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Mine closure and reclamation planning —

Part 1: Requirements

Planification de la fermeture et de la restauration des mines —

Partie 1: Exigences

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents shall be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 82, *Mining*, Subcommittee SC 7, *Mine closure and reclamation management*.

A list of all parts in the ISO 21795 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides requirements and recommendations for mine closure and reclamation planning applicable to both new and operating mines. The overarching objective is to promote consistency and quality in planning for mine closure and reclamation internationally. ISO 21795-2 provides guidance for implementation of this document.

The intended audience are those with responsibility for, or an interest in, planning for mine closure and reclamation. This includes mine planners and designers, mine operators, regulators, environmental assessors, communities, indigenous peoples, and financial stakeholders, amongst others.

Mine planning, design and operations must be fully integrated with the closure and reclamation process. Early, continual and comprehensive mine closure and reclamation planning is essential for all new and operating mines because it:

— leads to the highest degree of environmental and social success, usually at a lower cost than if mine closure and reclamation planning is not done from the beginning of the mining project;

— reduces risks and liabilities throughout the mine's operational life and on closure;

— allows for stakeholder involvement throughout, so that relevant knowledge and understanding are brought into the planning process;

— allows for devoting more attention to sustainable development activities identifying socio-economic opportunities for the various closure phases;

— helps build trust with governments, stakeholders and international communities;

— provides additional planning time to understand the complexity of the biophysical characteristics and socio-economic context of each mine site;

— provides for continual improvement and updating of closure and reclamation plans;

— allows companies to better integrate closure and reclamation activities with operations;

— provides time to identify, research and develop new technologies for mine closure strategies and mine closure treatments that increase robustness and resilience of mine closure and reclamation; and

— allows companies to better provision for and schedule closure and reclamation funding.

There are many leading practices and guidance documents related to mine closure and reclamation planning available in various jurisdictions and used by many mining companies and stakeholders. This document captures the intent of such guidance documents so that it can be applied globally.

Mine closure and reclamation planning —

Part 1:
Requirements

1 Scope

This document specifies a framework and the processes involved in mine closure and reclamation planning for new and operating mines. Requirements and recommendations are provided on:

— mine closure and reclamation plan objectives and commitments;

— technical procedures and techniques;

— mitigation of socio-economic impacts;

— financial assurance and associated planning;

— mine closure and reclamation planning for unplanned closure;

— post-closure management plan; and

— mine closure and reclamation plan documentation.

The following aspects of mine closure and reclamation are not addressed in this document:

— infrastructure such as rail lines, ports, off-site ore loaders, power stations, etc. that are associated with the mine operation, but which are not located at the mine site;

— detailed survey, testing or monitoring methods, detailed engineering procedures, detailed product requirements, or detailed construction and operational procedures; occupational health and safety management related to closure and reclamation, construction and exploration activities;

— relinquishment of a closed and reclaimed mine site, or portions thereof, to a party (governmental or private entity) not related to the mine operator;

— specific requirements for dealing with the radiological aspects of mine closure and reclamation, such as those that occur at uranium mining and processing facilities and other mines at which naturally occurring radioactive materials are present; however, the other aspects associated with closure and reclamation of these mines are included in this document; and

— closure and reclamation of abandoned mines.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20305, *Mine closure and reclamation — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20305 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Mine closure and reclamation planning framework

Mine closure and reclamation planning is required for all areas affected or potentially affected by the mining infrastructure and operations. The potentially affected areas include those on which the mine facilities are located, and adjacent areas that can potentially be impacted by surface water, groundwater and air quality from the mining facilities. In some cases, the potentially affected areas can be located across an international border in another country. The affected and potentially affected areas should be clearly defined in the closure and reclamation plan.

Six framework elements, shown in Figure 1 and detailed in Clause 5, form the foundation for establishing and maintaining effective mine closure and reclamation planning. This framework applies through the mine closure and reclamation planning and implementation process, from initial mine planning through to long-term post-closure. Details are provided on the processes, activities and steps necessary to implement the framework in Clause 6.

