MVLWB/AANDC

Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories

November 2013

Mackenzie Valley Land and Water Board

Aboriginal Affairs and Northern Development Canada

Affaires autochtones et Développement du Nord Canada

Cover photo: Image on left shows Colomac Mine site circa 1999 at abandonment. Image on right shows same site in 2012 after completion of remediation work.

Photo courtesy of Aboriginal Affairs and Northern Development Canada

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Definitions, Acronyms, and Initialisms

TERM	DEFINITION
AANDC	Aboriginal Affairs and Northern Development Canada (formerly known as Indian and Northern Affairs Canada).
active layer	the layer of ground above the permafrost which thaws and freezes annually.
advanced mineral exploration	any appurtenant undertaking in which the proponent requires a type A or type B water licence in order to carry out the proposed activities.
ARD/ML	acid rock drainage/metal leaching. See page 48, subsection 3.2.1.
Boards	Land and Water Boards of the Mackenzie Valley, as mandated by the *Mackenzie Valley Resource Management Act.*
care and maintenance	the status of a mine when it undergoes a temporary closure.
closure goal	the guiding statement that provides the vision and purpose of reclamation. Attainment of the closure goal happens when the proponent has satisfied all closure objectives. By its nature, the closure goal is a broad, high-level statement and not directly measurable. The closure goal is: "To return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities". Proponents can add to this goal, provided the reclamation standard expressed in the goal is maintained or improved and should be discussed with stakeholder.
closure principles	The four core closure principles are 1) physical stability, 2) chemical stability, 3) no long-term active care requirements, and 4) future use (including aesthetics and values). The principles guide the selection of closure objectives.
closure objectives	statements that describe what the selected closure activities are aiming to achieve; they are guided by the closure principles. Closure objectives are typically specific to project components, are measurable and achievable, and allow for the development of closure criteria.
closure options	a set of proposed alternatives for closing and reclaiming each mine component. The closure options are evaluated to determine the selected closure activity, which must be approved by the Board.

closure criteria	standards that measure the success of selected closure activities in meeting closure objectives. Closure criteria may have a temporal component (e.g., a standard may need to be met for a pre-defined number of years). Closure criteria can be site-specific or adopted from territorial/federal or other standards and can be narrative statements or numerical values.
contaminant	1) any physical, chemical, biological or radiological substance in the air, soil, or water that has an adverse effect; and 2) any chemical substance with a concentration that exceeds background levels or which is not naturally occurring in the environment.
CRP	closure and reclamation plan.
engagement	the communication and outreach activities a proponent is required, by the Boards, to undertake with affected communities and Aboriginal organizations/governments prior to and during the operation of a project, including closure and reclamation phases.
GLWB	Gwich'in Land and Water Board.
GNWT	Government of the Northwest Territories.
inukshuk	a stone representation of a person, used as a milestone or directional marker by the Inuit of Canada.
land owner	has the administration and control or ownership of land where an advanced mineral exploration or mine project will occur. AANDC (on behalf of Her Majesty the Queen) administers and manages Crown land, while the Commissioner of the Northwest Territories administers and manages Commissioner's land. Designated Land Claim Organizations received ownership of lands pursuant to their respective Land Claims in the Northwest Territories.
land use permit	a land use permit required for an activity set out in sections 4 and 5 of the Mackenzie Valley Land Use Regulations, for an activity set out in the Territorial Land Use Regulations, or for a land use permit (type C) required by Tlicho law for use in Tlicho lands for which a type A or type B land use permit is not required.
leachate	water or other liquid that has washed (leached) from a solid material, such as a layer of soil or water; leachate may contain contaminants.

long-term active care	a post-closure mine site is in long-term active care when sustained monitoring and maintenance of active facilities is required (e.g., for more than 25 years). This should be avoided whenever possible.
MVLWB	Mackenzie Valley Land and Water Board.
MVLUR	Mackenzie Valley Land Use Regulations.
MVEIRB	Mackenzie Valley Environmental Impact Review Board.
MVRMA	*Mackenzie Valley Resource Management Act.*
passive long-term care	occasional monitoring, coupled with infrequent maintenance or repairs, that takes place following reclamation in the post closure phase of the mine site. Many mine sites require ongoing passive care, which can be an acceptable practice.
passive treatment	treatment technologies that can function with little or no maintenance over long periods of time (e.g., use of wetlands).
progressive reclamation	selected closure activities that can be taken at advanced mineral exploration and mine sites before permanent closure. Progressive reclamation takes advantage of cost and operating efficiencies by using the resources available from an operation to reduce the overall reclamation costs incurred. It enhances environmental protection and shortens the timeframe for achieving the closure objectives.
proponent	applicant for, or a holder of, a water licence and/or land use permit.
reclamation	the process of returning a disturbed site to its natural state or which prepares it for other productive uses that prevents or minimizes any adverse effects on the environment or threats to human health and safety.
reclamation research	literature reviews, laboratory or pilot-scale tests, engineering studies, and other methods of resolving uncertainties. Proponents conduct reclamation research to answer questions pertaining to environmental risks; the design of reclamation research plans aims to provide data and information which will reduce uncertainties for closure options, selected closure activities, and/or closure criteria.

remediation	the removal, reduction, or neutralization of substances, wastes, or hazardous material from a site in order to prevent or minimize any adverse effects on the environment and public safety now or in the future.
risk assessment	analysis of potential threats and options for mitigation for a given site, component, or condition. Risk assessments consider factors such as risk acceptability, public perception of risk, socio-economic impacts, benefits, and technical feasibility. It forms the basis for risk management.
security deposit	funds held by the Crown (Aboriginal Affairs and Northern Development Canada) or land owner that can be used in the case of abandonment of an undertaking to reclaim the site or carry out any ongoing measures that may remain to be taken after the abandonment of the undertaking.
selected closure activity	the closure and reclamation activity chosen from the closure options for each project component.
SLWB	Sahtu Land and Water Board.
stakeholders	industry, federal agencies, the territorial government, Aboriginal organizations/governments, land owners, affected communities, and other parties with an interest in a project.
tailings	material rejected from a mill after the recoverable valuable minerals have been extracted.
Traditional Knowledge	a cumulative, collective body of knowledge, experience, and values built up by a group of people through generations of living in close contact with nature. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual, and political change.
type A water licence	a water licence required as per Column IV of Schedules IV to VIII of the Northwest Territories Waters Regulations SOR/92/203.
type B water licence	a water licence required as per Column III of Schedules IV to VIII of the Northwest Territories Waters Regulations SOR/92/203.
waste rock	all unprocessed rock materials that a mining operation produces.
WLWB	Wek'èezhìi Land and Water Board.

Introduction

Guidelines for the Development of Closure and Reclamation Plans for Advanced Mineral Exploration and Mine Sites in the Northwest Territories (hereinafter referred to as the Guidelines) is provided by Aboriginal Affairs and Northern Development Canada (AANDC) and the Land and Water Boards of the Mackenzie Valley (the Boards). This document supersedes AANDC's *Mine Site Reclamation Guidelines for the Northwest Territories* (updated in 2007) and compliments the 2002 *Mine Site Reclamation Policy.*

Over the last decade, proponents have submitted a wide range of closure and reclamation plans (CRPs) to the Boards with varying levels of detail and information. The inconsistencies are primarily a result of the lack of specific direction regarding the preparation of a CRP and have resulted in varying interpretations of what should be included in a plan. The inconsistencies are also due to variable project footprints and the type and level of reviewer (intervener) involvement. This has created complexities during the period of CRP preparation and review, causing inefficiencies and ultimately lengthening the review process.

AANDC and the Boards have developed the Guidelines in support of the vision of an efficient and effective regulatory process. Closure and reclamation planning takes a significant amount of time and resources from regulators, reviewers, and the proponent. The Guidelines clearly outline closure and reclamation expectations for all parties; therefore, their use will result in timely and efficient processing of applications and CRPs.

Purpose

The purpose of the Guidelines is to:

- Communicate fundamental closure and reclamation planning concepts;
- Outline specific requirements pertaining to the content of a closure and reclamation plan (CRP), taking into account that advanced mineral exploration and mine sites at various stages of operation will have different content in their plans;
- Clarify the roles and expectations of regulators and stakeholders in closure and reclamation planning;
- Provide guidance on engagement and communication related to closure and reclamation planning;
- Present technical considerations relevant to the closure and reclamation of mine sites; and,
- Provide proponents with a single document that presents guidance from AANDC and the Boards specific to water licences and land use permits .

