

The mine reclamation management planning project is important to the Canadian and global mining industry as it will provide a crucial overarching document that will guide users and guide the use and/or development of related standards for mine reclamation processes. The project will have direct benefits for Canadian industry and governments, as it will set forth important requirements and recommendations that can be referenced in regulations while also helping to save both money and time through the sharing of best practices for operations, use of technologies and equipment, design and construction, etc.

This will also improve the competitiveness of Canadian industry in a highly globalised industry by helping ensure that our high requirements and standards are being implemented in other jurisdictions. The mine reclamation management planning standard will also help industry secure the social license needed to undertake mining operations and activities.

It is important that Canada takes leadership of this specific standard, since this will help ensure that Canada sets the direction of the subcommittee, in turn helping to prevent unintended difficulties that may arise from impractical members. Canada also needs to take a leadership role to ensure that mining is undertaken in a sustainable manner in Canada and globally, recognising that Canada is a leader not only in mining, but also specifically in mine reclamation management.

### **5.2 Scope of standard**

This work item and subsequent standard will provide requirements and recommendations for the purposes of mine reclamation management planning. This will cover the main decision points and procedures that must be considered in planning for mine reclamation. The objective is to help ensure consistency and completeness in terms of the mine reclamation planning process. This includes the following issues and activities:

- Approach to reclamation
- Reclamation objectives
- Reclamation technologies
- Reclamation activities
- Post-reclamation maintenance and monitoring
- Financial provisions
- Mine reclamation plan

### **5.3 International leadership**

Since Canada is proposing the work item on mine reclamation management planning, it has responsibility to name an international convenor who will work to lead the associated international working group. For this, Canada has put forward Dr. Dirk van Zyl from the Norman B. Keevil Institute of Mining Engineering at the University of British Columbia. Professor van Zyl has more than 30 years of experience in research, teaching and consulting in tailings and mined earth structures. During that period, he was a faculty member for 13 years at four universities in the United States and Canada. For the last 10 years, much of his attention has been focused on mining and sustainable development. He has been involved internationally in many mining projects. These projects covered the whole mining lifecycle, from exploration to closure and post-closure, in a large range of climatic and geographic environments. His present research is in the area of the contributions that mining makes to sustainable development and the application of lifecycle assessment to mined earth structures.

## 6 Summary

This article has presented and discussed a new international standards development on mine reclamation management, with a focus on a new work item around mine reclamation management planning.

In order to provide context for readers, this paper first describes the general process of developing international standards. Two key aspects define this process: it follows a staged approach where, functionally and operationally, the widest engagement of stakeholders and experts involved with a subject is sought; and it is based upon a consensus-building process. The paper has also presented other ISO standards programs directly or indirectly focused on the mining sector, showcasing the many different international standards that already have been developed for use by the mining sector.

The need and purpose for an international standards program focused on mine reclamation has also been discussed. Key aspects include the use of standards to help improve the environmental performance of mines across their lives and to help mine operators gain a social license to operate. We then described the actual work program now underway through ISO to develop standards on mine reclamation and the important role that Canada is playing in this process.

One of the most significant ways Canada is contributing and taking leadership is by proposing a new work item on mine reclamation planning. This new work item is intended not only to provide basic requirements and recommendations for planning mine reclamation across the lifecycle of the mine, but also to provide a crucial framework for standards focused on focal points of mine reclamation.

## Acknowledgements

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