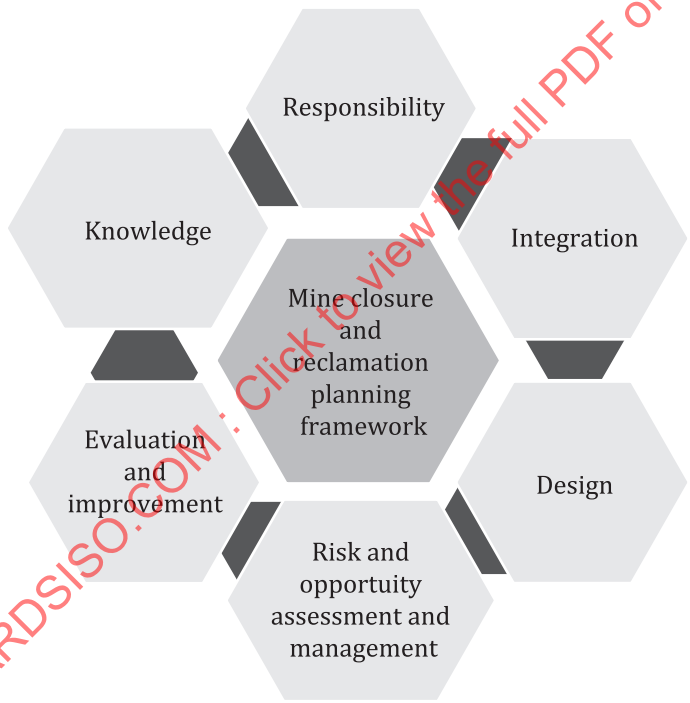

Figure 1 — Mine closure and reclamation planning framework

Each framework element is further explained below.

Responsibility — company responsibility (see 5.1.1), including stakeholder engagement (see 5.1.2), is inherent to the entire mine closure and reclamation planning process. Local jurisdictional requirements can exist (see 5.1.3). Financial management and provisioning for closure (see 5.1.4) is critical to responsibility.

Integration — mine closure and reclamation planning is an integral part of the mining life cycle, including with respect to physical and chemical controls for sustainable land and water use (see 5.2.1). Mine closure and reclamation treatments are required to be resilient (see 5.2.2 and 5.2.3), considering socio-economic considerations in the transition to closure (see 5.2.4). Engagement with stakeholders on mine closure and reclamation (see 5.1.2) is also a critical element.

Design — it is developed in the context of meeting closure and rehabilitation objectives, which in turn are developed in consultation with stakeholders (see 5.3.1 and 5.1.2). Robust lifecycle design and management should reflect this, so as to facilitate successful mine closure and reclamation (see 5.3.3).

Risk and opportunity assessment and management — it is the process to assess and manage mine closure and reclamation risks, and to identify and act on opportunities throughout the life of the mine (see 5.4).

Evaluation and improvement — quality assurance provides the maintenance of the mine closure and reclamation planning standard at the corporate and operational level (see 5.5.1), while the process of adaptive management facilitates continuous improvement through the life of the mine (see 5.5.2).

Knowledge — identifying uncertainty through knowledge gaps, building knowledge, managing, disseminating and retaining knowledge and data that support mine closure and reclamation planning throughout the life of the mine and beyond (see 5.6).

5 Framework elements for mine closure and reclamation planning

5.1 Responsibility

5.1.1 Mine operator responsibility

Mine closure and reclamation are mine operator responsibilities, and the associated planning shall be incorporated in mine operator policies and procedures and be endorsed by mine operator executives with enough authority to allocate the necessary financial and human resources. Mine operators shall demonstrate that they have internal policies, procedures and standards to conduct mine closure and reclamation planning and that these are embedded within organizational systems.