Authority

AANDC and the Boards have a collective responsibility for the development of the Guidelines. AANDC, together with the Boards, is responsible for managing Crown land and waters in the NWT as well as the administration, inspection, and enforcement requirements associated with the *Mackenzie Valley Resource Management Act* (MVRMA), the *Northwest Territories Waters Act*, and the *Territorial Lands Act*. AANDC Inspectors are responsible for ensuring compliance with legislation, regulations, and the conditions of water licences and land use permits issued by the Boards. Approval from the Minister of Aboriginal Affairs and Northern Development Canada is required for type A water licences.

Sections 65, 102(1), and 106 of the MVRMA authorize the Boards to develop the Guidelines:

> 65. Subject to the regulations, a board (Gwich'in Land and Water Board/Sahtu Land and Water Board/Wek'eezhii Land and Water Board) may establish guidelines and

policies respecting licences, permits and authorizations, including their issuance under this Part.

106. The Board may issue directions on general policy matters or on matters concerning the use of land or waters or the deposit of waste that, in the Board's opinion, require consistent application throughout the Mackenzie Valley.

In addition to the Guidelines, there may be other considerations for different types of mineral exploration and mining operations. For example, for coal mines the Territorial Coal Regulations pursuant to the *Territorial Lands Act* should be consulted, while reclamation of uranium mines in Canada falls under the jurisdiction of the Canadian Nuclear Safety Commission pursuant to the *Nuclear Safety and Control Act* and Regulations. Compliance with all applicable federal and territorial laws and regulations is always required and is implied throughout this document. In the case when the land owner is a designated Land Claim Organization, they may have their own rules and guidelines that would need to be considered.

How The Guidelines Were Developed

During the early 1980s, the public became increasingly concerned about the growing number of insolvencies and abandoned mine sites that were creating significant environmental liabilities, thus the Northwest Territories Water Board and AANDC (formerly Indian and Northern Affairs Canada) began to include a condition that abandonment and restoration plans had to be submitted for approval as a requirement of water licences and land leases (surface).[1] To support this requirement, AANDC developed *Guidelines for Abandonment and Restoration Planning for Mines in the Northwest Territories* in 1990, and the *Mine Site Reclamation Policy for the Northwest Territories* in 2002. This policy document laid the foundation for approaches to environmental protection and the disposition of liability related to mine closure in the NWT.

In 2006, AANDC released the *Mine Site Reclamation Guidelines for the Northwest Territories* (updated in 2007) which were greatly expanded from the 1990 version and complimented the 2002 *Mine Site Reclamation Policy*. AANDC developed these guidelines following extensive engagement including a 'Mine Reclamation and Closure' workshop on February 1–3, 2005 and a workshop on 'Incorporating Community Knowledge in Mine Reclamation Planning' on May 16–17, 2005. AANDC conducted interviews with Elders on closure and reclamation planning and incorporated many of the recommendations from the interviews and workshops directly into their guidelines and carried them forward to this document.

The Boards developed draft *Closure and Reclamation Guidelines* in 2008 with the goal of providing proponents with a step-by-step process and specific direction on the level of detail that would be expected in a CRP. The intent was to augment the AANDC guidelines and enhance clarity and consistency for proponents operating in the Mackenzie Valley; however, as a result of the review of the Board's draft 2008 document, it was clear that a single comprehensive guidance document regarding closure and reclamation would offer even greater clarity for proponents.

This document represents a joint initiative between AANDC and the Boards to create a single guidance document containing direction on the level of detail, the information required, and the process for developing CRPs required by water licences. Numerous organizations were invited to participate in a working group to support the development of the Guidelines. GNWT Environment and Natural Resources, Environment Canada and Fisheries and Oceans Canada were active participants and provided valuable input.

[1] During the early 1980s, the Land and Water Boards of the Mackenzie Valley were not in place; the Northwest Territories Water Board performed their functions for the entire Northwest Territories.

Application

The Guidelines will be applied by AANDC and the Boards in accordance with their respective mandates and responsibilities. The Guidelines will be applied by the following Boards operating under the MVRMA:

- Mackenzie Valley Land and Water Board
- Gwich'in Land and Water Board
- Sahtu Land and Water Board
- Wek'èezhìi Land and Water Board.

The proponents of advanced mineral exploration or mine sites requiring a type A or type B water licence (for both operating and abandoned mine sites) must submit CRPs at various stages of the development (e.g., approximately every three years or at major milestones such as the transition from construction to operations) as a condition of their water licence. Proponents are encouraged to contact the appropriate Board prior to preparing their CRPs to ensure they understand how to effectively use the Guidelines to develop their CRPs. [2]

Monitoring and Performance Measurement for the Guidelines

Mechanisms will be required to monitor and assess performance and to evaluate the effectiveness of the Guidelines. AANDC and the Boards will develop and review a performance measurement framework. The Guidelines will be reviewed and amended as necessary within that framework. The framework will also describe how stakeholders will be involved in the evaluation process.

Structure of this Document

Three distinct and equally important sections form the Guidelines:

1.0 Expectations for Closure and Reclamation Planning

This section highlights closure and reclamation planning concepts, outlines regulatory requirements and expectations, describes financial security requirements, and lists engagement and communication considerations for advanced mineral exploration and mine sites.

2.0 Template for Preparing Closure and Reclamation Plans

This section provides a template to guide the proponent through the preparation of a CRP. The Boards are willing to consider different formats for the closure plan as long as the proponent provides a clear rationale for the change or deviation.

3.0 Technical Considerations for Effective Closure and Reclamation

This section provides additional guidance on new and updated technical concepts and considerations as well as specific northern considerations. Although these considerations are focussed on mine sites, many apply to advanced mineral exploration sites if they require a water licence.

For references and additional documents, see Appendix A.

[2] The Northwest Territories Water Board issues water licences in the Inuvialuit Settlement Region and may require proponents to follow the Guidelines. Proponents are encouraged to contact the NWT Water Board for information on how to most effectively use the Guidelines. AANDC would recommend the use of these Guidelines by proponents for advanced mineral exploration or mine developments that occur in the Inuvialuit Settlement Region.

Part 1 - Expectations for Closure and Reclamation Planning

Closure and reclamation planning at advanced mineral exploration or mine sites should reflect the collective desire and commitment to operate under the principle of sustainable development and sustainable closure. [3] Part 1 of this document describes a number of key elements that are vital to successful closure and reclamation planning. The objectives-based approach to closure and reclamation outlined in section 1.1 describes the concepts for closure and reclamation planning. Section 1.2 outlines required regulatory submissions for both advanced mineral exploration and mine sites. An overview of financial security requirements is summarized in section 1.3, while engagement and communication expectations and considerations are briefly discussed in section 1.4.

1.1 Closure and Reclamation Concepts – An Objectives-Based Approach

A comprehensive CRP is a necessary and integral element of all advanced mineral exploration and mine sites that require a type A or a type B water licence. The development of a CRP needs to follow an objectives-based approach with the overarching closure goal at its foundation; this will allow closure planning to be more coordinated and consistent for an advanced mineral exploration project progressing toward the development of a mine. The closure goal is supported by closure principles which guide the selection of clear and measurable closure objectives for all project components. For each closure objective, proponents propose a set of closure options that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective. The Boards expect proponents to seek stakeholder input as they develop or refine the closure goal, objectives, activities, criteria, and other aspects of closure planning. Each of these steps are described below and illustrated in figure 1 (next page).

1.1.1 Closure Goal [4]

The closure goal is the guiding statement and starting point for closure and reclamation planning. The closure goal at all mining operations is to return the mine site and affected areas to viable and, wherever practicable, self- sustaining ecosystems that are compatible with a healthy environment and with human activities. [5] Proponents can add to this goal, provided they maintain or improve the reclamation standard expressed in the goal and have discussed the change with stakeholders. The closure goal is met when the proponent has satisfied all closure objectives. This goal is also applicable to advanced mineral exploration projects.

1.1.2 Closure Principles

Closure principles guide the selection of closure objectives. The following four core closure principles are applicable to advanced mineral exploration and mine sites (figure 2):

Physical Stability – Any project component that remains after closure should be constructed or modified at closure to be physically stable, ensuring it does not erode, subside, or move from its intended location under natural extreme events or disruptive forces to which it may be subjected. Closure and reclamation will not be successful in the long-term (e.g., 1000 years) unless all physical structures are designed such that they do not pose a hazard to humans, wildlife, aquatic life, or environmental health and safety. [6]

Chemical Stability – Any project component (including associated wastes) that remains after closure should be chemically stable; chemical constituents released from the project components should not endanger human, wildlife, or environmental health and safety,

[3] Sustainable closure refers to the concept that successful closure and reclamation not only involves appropriate levels of engineering, Traditional Knowledge and science but that stakeholders are comfortable with the end result and play an active role in reclamation activities and post-closure monitoring.

[4] The term "closure goal" is used to represent the "closure and reclamation goal". This is also the case with the terms: closure principles, closure objectives, closure options, selected closure activity, and closure criteria.