The respective roles and responsibilities for mine closure and reclamation for any given mine site shall be established and clearly documented in relevant corporate and operating policies, plans and procedures. Individuals responsible for mine closure and reclamation planning shall have the necessary competencies, including education, training and experience to understand regulatory and other requirements.

5.1.2 Stakeholder engagement

Stakeholders shall be engaged at all stages of the life-of-mine planning process. Outcomes of engagement shall be addressed in mine closure and reclamation plans and in their implementation. Stakeholders shall be identified early and updated progressively and include, the mine operator, rights holders, downstream communities, regulators, non-government organizations, investors, community groups, as well as future land and water users.

5.1.3 Regulations

Mine closure and reclamation planning and design can be covered in local, national and regional regulations.

5.1.4 Financial plan

The mine operator shall develop a financial plan that details what the financial provisions are for each stage of the life of the mine, including provisions for unplanned closure and post-closure requirements. These shall include provisions for the necessary cash flow needed to fulfil the commitments of the mine closure and reclamation plan.

5.2 Integration

5.2.1 Physical and chemical control for sustainable land and water use

Mine closure and reclamation planning and design shall meet established objectives and commitments (as described in 5.3.1), leave the mine site in a stable and safe condition and provide for ongoing post-mining land use. Mine features shall not release chemicals into the air, water or surrounding soils that result in unacceptable impacts to human health or the environment as determined by site-specific risk assessments.

To meet these requirements, the mine operator shall establish measurable mine closure and reclamation completion criteria that shall be used to determine when mine closure and reclamation objectives have been met. The mine operator also shall provide for monitoring of the success of mine closure and reclamation activities.

5.2.2 Mine closure and reclamation treatment resilience

Mine closure and reclamation treatments shall be resilient so that they can respond to changes and risks in a dynamic environment. The treatments shall provide for meeting the closure and reclamation objectives prior to, during, or following changes and disturbances, so that these objectives are met and sustained under both expected and unexpected conditions.

Mine closure, reclamation planning and design shall provide sufficient resilience to reduce the risk of catastrophic and/or chronic failure and to enhance the potential for post-closure facilities and landforms to adapt to changed conditions as necessary to still meet the design intent following damaging natural events with minimal active management. The mine closure and reclamation plan shall also demonstrate that post-closure facilities and landforms have been designed for closure in a manner sufficiently resilient to cope with the effects of climate change.

5.2.3 Long-term post-closure and reclamation

The post-closure phase shall provide for adaptive management, and for ongoing environmental protection until completion criteria and post mining land-use requirements are met, and shall include site management that provides necessary monitoring, inspections, reporting, maintenance, and repairs, as well as regular certifications of the integrity of mine waste containment structures. Secure long-term funding shall be available to support these activities.

The mine closure and reclamation plan shall consider options for potential access controls to protect human health and safety and the integrity of the post-closure environment and post mining landforms. Access controls can include physical controls that are compatible with the land-use objectives and/or legal land-use restrictions or covenants on the property.

5.2.4 Social transition to closure

Stakeholder engagement and communication is integral to developing plans for social transition, through all the process of the project. Planning for social transition shall include provisions both for social transition costs, such as ongoing consultation and engagement, workforce adaption and community financial preparedness, and for potential social investment projects that will support communities when mining ends and there is a transition to a post-closure land use.

5.3 Design

5.3.1 Mine closure and reclamation objectives and commitments

Mine closure and reclamation objectives and commitments shall be established as a basis for mine closure and reclamation planning. With equal priorities, these objectives shall include the management of human health and environmental risks, providing for the sustainability of the mine closure and reclamation works and resulting land use, and reducing long-term maintenance requirements and

liabilities. The objectives shall also consider the results of stakeholder engagement, that regulations can apply, and the mine operators' requirements.

Objectives and commitments shall also address socio-economic and cultural aspects of mine closure and reclamation. This shall include managing the transition of the workforce and communities through to and beyond closure. It shall also consider future post-closure opportunities provided by the closed and reclaimed site for the local communities and indigenous peoples where relevant.

Objectives shall establish goals and standards to be achieved, while commitments shall include specific actions that the mine operator agrees to undertake.

5.3.2 Timely mine closure and reclamation planning

For new mines, mine closure and reclamation planning, including the associated post-mining land-use planning, shall commence with the initial mine development planning, be included in the environmental and socio-economic assessment and permitting of the mining project, and be continually refined and updated thereafter as necessary. For operating mines, mine closure and reclamation planning and execution shall be undertaken as soon as possible in accordance with the requirements in this document. Stakeholder engagement shall be undertaken to share knowledge and reach agreement on mine closure and reclamation objectives, post-mining land use and timing of the works.

5.3.3 Mine design and operation for mine closure and reclamation

Mine planning, design and operations shall be fully integrated with the closure and reclamation process, and shall consider the closure and reclamation requirements and the post-closure land use. Scheduling of progressive closure and reclamation shall be included for mine features and domains such as tailings and waste rock management, mine pits, underground workings, heap leach management facilities, processing facilities, water management infrastructure, and all forms of supporting and service infrastructure to optimise mine closure and reclamation outcomes. The elements of mine closure planning and design shall be developed and matured in accordance with industry practice for capital project development and associated progressive mine closure and reclamation schedules.

5.4 Risk and opportunity assessment and management

Risks of failure of the mine closure and reclamation plan elements and risks to achieving the post-closure and reclamation objectives shall be assessed and managed by implementing appropriate risk management plans. These risks include those to human health and safety, the environment and communities. The residual risks remaining after risk management is implemented shall also be identified. These risk management plans shall be regularly updated during the operating phase of the mine, so they reflect current knowledge and stakeholder expectations.

Mine closure and reclamation opportunities shall be identified and managed throughout the lifecycle of the mine and shall be included in the mine closure and reclamation plan.

5.5 Evaluation and improvement

5.5.1 Quality assurance

Quality assurance shall be used by the mine operator to maintain a high standard of planning, design and construction of mine closure and reclamation.

Quality assurance shall be provided by competent and qualified professionals. It shall include, as a minimum, the peer review of the mine closure and reclamation plan, the design during its various stages of development, and inspections and certifications of the integrity of post-closure facilities and post mining landforms that are to remain in place. The mine operator shall have policies in place that require quality assurance be performed based on a quality assurance plan that is part of the mine closure and reclamation plan implementation.

The ISO 9000 family of standards are focused on quality management and can help establish effective and efficient quality management systems.

5.5.2 Adaptive management

Adaptive management shall be used where necessary to facilitate the implementation of additional mine closure and reclamation treatments. Adaptive management shall not be used as a tool to reduce the integrity of closure designs. Rather, these are measures that allow for adjusting designs and construction methods that are demonstrated to not meet the mine closure and reclamation objectives. It provides for a management system which includes implementing mine closure and reclamation treatments, monitoring the performance of these, making necessary changes or retrofits, and capturing the lessons learned to revise designs or operating procedures for future application.

Where necessary, adaptive management shall be applied both during the progressive mine closure and reclamation and after mine closure and reclamation implementation. Adaptive management shall also address the application of new knowledge which may come from a variety of sources including stakeholder engagement.

5.6 Knowledge and data management

Companies shall have systems and processes that effectively gather, retain and make available knowledge and data necessary for the effective operation of mine closure and reclamation planning.

Assumptions for mine closure and reclamation shall initially be conservative in design and in closure planning, as it is acknowledged assumptions are initially broad due to a lack of knowledge and information during the initial pre-closure period.

As a mine matures, these broad assumptions shall be tested and replaced with more precise design level processes, such as conceptual, prefeasibility, feasibility and detailed; the adaptive management process is key to that activity. Improved knowledge reducing uncertainty, closure risk and a reduction of and knowledge gaps is required.