[5] As per AANDC's standard of reclamation in the NWT, as stated in 2002 *Mine Site Reclamation Policy for the Northwest Territories*.

[6] Health and safety considerations at advanced mineral exploration and mine sites are critical, and may influence which closure options are safe to implement and if other contingency measures or approaches need to be considered. The northern and mostly remote nature of many NWT sites makes this even more relevant, both in terms of the health and safety of workers as well as considerations for public access in the post-closure phase.

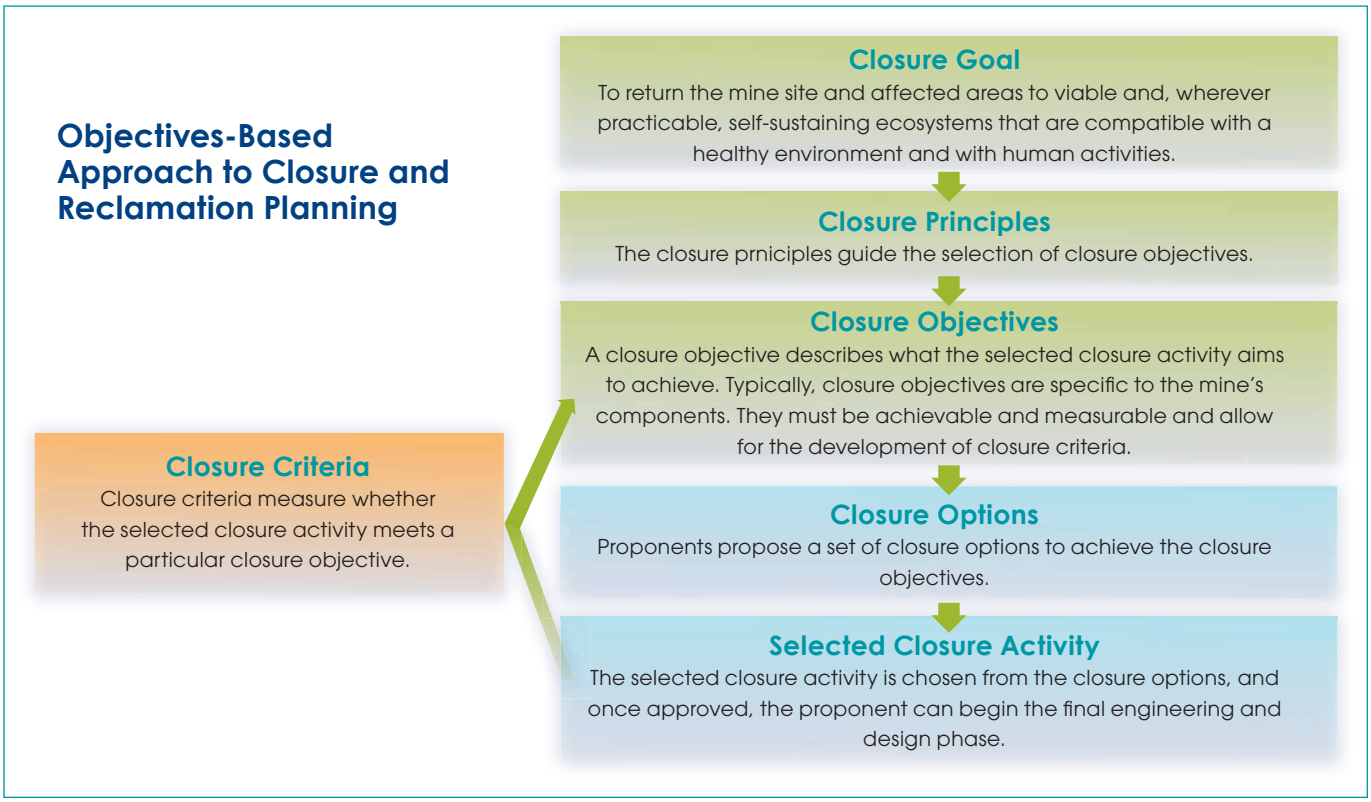


Figure 1: Objectives-based approach to closure and reclamation planning.

should not result in the inability to achieve the water quality objectives, and should not adversely affect soil or air quality in the long term.

No Long-Term Active Care – The proponent must make all practical efforts to ensure that any project component that remains after closure does not require long-term active care and maintenance. Thus, any post-closure monitoring can only continue for a defined period of time. Physical and chemical stability will help ensure achievement of this principle.

Future Use (including aesthetics and values) – The site should be compatible with the surrounding lands and water bodies upon completion of the closure activities.

The development of closure objectives at a project site should incorporate the principle of future use by considering:

- Naturally occurring bio-physical conditions, including any physical hazards in the area (pre- and post-development);
- Characteristics of the surrounding landscape pre- and post- development;
- Intended level of ecological productivity and diversity for post-closure;
- Local community values and culturally significant or unique attributes of the land;
- Level and scale of environmental impact;
- Land use of surrounding areas, and potential future use by humans and wildlife;
- Integration with and implications of other nearby projects, and the proximity to protected areas; and
- Stakeholder input.

Figure 2: Closure goal, principles, and component-specific objectives.

1.1.3 Closure Objectives

Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be measurable, achievable, and allow for the development of closure criteria. CRPs must include closure objectives for each project component (refer to Part 3) at advanced mineral exploration or mine sites. These objectives must be guided by and directly relate to the closure goal and the closure principles.

During the project approval process and throughout the life of the project, proponents must engage with stakeholders to develop and refine closure objectives. When site-specific factors (such as community concerns, physical or chemical conditions, and site history) or new information resulting from reclamation research (section 1.1.7) necessitate modifications to closure objectives, proponents must engage stakeholders and submit proposed changes with supporting rationale to the appropriate Board for approval (usually as part of an interim closure and reclamation plan or annual progress report). Stakeholders may also present proposed changes with supporting rationale to the Board for approval if they believe modification of the closure objectives is necessary.

1.1.4 Closure Options

Proponents explore a set of closure options for each project component in order to achieve the closure objective. After receiving feedback from stakeholders (e.g., in writing and/or via workshops), a proponent will choose the selected closure activity for each component and present it to the Board for approval along with rationale and stakeholder

views. Reclamation research (subsection 1.1.7) and/or environmental monitoring may be required to determine appropriate closure options.

It is important to document all closure options considered throughout the life of a project to ensure there is a record of the rationale used for certain decisions and to learn from past experiences. It is the responsibility of the proponent to ensure that the closure options proposed would achieve the stated closure objectives, comply with all closure and reclamation requirements and include best practices.

When selecting closure options, proponents should be aware the expected design life of components is in the order of 1000 years rather than 100 years as in the past.

1.1.5 Selected Closure Activity

The selected closure activity is chosen based on the closure options for each project component and outlines specific actions and measures to be undertaken. Established literature, bench scale, or pilot testing should support the activity so that stakeholders can be reasonably assured that the option will be successful. The selected closure activity may change prior to the final CRP based on factors such as environmental considerations, stakeholder input, the availability of new technologies/practices, the results of environmental monitoring programs, or the results of specific reclamation research (subsection 1.1.7). Proponents should develop a contingency plan to outline how the selected closure activity will be modified if it is unsuccessful. Once the Board approves the selected closure activity, the proponent can begin the final engineering and design phase for each project component.

1.1.6 Closure Criteria

Closure criteria are developed for each closure objective for approval by the Board. They are used to determine if selected closure activities have met the closure objectives for each project component. Closure criteria can be site-specific or adopted from provincial/territorial/federal standards and can be narrative statements or numerical values. Closure criteria must be meaningful, measurable, and achievable to ensure successful reclamation of project components. Closure criteria may also have a temporal aspect to consider (e.g., a standard may have to be met for a pre-defined number of years).

Closure criteria should be discussed amongst all stakeholders in the early stages of project development following licensing. Closure criteria are normally expanded upon during the development of interim CRPs and finalized as closure and reclamation planning approaches the end of operations in the final CRP.

In the early stages of project development, certain closure criteria will be determined based, in part, on the results of environmental monitoring programs or reclamation research. A brief description of, or references to, the ongoing or future reclamation research related to the development of closure criteria should be provided along with the timeframe by which the work will be completed.

1.1.7 Reclamation Research Plans

Proponents develop reclamation research plans to resolve uncertainties and answer questions pertaining to environmental risks for closure options or selected closure activities (figure 3). Reclamation research includes engineering studies and/or focussed research undertaken with the intention of reducing uncertainties to an acceptable level. It is essential that proponents initiate reclamation research as early as possible and that it be fully supported so that the Boards and stakeholders can use the resulting information in the closure planning process in a timely manner.