Companies shall plan for handover of mine closure and reclamation knowledge for subsequent owners and for society, as a whole. Ownership of knowledge shall be respected, particularly where the knowledge of indigenous peoples is incorporated into planning.

The compilation of knowledge and data, making that available and using that knowledge effectively, while retaining that knowledge for society, as a whole, is a core component of mine closure and reclamation.

6 Mine closure and reclamation planning activities

6.1 General

The mine closure and reclamation planning activities specified in 6.2 to 6.8 are aimed at developing cost-effective mine closure and reclamation plans and designs that can be implemented, which address the requirements and concerns of affected stakeholders, especially indigenous peoples, where relevant.

The outcome of closure planning shall be a documented mine closure plan to provide a record and to show continuity of implementation. It shall be endorsed by the mine operator's senior management. Since conditions and circumstances change over time, these plans shall be updated as necessary.

Mine closure and reclamation planning shall include the following:

— determination of the objectives and commitments to mine closure and reclamation (see 6.2);

— specification of technical requirements to demonstrate effective mine closure and reclamation planning (see 6.3);

— specification of socio-economic requirements for mine closure and reclamation (see 6.4);

— establishment of a funding plan for mine closure and reclamation (see 6.5);

— mine closure and reclamation planning for unplanned closure (see 6.6);

— development of an effective long-term post-closure management plan (see 6.7); and

— documentation of mine closure and reclamation plans (see 6.8).

6.2 Mine closure and reclamation plan objectives and commitments

Mine closure and reclamation planning shall be based on a closure vision, mine closure and reclamation objectives, and closure commitments. Regulatory requirements and stakeholder inputs are also drivers.

Stakeholder engagement shall be planned and shall take place throughout the life-of-mine. There are several requirements pertaining to stakeholder engagement, including:

— a stakeholder engagement plan shall be developed for mine closure and reclamation planning activities;

— special rights holders, including indigenous peoples, shall be identified during the stakeholder identification process;

— the engagement approach shall be determined for identified individuals or groups of stakeholders, and shall be sensitive to the cultural and socio-economic context;

— processes shall be in place to receive, understand and effectively respond to stakeholder inputs, concerns and comments related to mine closure and reclamation; and

— all stakeholder engagement processes and outcomes shall be documented.

Mine closure and reclamation objectives shall be developed by considering the following:

— regulatory requirements;

— mine operator standards, policies and guidelines;

— mine operator commitments to regulatory bodies and stakeholders;

— long-term physical and chemical control of post-closure facilities and post mining landforms and disturbed areas;

— human and ecological receptors potentially at risk;

— post mining land use;

— stakeholder needs and expectations;

— leading international practices for projects in similar climates, with similar physical and chemical conditions and environmental settings, and similar socio-economic settings;

— mine operator financial resources;

— legal and technical practicalities; and

— climate change.

The objectives for the mine closure and reclamation plan shall inform mine closure and reclamation planning and design and shall have measurable completion criteria.

Commitments regarding mine closure and reclamation that the mine operator makes to stakeholders, including regulatory agencies or other parties, shall be documented and shall be included in the mine closure and reclamation planning process.

6.3 Technical procedures and techniques

6.3.1 General

A mine closure and reclamation plan shall be developed to include the entire mine site, including key components such as mine pits, waste management, water, infrastructure, contaminated media (soil, surface water, groundwater and air), and socio-economic factors.

Mine closure and reclamation options that address the mine closure treatments, and which maximize opportunities, shall be identified and evaluated to select the preferred mine closure and reclamation option that on an overall basis best meets the objectives.

6.3.2 Mine site characterization

A site description shall be provided which includes the characteristics of the region within which the mine site is located. If mining has previously been carried out, it should be included in the description.