Reclamation research results will provide information that can lead to the development of appropriate closure criteria applicable to a site in a northern context. For example, closure standards and closure criteria for mine sites in southern Canada may not be applicable in the NWT due to the unique environmental setting (e.g., climate, permafrost, trophic level of lakes, etc.), which is why reviewing research of similar, nearby developments can be beneficial.

Reclamation research will facilitate the transition from operations to closure and reclamation, as it will aid in determining which closure option is suitable for the selected closure activity. For mine sites, the research is generally component-specific and can take several years to complete (e.g., revegetation studies, rock pile studies, etc.). Reclamation research can also be cost effective as it may provide insight into the selection of closure options or activities which can take advantage of equipment, personnel, and infrastructure available during operations.

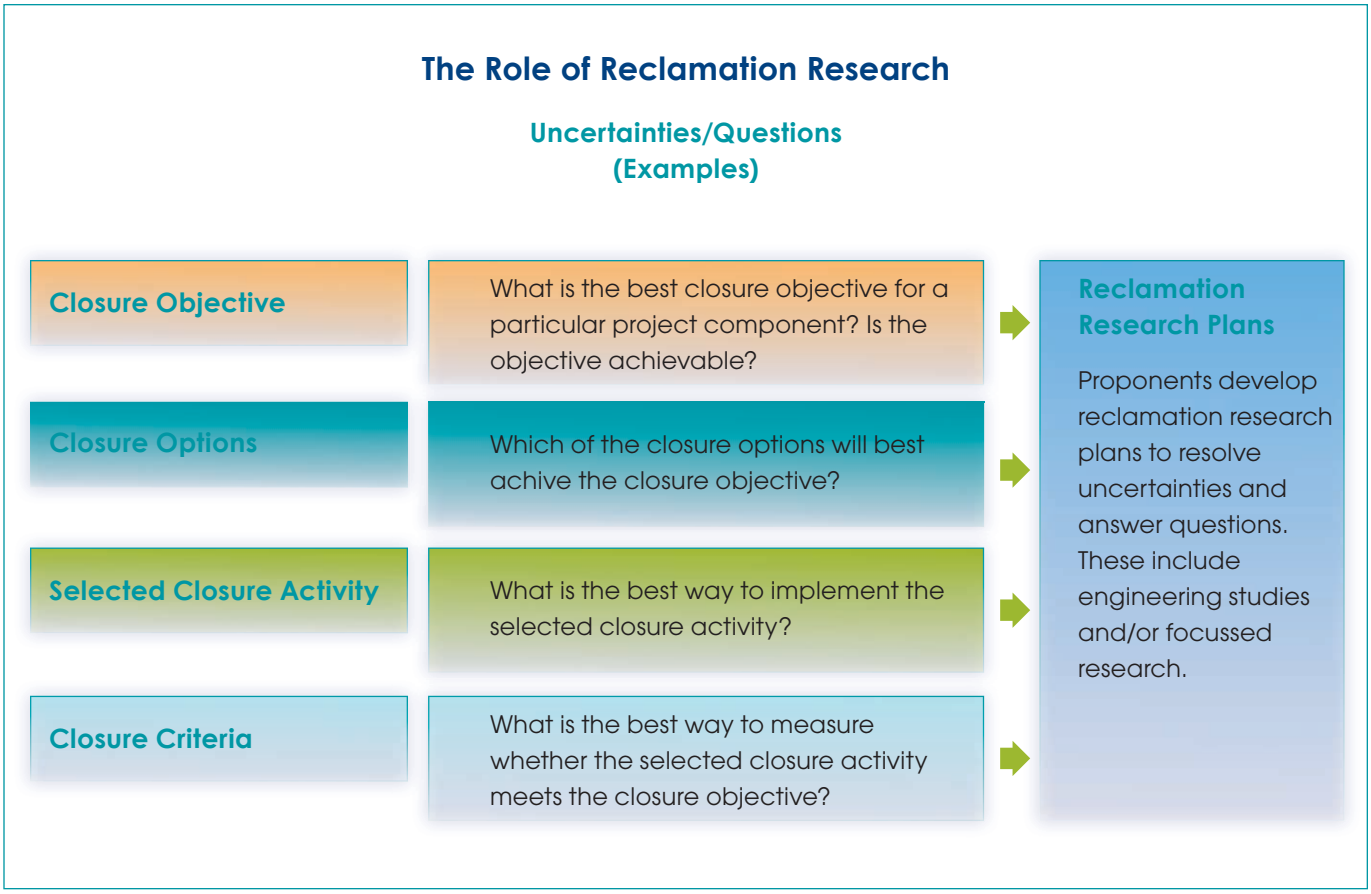


Figure 3: The role of reclamation research.

1.2 Closure and Reclamation Plans - Required Regulatory Submissions

Most applications for mine developments and some advanced mineral exploration projects in the Mackenzie Valley will be required to undergo an environmental assessment or an environmental impact review with the Mackenzie Valley Environmental Impact Review Board. Once the application is approved by the Review Board or Panel and the Minister of Aboriginal Affairs and Northern Development Canada accepts the recommendations, the environmental assessment phase is complete, and the project returns to the licensing phase. Subsections 1.2.1 and 1.2.2 outline the submissions required for advanced mineral exploration and mine sites respectively. The number of submissions and level of detail will vary depending on the scale of the project. Land leases (surface) issued by AANDC or other land owners may also have closure and reclamation requirements. [7]

1.2.1 Advanced Mineral Exploration

A CRP is required as a condition of type B water licences for advanced mineral exploration projects. The intent of a CRP is to provide a description of the plan that would be followed in order to close and reclaim the site, either temporarily pending further exploration work or permanently should the project not proceed to mine development.

During advanced mineral exploration, the results of a feasibility study may lead to the decision to proceed to mine development. If a proponent intends for their project to develop into a mining operation, it is important they contact the appropriate Board to begin preparing their type A water licence application well in advance of a planned submission. Figure 4 provides an overview of regulatory process steps for advanced mineral exploration.

1.2.2 Mine Development – Mining and Milling

A CRP is required as a condition of type A water licences for mine developments. The intent of closure and reclamation planning for a mine site is to provide detailed descriptions of approaches to closing and reclaiming the site while achieving the closure goal and objectives. It is also important to incorporate long-term local community values and cultural considerations into the planning phase.

The requirements for closure and reclamation planning and reporting listed below generally correspond to the mine development stages (i.e., mine design, construction/operations, reclamation), and are reflected in the following plans:

- A conceptual closure and reclamation plan;
- One or more interim closure and reclamation plan(s); and
- A final closure and reclamation plan.

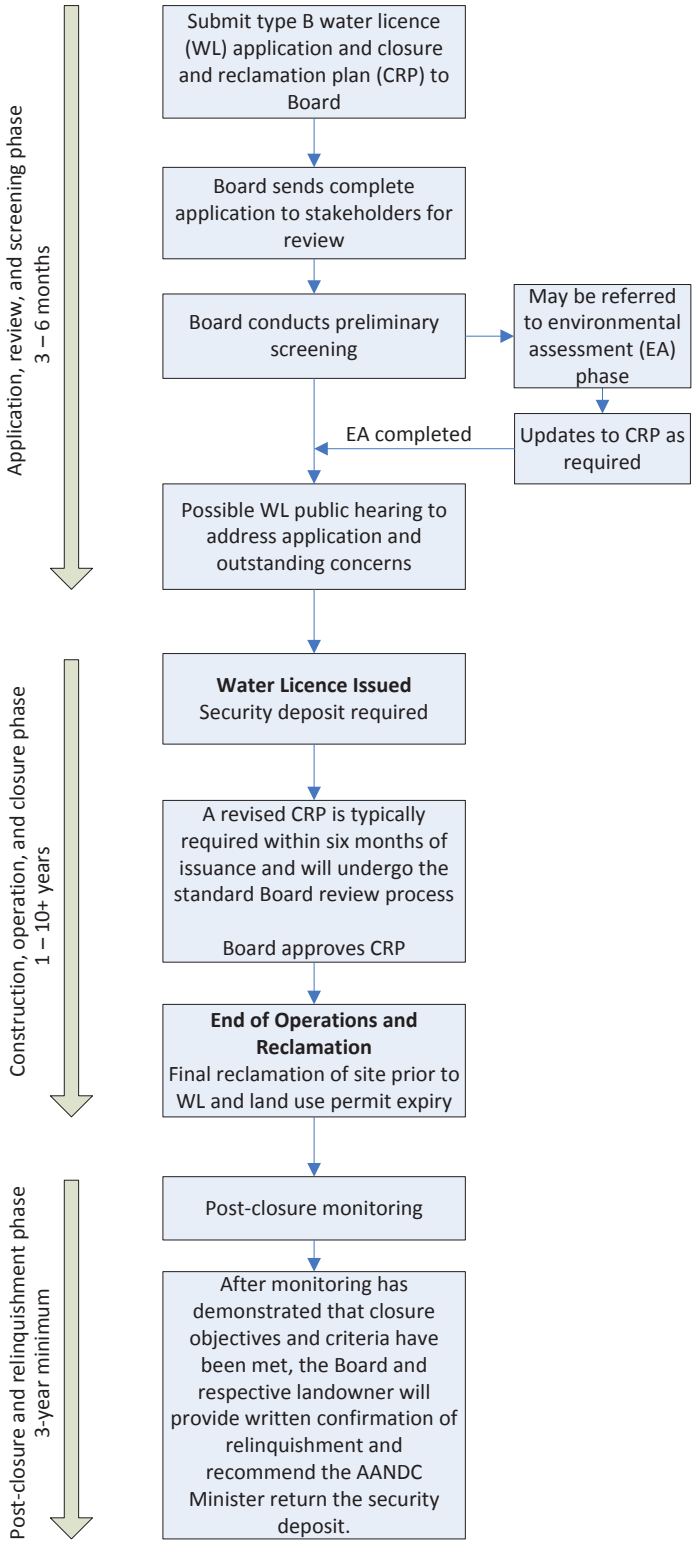
Other reports often required as conditions of a water licence include: an annual closure and reclamation progress report; a reclamation completion report documenting completed reclamation work; and a performance assessment report comparing the documented closure objectives against the actual post-closure site conditions. Figure 5 provides an overview of regulatory process steps for mine developments.