Site characterisation is an ongoing activity throughout the mine life. The information shall include the historic and current baseline of the mine site and adjacent region, and include biological, physical and chemical characteristics. It shall include a description of the area's climate, geology, geochemistry, soils, hydrogeology, surface water hydrology, the aquatic and terrestrial environment, current land use, and the socio-economic and cultural characteristics of relevant communities and indigenous peoples, and the workforce.

Mining and processing due to the nature of the activity will change a site characterization, changing the current and expected residual impacts and risks that will exist at closure and post-closure. The nature of that change shall be assessed during concurrent risk assessments, utilising the advancing knowledge base specific to feature and facilities.

6.3.3 Physical and chemical stability

The following factors shall be considered in designing for physical stability:

— design life, which shall be of sufficient duration to provide for a sustainable post mining land use and be equal to, or exceed, the post-closure phase;

— extreme events (such as earthquakes, wind, fire, drought and floods), the magnitude and frequency of which shall be determined, and be managed according to the level of risk the event poses to the mine closure and reclamation of the site;

— anticipated impacts of climate change; and

— ongoing changes that are expected to occur such as weathering and degradation of construction materials, water and wind erosion, and other perpetual disruptive forces.

Post-closure facilities and post mining landforms for which physical stability is relevant include tailings storage facilities, waste rock management facilities, water storages, heap leach management facilities, mine pits, underground workings and surface water diversions.

At a minimum, the following factors shall be considered in designing for chemical control:

— minimize to the extent practical (including through segregation) the presence of potentially polluting chemicals in mine wastes;

— minimize chemical reactions (including acid generation) from occurring in mine wastes;

— minimize water infiltration through mine waste or wind dispersion of mine waste;

— collect and treat contaminants; and/or

— remove wastes that contain contaminants that can be released to soil, air, or water.

Key concerns for achieving chemical control include acid and metalliferous drainage, flushing of mill reagents, hydrocarbons and other leachable hazardous materials. Post-closure facilities and post mining landforms for which chemical control is relevant include tailings management, water storages, waste rock management facilities, heap leach management facilities, open pits and underground workings.

Active water treatment can be required. Requirements for post-closure active water treatment shall be avoided where possible. Adequate financial, managerial, and technical provisions shall be made to sustain long-term water treatment if required.

6.3.4 Contaminated media

Any contaminated materials, soils, surface water or groundwater shall be managed while planning for the health and safety of workers and for the protection of the environment. Contaminated media can include:

— residual or waste industrial products which were used in, or created by, the metallurgical process (e.g. cyanide contaminated materials or dross/slag);

— process reagents and other chemicals;

— surface and subsurface soils that have been contaminated by, for example, fuel and fuel oils, spilled chemicals or mine waste leachate;

— surface water and groundwater contaminated by, for example, fuel and chemical spills, mine waste leachate;

— process equipment and buildings containing and/or coated with chemicals, residual metalliferous dust, etc.; and

— fuel and petrochemicals.

These media shall be managed so that they do not pose an unacceptable threat/risk to human health and the environment. Treatments that shall be considered include the following.

1. For soils:
   — risk assessment to demonstrate the residual contaminants no longer pose an unacceptable risk to human health and the environment;
   — removal and disposal in a secure location or facility;
   — installation of a cover system with a sufficient depth of soil or other media;
   — natural attenuation; or
   — in-situ or ex-situ treatment.
2. For surface water and groundwater:
   — risk assessment to demonstrate the residual contaminants no longer pose an unacceptable risk to human health and the environment;
   — subsurface seepage barriers;
   — seepage interception, treatment and discharge;
   — surface water and groundwater extraction and treatment;
   — in-situ or in-plant treatment of surface water and groundwater; or
   — management plan that prevents future use of contaminated surface water and groundwater.

6.3.5 Infrastructure decommissioning and disposal

The decommissioning and disposal of processing facilities, infrastructure and equipment shall be planned and described within the mine closure and reclamation plan, and shall include:

— safety;

— deconstruction and demolition methods;

— re-sale/recycling/re-use studies, and;

— materials removal with disposal on-site and off-site or retained on site for future use with appropriate custodianship arrangements.

6.3.6 Post-closure land-use plan

A post-closure land-use plan shall be established and be included in the mine closure and reclamation plan. Key considerations shall include:

— pre-mining land use;

— post-closure land-use objectives;

— landform engineering evaluations;

— landowner agreements;

— indigenous peoples' agreements; and

— mine closure and reclamation site plan.

Regulatory requirements can also exist.

6.3.7 Closure and reclamation plan alternatives and opportunities analyses

An alternatives and opportunities assessment shall be conducted and include:

— identification of feasible alternatives that meet objectives and criteria;

— comparative analyses of alternatives, including considerations of opportunities provided by closure and reclamation;

— identification of risks for each alternative, including physical and chemical stability in the long-term; and

— identification of information gaps to be filled to reduce the risk of an alternative.

This process shall be revisited as additional information is provided or in the event of significant operational changes, or when mine waste or site conditions are significantly different from those used during the previous plan update.

All alternatives shall be considered and evaluated. Evaluation of identified alternatives shall include the following steps:

— identifying mine closure and reclamation objectives;

— identifying performance and alternatives evaluation criteria and parameters;

— considering potentially suitable technologies and general mine closure and reclamation treatments;

— conducting screening to eliminate the less effective technologies and treatments;

— using the remaining technologies and treatments to develop short lists of potentially feasible closure plans and designs for further evaluation;

— using multi-parameter decision analysis tools to select the preferred alternatives from the short lists;

— performing a risk and opportunity assessment on each preferred alternative to identify the residual and latent risks and opportunities associated with mine closure and reclamation; mitigating risks by implementing design changes and establishing risk management plans for those risks not addressed by the design changes; and

— developing plans to maximize achievement of the identified opportunities.

6.3.8 Reclamation

Reclamation shall be established over mine landforms and, as required, over disturbed areas that are demonstrated to be sufficiently stable in the long term, meet the mine closure and reclamation objectives, and closure criteria. Key elements of reclamation shall include:

— water management, vegetation, land use and mine landform requirements;

— required administrative controls needed to support the land use.

6.3.9 Progressive mine closure and reclamation

Progressive mine closure and reclamation allows for adaptive management, particularly of soil and vegetation covers and surface water drainage systems, as well as for improved end of mine life closure and reclamation cost estimates.

Progressive mine closure and reclamation planning shall take place during operations, where practicable. Progressive reclamation planning can include pilot scale testing to refine the mine closure and reclamation plan and closure criteria.

Information obtained during progressive mine closure and reclamation shall be used in the updates of the mine closure and reclamation plan and cost estimate.

Stakeholders, particularly local communities, are inherently interested in the process of progressive closure, reclamation and ultimately the social changes and impacts before and during the transition of mine areas and assets to post-closure land use. Regular communication and engagement of stakeholders shall occur to communicate progressive closure and reclamation activities in concert with social transition planning and engagement.

Progressive mine closure and reclamation can occur on parts of the mine site that are no longer required for the mine's operations. Such areas include completed segments or stages of mine rock, tailings and heap leach management facilities, water storage facilities, roads no longer required, surface facilities no longer used, and areas disturbed during the mine's construction.

6.3.10 Mine closure and reclamation schedule

A mine closure and reclamation schedule shall be prepared and included in the mine closure and reclamation plan. It shall provide for:

— time to perform the pre-closure activities such as detailed design, permitting and contractor procurements;

— progressive closure activities;

— duration of mine closure and reclamation activities;

— schedule for the adaptive management and post-closure phase activities, including monitoring; and

— the extent and timing of any planned stakeholder involvement in the mine closure and reclamation implementation process.