Part 2 of the Guidelines provides a detailed template for developing CRPs that is intended to simplify the CRP development and review processes once an application is received. The template provides descriptions of all the information to be included in the CRP, including but not limited to the purpose of the plan, regulatory requirements, engagement, `life of project' schedule, project description, closure objectives and closure criteria, monitoring and reporting, reclamation research, progressive reclamation, and temporary closure activities.

[7] For further information, see AANDC Lands Division or respective land owner or refer to lease documents directly.

Closure and Reclamation Planning – Regulatory Process

Advanced Mineral Exploration



A type B water licence application for advanced mineral exploration is the trigger for the use of these Guidelines. A type A or B land use permit application will also be required.

Refer to http://www.mvlwb.com for the requirements for land use permits and water licences under the Mackenzie Valley Land Use Regulations and Northwest Territories Waters Regulations

Figure 4: Advanced mineral exploration regulatory process general steps.

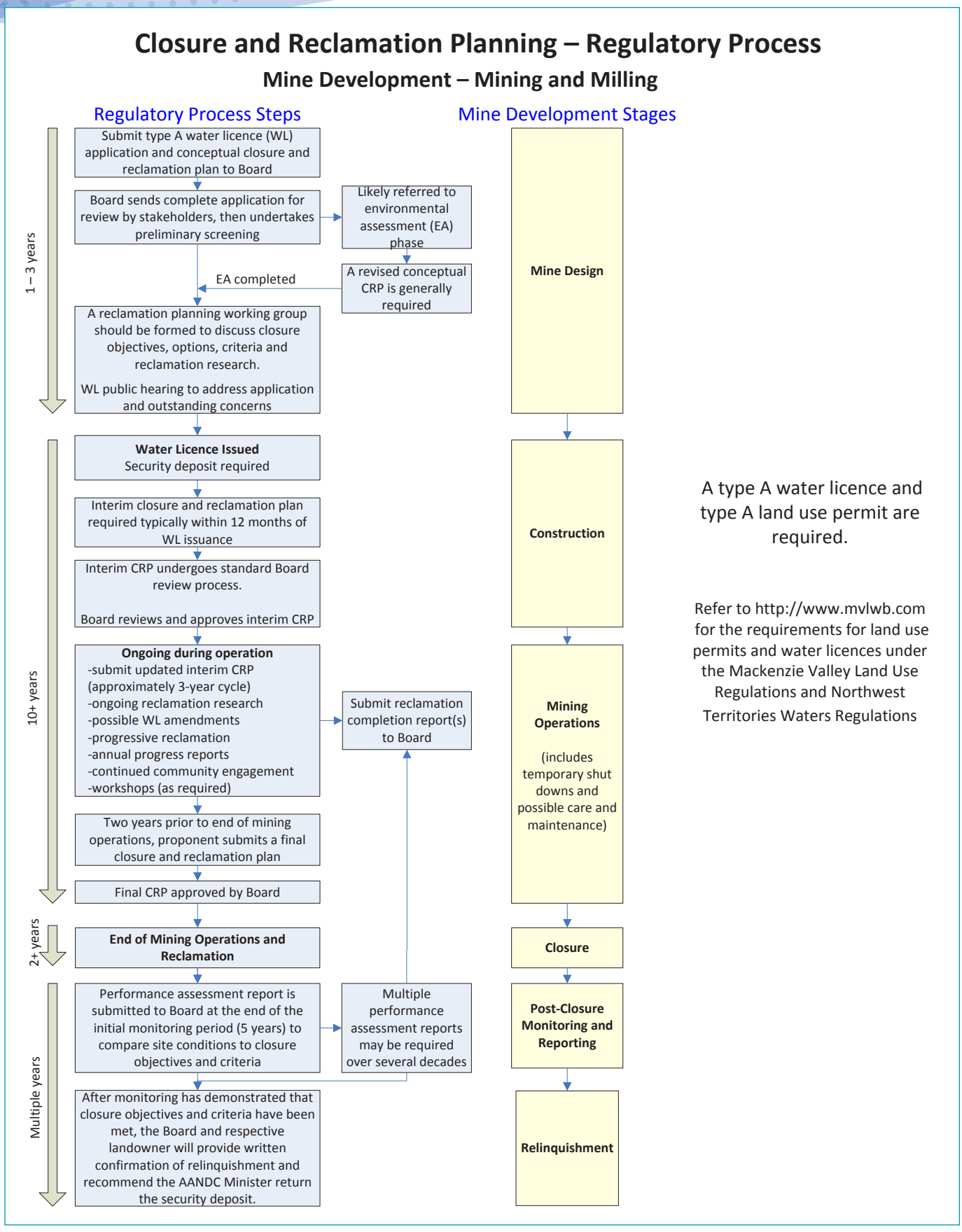


Figure 5: Mine development regulatory process general steps.

Closure and reclamation planning and reporting requirements for new, existing, or closed mines are illustrated in figure 6 to show how they relate to the life stages of a mine and will be further discussed in the following sections.

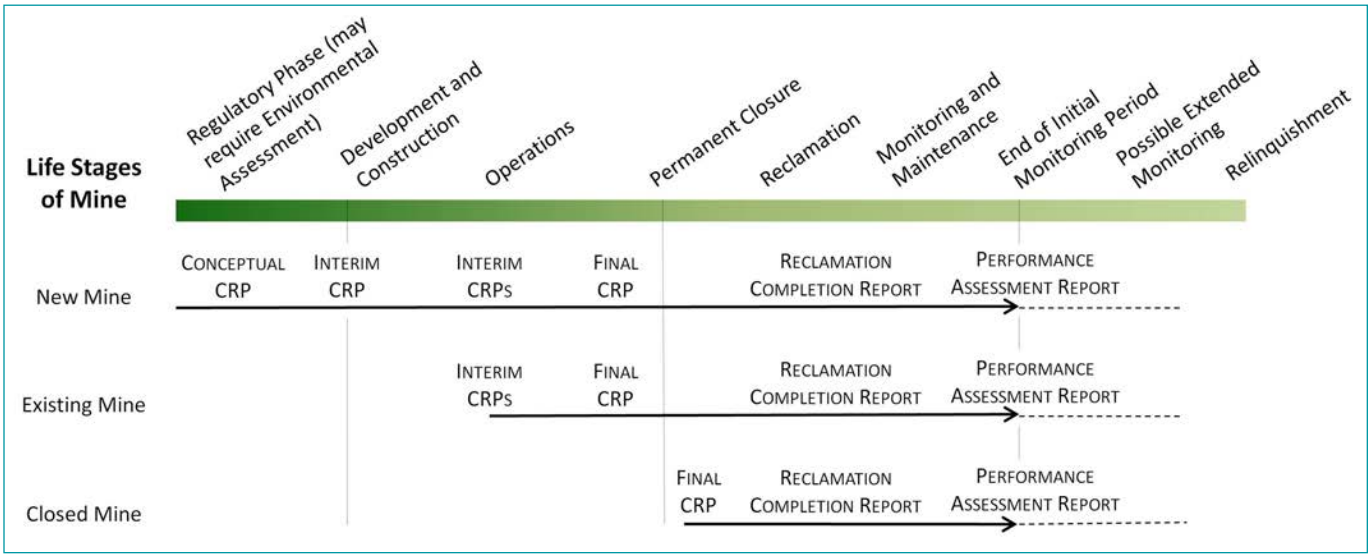


Figure 6: Closure and reclamation planning through life of the mine.

Conceptual Closure and Reclamation Plan

For new mines, a conceptual CRP is prepared during initial mine planning prior to the actual construction at the mine site and is most commonly included as part of the developer's assessment report during the environmental assessment process [8] (see figure 5). It is based on the proponent's proposed mine plan and to some degree on assumed future conditions. The general purpose of the conceptual CRP is to demonstrate the satisfactory closure and reclamation of the mine site and to describe the likely residual risks to human health and the environment.

As previously mentioned, most mine developments are required to undergo an environmental assessment or environmental impact review. Depending on the discussions and commitments made during the environmental assessment phase, the proponent may need to update and re-submit the conceptual CRP during the development of the initial water licence. As engagement is necessary during the preparation of the conceptual CRP, a closure and reclamation stakeholder working group is one method to ensure that stakeholder input is considered during the early stages of mine planning and conceptual CRP development. Engagement should focus on addressing specific issues and providing input into the development of closure objectives, closure options, relevant reclamation research, and other key closure issues to produce an acceptable conceptual CRP (see figure 5).

[8] See the Mackenzie Valley Environmental Impact Review Board website (www.reviewboard.ca) for details about the developer's assessment report and the environmental assessment process.

To be effective, the conceptual CRP should place emphasis on:

- Identification of closure objectives for individual project components;
- Realistic descriptions and assessments of closure options related to temporary, unpredicted, or indefinite closure;
- Identification of uncertainties related to closure objectives, options, or criteria, and potential reclamation research or engineering studies to address uncertainties;
- A review of similar case studies and a description of applicable lessons learned from other sites;
- Credible evidence that the selected closure activities can achieve the stated closure objectives;
- Photographs depicting what the site looks like before operations begin, conceptions of the maximum extent of disturbance during mining operations, and the post-closure landscape;
- Identification of any likely post-closure monitoring requirements and responsibilities for the selected closure activities;
- Conceptual projections of the likely post-reclamation risks to environmental, human, and wildlife health (risk assessment); and
- Closure and reclamation liability costs and a financial security estimate to a level of detail reflective of the available information.

Interim Closure and Reclamation Plan

An interim CRP is generally a requirement of a type A water licence and is usually expected within 12 months of water licence issuance or as directed by the Board (see figure 5). The proponent's mine plan may have changed following the environmental assessment phase; similarly, sections of the conceptual CRP will change as the first version of the interim CRP is developed. Several updates of an interim CRP may be necessary depending on the mine life as interim CRPs are generally revised on approximately a three-year cycle. Consequently, the content and focus of the interim CRP will become more refined following a thorough review of closure objectives, closure options, selected closure activities, reclamation research, and closure criteria as the project progresses and subsequent versions of the interim CRP are produced.

The general purpose of the interim CRP is to update the preceding conceptual or interim CRP according to the current mine operating plan, ongoing engagement, reclamation research results, advances in mine technology, and/or progressive reclamation. Each subsequent interim CRP provides increasing levels of detail on the closure and reclamation of individual project components and details for components that are to be progressively reclaimed during mine operation.

One of the main purposes of the interim CRP is to identify uncertainties surrounding closure options, thereby guiding corresponding areas for reclamation research during operations. For example, during the early stages of mine life, the following questions may be asked: What will water quality be in open pits if they are flooded to create pit lakes? If the tailings containment area were to be vegetated, would it be safe for wildlife? In these cases, research should begin early enough in the process so that there is more certainty or an acceptable level of uncertainty at closure. New reclamation research plans may be necessary as proponents progress from the conceptual CRP to the last version of the interim CRP.

The interim CRP is also used to progress from the initial closure objectives, as outlined and intended in the conceptual CRP, to increasingly solidified closure objectives as research findings, operational data, additional stakeholder input, and other information is acquired. The exercise of collectively

developing closure objectives is particularly useful in that stakeholders have the opportunity to gain an understanding of the complexity of certain objectives and the difficulties in setting measurable closure criteria. A closure and reclamation stakeholder working group can provide input on the development of closure objectives, an analysis of alternatives or options, and the identification of closure activities and closure criteria. Proposed changes to closure objectives by any party should be well supported by a full rationale.

To be effective, the interim CRP should place emphasis on:

- Renewed or updated statements of closure objectives for the mine site;
- Development of a reclamation and progressive reclamation schedule;
- Detailed or updated descriptions of closure options related to temporary or permanent mine closure to a level of detail appropriate to the information available (the level of detail should increase through the mine life as new information is made available);
- Contingency plans for reclaiming individual project components (e.g., contingencies in case poor water quality prevents the flooding of an open pit);
- An explanation of which closure options were considered and why selected closure activities were chosen for each project component;
- Updated reclamation research plans;
- Evidence that the closure objectives are achievable through the selected closure activities;
- Closure criteria for each closure objective;
- Updated photographs depicting the original landscape, what the site looks like during operations, and a description of the anticipated landscape at final closure with less emphasis on the baseline conditions and information;
- Plans for upcoming engagement;
- Details of post-closure monitoring requirements and responsibilities (these should become more refined as projects approach the end of operations);
- Updated descriptions of the likely post-reclamation risks to environmental, human, and wildlife health (risk assessment); and
- Updated closure and reclamation liability costs and financial security estimates to a level of detail reflective of the available information.

The Board will establish a process for the development of an interim CRP. This process will vary depending on the circumstances and stage of planning. Below is an example of the process with the party responsible for each step indicated in parentheses.

Identify Reviewers/Stakeholders (Board)

↓

Site Visit with Reviewers/Stakeholders (Proponent)

↓

Submission of Closure Goal and Proposed ClosureObjectives (Proponent)

↓

Closure Objectives, Options, and Uncertainties Workshop (Board and Proponent)

↓

Consideration of Objectives, Options, Uncertainties (Board)

↓

Submission of the Interim CRP (Proponent)

↓

Review of the Interim CRP for Approval (Board)

Final Closure and Reclamation Plan

The final CRP is typically required two years prior to the end of operations, or required by a condition of a water licence for an abandoned mine (see figure 5). It provides detailed descriptions of the proposed reclamation activities for the mining operation and must be approved before permanent closure takes place or immediately after unplanned closure. For large, multi-year reclamation projects, the final CRP may include a schedule for updates to the plan during implementation of the work. The proponent should provide these updates in its annual CRP progress report, which may continue to be required post-closure.

As a project advances, the level of analysis and deliberation regarding certain closure options will diminish upon the completion of selected closure activities. Additionally, predicted residual effects of selected closure activities should be increasingly detailed in the final CRP since more information, including monitoring and research results, will be available to determine the duration, frequency, and magnitude of the effects. Proponents should complete the reclamation research and site monitoring required to finalize closure criteria in time to include appropriate closure criteria in the final CRP. The final CRP should fully describe the level of detail and certainty surrounding post-closure monitoring and contingency planning.

To be effective, the final CRP should place emphasis on:

- Final statements of closure objectives for the mine site generally and for each project component;
- A complete set of closure criteria that are used to determine whether the selected closure activity meets the closure objective;
- Detailed descriptions of selected closure activities for each project component to a "detailed engineering" or "issued for construction" level of detail;
- Detailed descriptions and assessments of possible contingency plans;
- An updated detailed closure and reclamation schedule;
- Long-term information management in connection with post-closure activities;
- A records management procedure for long-term information related to reclamation;
- Updated photographs depicting what the site looked like immediately prior to closure;
- Detailed post-closure monitoring and care and maintenance programs and responsibilities;

- Detailed descriptions of the projected post-reclamation risks to environmental, human, and wildlife health (risk assessment);
- Detailed closure and reclamation liability costs and financial security estimates based on achieving approved closure objectives and closure criteria;
- A summary of reclamation already completed or in progress and a list of related documents;
- A conformance table of applicable permits and licence requirements for the reclamation plan (including those of other regulatory authorities such as Government of the Northwest Territories and Fisheries and Oceans Canada);
- The management team's roles and responsibilities related to mine closure;
- A record of engagement related to final closure planning;
- A summary of instances of non-compliance related to specific mine components, and how these have been addressed in terms of planning for final closure; and
- Remaining residual risks or, for abandoned mines, descriptions of any risk assessments which should be based on site-specific data.

Annual Closure and Reclamation Plan Progress Report

AANDC and the Boards would like to emphasize the importance of planning, research, implementation, and monitoring for closure and reclamation to ensure that approaches are continually evaluated and revised as necessary to achieve the overall closure objectives, principles, and goals.

The annual CRP progress report provides an opportunity for all parties to track, modify, and report on reclamation. The annual review of research results also provides an opportunity to identify missing research tasks, which allows the research plans to continually evolve. The progress reports keep all parties informed about closure planning and allow the Board to confirm that the proponent has remained on schedule.