6.3.11 Mine closure and reclamation cost estimate

A cost estimate for mine closure and reclamation shall be included in the mine closure and reclamation plan.

Cost estimating shall be performed in accordance with internationally acceptable cost estimating standards. Regulatory requirements also can exist.

The closure cost estimates shall include, but are not limited to:

— detailed work breakdown structure;

— capital and operating costs;

— direct and indirect costs;

— contingencies appropriate to the level of design and certainty associated with site conditions;

— progressive reclamation;

— closure, demolition and decontamination;

— adaptive management phase activities;

— socio-economic transition activities; and

— long-term post-closure phase activities including monitoring.

6.3.12 Management of risks and opportunities

Risk assessments should follow the guidance given in ISO 31000. It shall be initially performed during the mine closure and reclamation planning and design process, and be updated through to the post-closure phase.

Risks and opportunities associated with mine closure and reclamation as it relates to workforce, financial, assets, legal and other obligations, operations and project management and execution shall be identified, and corresponding management plans aimed at minimizing risk and maximizing opportunities shall be established.

Risk assessments shall include both the risks that the mine closure and reclamation plans and designs do not meet the mine closure and reclamation objectives and regulatory requirements, as well as the risks of possible failures of each mine site component following closure.

Risks identified shall be managed and documented in the mine closure and reclamation plan.

Risks that exceed acceptable levels (as determined by stakeholder engagement, applicable regulations and by the mine operator) for mine closure and reclamation shall be identified and contingency or emergency response plans shall be developed to address those risks. The residual risks remaining after consideration of the contingency and emergency response plans shall also be identified.

Opportunities associated with mine closure and reclamation shall be considered, including those associated with enhancing the land-use potential and/or providing socio-economic benefits.

6.4 Mitigating socio-economic impacts

The cessation of mining activities often leads to a rapid decline in economic activity as a result of a decline in direct and indirect employment, as well as in local suppliers and services. This decline in economic activity can have negative consequences and the plan shall include measures to proactively manage, mitigate or remediate the potential impact.

Mine operators undertaking mine closure and reclamation planning shall develop strategies to mitigate the socio-economic impacts of mine closure. Mine operators shall develop plans for post-mining economic transition.

6.5 Financial planning and assurance

The mine operator shall provide a financial plan that demonstrates how sufficient funding will be made available to implement the mine closure and reclamation plan. Financial assurances or provisions can be required in local, national and regional regulations.

In establishing the financial plan, the mine operator shall provide the anticipated mine closure and reclamation costs to be incurred during operations, active closure, adaptive management, and long-term closure phases. The mine operator shall include the approach proposed to meet the cash flow requirements of the mine closure and reclamation activities through to the end of the long-term closure phase. The company shall use realistic escalation and discount rates that are consistent with the management requirements for the period of post-closure and that can be supported by recognized financial institutions.

The amount of funding needed shall be based on sound planning, engineering design and cost estimating, suitable contingency allowances, and local and site-specific cost structures. Applicable local jurisdictional requirements can exist.

6.6 Mine closure and reclamation planning for unplanned closure

Mine closure and reclamation plans shall include plans and contingencies for unplanned closure of the mining operation. Objectives for the suspension or cessation of operations shall be included in the plan, and as a minimum shall include:

— to protect human health and the environment;

— to maintain physical and chemical stability of the site; and

— to minimize socio-economic impacts.

Other objectives may be established during the stakeholder engagement process that can be addressed by the regulatory agencies.

Mine closure and reclamation plans for suspension or cessation of operations shall consider:

— decommissioning non-essential operations;

— continuing activities such as site security, water management;

— maintaining essential plant and equipment;

— environmental monitoring; and

— providing appropriate staffing.

Plans for unplanned closure shall consider:

— how the plan can be implemented earlier than expected;

— that adequate funding is available to complete the planned activities; and

— communication of these changes to stakeholders.