Each annual CRP progress report should include at a minimum:

- A discussion on whether the closure and reclamation planning and implementation remains on schedule and a summary of any new scheduling setbacks;
- A summary of engagement since the previous year;
- A description of important research results that will be used to inform closure planning going forward;
- Progressive reclamation completed within the last year and the detailed plan for any proposed progressive reclamation for the upcoming year; [9]
- Any engineering design changes proposed for the upcoming year;
- A list of other closure-related reports or studies submitted since the last annual CRP progress report;
- A list of any factors that would influence an increase or decrease in the total reclamation liability next time an updated estimate is required; and
- Any other information to ensure that stakeholders are aware of the closure planning process and timelines.

The annual CRP progress report should contain a section with any proposed changes to the CRP with supporting rationale. For any proposed change,

[9] Please note that the proponent must contact the Board and the AANDC Inspector ten days prior to commencing any progressive reclamation activities.

reassess the associated residual risks. The proposed changes, any significant studies, reclamation completion reports, and any proposed final designs will be for Board approval and should be incorporated into the next update of the CRP.

Reclamation Completion Report

The general purpose of the reclamation completion report is to provide:

- Details, including figures and photos, of the final reclamation work;
- An explanation of any work that deviated from the approved design and CRP;
- An inventory of the infrastructure removed and that remaining;
- All engineered "as-built" reports; and
- Descriptions of any monitoring that is still required.

This facilitates future assessment, maintenance and, if needed, repair work at the site. Necessary ongoing monitoring should continue during the closure and reclamation stage. The report should also provide a preliminary assessment on the achievement, or lack thereof, of appropriate closure objectives and criteria.

For smaller projects, a single reclamation completion report outlining how the site was reclaimed would be appropriate. For larger projects, where facilities or components are closed and reclaimed prior to the end of operations, a reclamation completion report would be expected following the closure of each of the facilities/components as well as a final reclamation completion report that lists all of the previous component-specific reports.

The final reclamation completion report should provide updated photographs of the components and the site, and a description (including timeline) for any environmental monitoring and mitigation plans. With each reclamation completion report, there may be an opportunity to revise the financial security estimate depending on the stage of the operation and the current CRP.

Performance Assessment Report

The general purpose of the performance assessment report is to provide a detailed comparison of conditions at the site against the appropriate closure objectives and closure criteria. In some cases where there has been an unacceptable level of residual risk identified or if questions remain concerning the achievement of certain closure criteria, a need may exist to carry out additional activities (e.g., active water treatment).

The proponent should prepare a performance assessment report after the final reclamation completion report has been submitted and after a time period needed to assess the performance of the reclamation. A performance assessment should be completed when it is anticipated that environmental conditions demonstrate that certain closure objectives will be achieved, such as closure objectives requiring short term monitoring (e.g., five years) and those related to general site stability and construction-related issues. At this time, the environmental conditions are again assessed against the closure criteria and any ongoing residual and/or environmental risks. The monitoring and maintenance plan will require updating if subsequent performance assessment reports are required by the Board. This will likely be the case for longer term closure objectives (e.g., 20 years or more) for individual project components. Note that some mine components may remain on site in perpetuity, such as tailings caps, waste rock piles, and landfills.

In addition to the information described above, the performance assessment report should provide the following:

- An update on the site liability (the closure and reclamation costs associated with all liabilities on site);

- Updated photographs of the components and of the site;
- Updated human and wildlife health and safety conditions;
- Descriptions of engagement and community participation in site monitoring; and
- Maintenance and management activities.

With each performance assessment report, there may be an opportunity to revise the security estimate depending on the stage of the operation and the current closure and reclamation plan.

Relinquishment

The closure and reclamation planning process occurs in an effort to achieve successful relinquishment. Relinquishment occurs when the Crown and/or the landowner release a proponent from liability associated with the project, typically resulting in a return of the security. Relinquishment will be determined on a project-by- project basis after, at a minimum:

- Monitoring has demonstrated that closure objectives and closure criteria have been met;
- Supporting documentation exists for the above in one or more performance assessment reports; and
- The Board has recommended that the Minister for Aboriginal Affairs and Northern Development Canada return the security deposit held for the advanced mineral exploration or mine operation (based on the recommendations of an AANDC Inspector).

1.3 Financial Security Requirements

Every new and existing advanced mineral exploration and mining operation must be able to support the cost of reclamation and be able to provide adequate security to ensure that the operator, rather than the landowner, bears the cost of reclamation, including care and maintenance, permanent closure, and post-closure monitoring.

The MVRMA, the Northwest Territories Waters Act, and associated regulations provide the Boards with the authority to set the financial security amounts for land use permits and water licences. The Territorial Lands Act allows AANDC or other land owners to issue land leases (surface) and require proponents to submit and maintain financial security. The Boards also have the ability to increase or decrease the amount of security held for a particular project if sufficient evidence indicates that the total liability at the site has increased or decreased. It is important to note that environmental agreements may require security in addition to that set by the Board. [10]

The conditions of a water licence outline the requirement for a proponent to provide adequate financial security for their project. The amount of security required by a proponent will depend on the nature and scale of the project and the level of uncertainty with respect to residual effects and impacts following operations. The reclamation research is intended to reduce the level of uncertainty, and therefore it is expected that the CRP and the estimate of site liability will become more refined and accurate as the project approaches the end of operations.

The total financial security required at any time during the life of the mine should be equal to the total outstanding reclamation liability for land and water combined, and estimates should be based on the cost of having the required reclamation and monitoring work completed by a third-party contractor. Proponents should use the RECLAIM model to estimate security or contact Board staff if planning to use another model.

Proponents must provide a security deposit that gives the Minister of Aboriginal Affairs and Northern Development Canada direct, unencumbered access

[10] Each of the NWT's three diamond mines has an environmental agreement—a legal contract among the mining company, federal and territorial governments, and in two cases, Aboriginal organizations. The agreements set out requirements for the company's environmental management plans, monitoring programs, and in two cases, closure and reclamation plans. Each of the environmental agreements for the diamond mines establishes a monitoring agency, funded primarily by industry. Aboriginal governments play a key role in these agencies. The agencies advise the company, communities, and the Minister of Aboriginal Affairs and Northern Development Canada on environmental issues related to the project.

to the full amount and in a form that will retain its full value throughout the life of the mine and throughout post-closure monitoring. The security deposit will be held outside the control of the proponent or its creditors in the event of insolvency. New or innovative forms of security, such as reclamation trusts, may be considered. [11]

When ongoing reclamation work reduces the outstanding environmental liability, it will result in a proportional reduction in the level of required financial security. Proponents should request credit for progressive reclamation work in a timely fashion. [12]

AANDC's Renewable Resources and Environment Directorate administers and manages security deposits for water licences and environmental agreements for the NWT Region, while AANDC's Operations Directorate administers and manages land use permit and land lease (surface) security deposits.

1.4 Communication and Engagement

Effective communication, along with thorough and frequent engagement, needs to occur on various levels when developing CRPs for advanced mineral exploration and mine sites. It is important that all comments from stakeholders are clearly and accurately documented and considered in the CRP development and approval process.

The level of CRP engagement will evolve through the life of the project and into post-closure. Input should be sought as early as possible—for example during the development of the conceptual CRP for a mine—and continue with the interim CRP(s) and final CRP, such that comments regarding closure objectives, closure options, selected closure activities, and closure criteria can build on earlier comments and lead to CRPs that are well understood and supported by stakeholders.

Below are several approaches that have been successfully undertaken by proponents developing CRPs in the NWT to ensure effective communication and engagement:

- For mine sites, a closure and reclamation stakeholder working group could meet periodically to share information and provide comments and guidance to the proponent;
- The development of a 3-D model to scale of the pre-development landscape, the mine during operations, and the final closure landscape;
- Hosting regular site visits throughout the project to discuss closure planning and monitor remediation progress;
- The establishment of community-based programs for activities such as aquatic and terrestrial ecosystem health monitoring, stream flow measurements/monitoring, reclamation progress, re-vegetation, etc., and
- Reporting to Aboriginal governments, communities, and other stakeholders to discuss how their input was considered and to obtain feedback on the CRP development process.

In some cases, closure and reclamation planning recommendations made by Aboriginal governments and communities may not align with western scientists' ideas of best practices. In these cases, all the reasons for the recommendations put forward should be examined carefully and communication efforts should respectfully build on existing perceptions related to environmental effects from the given project.

[11] AANDC has the authority to determine acceptable forms of security.

[12] AANDC's *Mine Site Reclamation Policy for the Northwest Territories* (2002).

The Boards have developed engagement guidelines that outline specific engagement requirements and best practices for proponents. Similarly, the Mackenzie Valley Environmental Impact Review Board requires engagement as well as the incorporation of Traditional Knowledge during the environmental assessment phase, and certain Aboriginal governments have engagement and/or Traditional Knowledge policies and guidelines that must be adhered to.

Part 2 - Template for Preparing Closure and Reclamation Plans

The annotated template provided below identifies the minimum requirements for closure and reclamation plans (CRPs) for advanced mineral exploration and mine sites. The template includes the name of each required section within the plan and details about what proponents should include in that section. These requirements reflect current industry norms for CRPs, lessons learned by the Boards from projects in the NWT, and input provided by stakeholders during numerous closure planning processes.

The purpose of this template is to set realistic and consistent expectations for the content of CRPs, to simplify the review process for stakeholders, and to reduce ambiguities for proponents. The template's design makes it compatible with each stage of development, so as the operation evolves from advanced mineral exploration through to mine development, the same order and type of information is required but in more detail.

The template serves as a guide, and proponents are encouraged to offer suggestions that may enhance the conveyance of information; however, if a proponent chooses to deviate from the template, they should provide a thorough rationale along with the recommended changes to the format or content. All proponents should contact Board staff prior to preparing a CRP.

The template is suitable for both advanced mineral exploration and mining operations. Any differences in the Boards' expectations between these two types of projects are noted below. Where the type of project is not specified, proponents should assume the information is required for both advanced mineral exploration and mine sites, although a greater level of detail is generally required for mining operations, and the level of detail increases as the project nears completion.

Closure and Reclamation Plan Template

Table of Contents

Include lists of tables, figures, maps, photos, and appendices presented in the CRP.

1.0 Plain Language Summary

Provide a plain language summary of the CRP with a level of detail dependant on the stage of the project. This summary is for the benefit of stakeholders that are reviewing the plan, including those who may not review the entire document. It can also be used as a stand-alone document, for example, to brief communities at public events.

For all projects, the plain language summary should focus on the key aspects of the current CRP. Note any major uncertainties and how they will be addressed (e.g., research plans or engineering studies). For interim and final CRPs, note any differences from the previously approved plan and from the conceptual CRP discussed during the environmental assessment phase.

Proponents with CRPs that are more complex should consider providing summaries that are specific to each project component. These proponents are also strongly encouraged to include summary tables, which can be very useful for illustrating the connections between related closure concepts. For example, conceptual or early interim CRPs can include tables that present closure objectives, closure options, and selected closure activities. This allows the Board and stakeholders to understand how the selected closure activities will meet the closure objectives. CRPs for projects approaching closure can include a table that presents closure objectives, closure criteria, and monitoring. This table would demonstrate how the proponent's success in meeting objectives will be measured and assessed. Tables can be organized by project component and even further divided into valued ecosystem components (e.g., air, land, wildlife, etc.). Proponents should tailor these summary tables so they present information in the most useful way possible.

2.0 Introduction

2.1 Purpose and Scope of the Closure and Reclamation Plan

Describe the purpose and scope of the CRP as it relates to the Boards' requirements, previous versions of the interim CRP, and the expectations of stakeholders. Provide a general description of the project including, a brief description of the proponent(s) and the overall spatial and temporal extent of the project. (See section 4.0 for more details.) State whether the plan is a conceptual CRP, a version of an interim CRP, or a final CRP. Provide the approval dates of any previous CRPs.

2.2 Goal of the Closure and Reclamation Plan

The closure and reclamation goal (or closure goal) as described in Part 1 is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. Proponents can add to this goal, provided the reclamation standard expressed in the goal is maintained or improved. The four closure principles of physical stability, chemical stability, no long-term active care requirements, and future use (including aesthetics and values) support the closure goal. This closure goal applies to both mines and advanced mineral exploration projects.

2.3 Closure and Reclamation Planning Team

The CRP should describe, list, or show (e.g., organizational chart) the important internal and external organizational relationships and specific responsibilities (e.g., accountability structure, operations vs. post closure, etc.) that will facilitate and manage the closure and reclamation process; include any consultants working on behalf of the proponent and their reporting relationships.

2.4 Engagement

Proponents must outline their approach to engagement and how they have or will integrate local community values into closure and reclamation planning, including any strategies for engaging communities in CRP development and implementation. It is usual for the level of public involvement to increase in relation to the size and duration of the project and the complexity of facility development, traditional significance of the area to residents, and anticipated future use (see Part 1, section 1.4 of the Guidelines). Public meetings, face-to-face meetings, and workshops may be required at various stages; typically these occur prior to submission of conceptual, interim, or final CRPs. In the appropriate appendix, proponents should provide an engagement log detailing all relevant meetings, teleconferences, e-mails, workshops, etc. with the topics of discussion, the outcomes (including any changes or improvements made by the proponents), and persons involved, plus a record of all files, letters, invitations, presentations, e-mails, etc.

2.5 Regulatory Instruments for Closure and Reclamation

The Boards need a detailed summary (see example below) of all existing and potentially required permits, authorizations, and agreements, with the regulatory authority with jurisdiction for closure and reclamation identified. Regulatory instruments under consideration would include:

- water licence(s)
- Fisheries and Oceans Canada authorization(s)
- land use permit(s)
- environmental agreements
- land leases (surface)

Also, proponents must provide a conformance table that references where the CRP satisfies the conditions of the water licence and other applicable licences and permits. This important tool assists the Board when it is determining whether to approve the CRP.

In addition to the above requirements, there may be other guidelines that the proponent will have to follow (e.g., MVLWB Guidelines for Developing a Waste Management Plan, AANDC's Guidelines for Spill Contingency Planning). The proponent may also have their own company closure standards or want to reference relevant guidelines that are not specific to CRPs or the NWT.

Example Table of Permits, Authorizations, and Agreements

List of Existing Permits, Authorizations, and Agreements and the Contact Information for the Responsible Authorities and the date of expiry	**Indicate the Requirements and Where they are Addressed Within the CRP.**
e.g., type A Water Licence (MV2011L2-0001), Mackenzie Valley Land and Water Board, expires January 1, 2020	Security liability estimate can be found within Appendix XII
e.g., Fisheries Authorization (11-HCAA- CA6-12129), Fisheries and Oceans Canada, expires January 1, 2020	Proposed dike breach locations can be found within subsection 5.3.2 and within figure 5.3.

3.0 Project Environment

Proponents need to provide detailed descriptions of pre-disturbance conditions and the current development status of the project. The amount of information presented for each subsection should be sufficient to understand baseline conditions. Much of this information may be derived from current/historic baseline data, the environmental assessment phase (if applicable), or updated with data and information from monitoring plans, studies, and reclamation research.

3.1 Atmospheric Environment

Provide an overview of the regional and local climate setting, temperature, and precipitation statistics and trends based on regional and project-specific climate stations. Provide general descriptions of regional and site air quality conditions (e.g., due to emissions and dust from the project). Use tables and figures to help summarize and depict data.

3.2 Physical (Terrestrial) Environment

Provide an overview of the regional and local physiography (e.g., topography and relative relief and drainage basin, surface- and ground-water characteristics), surficial and bedrock geology, extent and distribution of permafrost, geologic hazards and hydrogeology. Use maps, photo mosaics, tables, and figures to help summarize and depict monitoring stations or wells and other data and information.

3.3 Chemical Environment

Provide an overview of regional and local soil and sediment chemistry, surface water quality (i.e., lakes, streams, springs), groundwater quality (i.e. from production and/or monitoring wells), and acid rock drainage (ARD) and metal leaching (ML) potential. (See Part 3.0, subsection 3.2.1 for more about ARD/ML.) Use maps, tables, and figures to help summarize and depict sampling locations, data, and information.

3.4 Biological Environment

Provide an overview of vegetation (flora), aquatic life, terrestrial wildlife (fauna), avifauna and their respective habitats, and the overall ecosystem(s); use maps, tables, and figures to help summarize and depict monitoring locations, biogeoclimatic zones, habitat extent and boundaries, and genera/species data and information.

4.0 Project Description

4.1 Location and Access

Describe regional and local contexts of affected areas, and provide relevant reference coordinates where applicable; use detailed maps and photo mosaics. Describe access points and methods of access, with seasonal variations and limitations.

4.2 Site History

Provide a relevant summary of the history of any ore discovery, exploration, and previous development and operations that have led to the current project. This would also include any ownership changes and a synopsis of the application, permitting, and licensing process to date. This information should be presented in chronological order. Use figures and photos to depict major site changes and tables where the site history is complex and extensive.

4.3 Site Geology

Describe major rock types and structure, to the level of detail appropriate to depict the mining resource, extraction methods that were/will be used, and the rationale for footprint and specific target areas. Use tables, maps, cross sections, photos, and figures to help the presentation of relevant information.

4.4 Project Summary

For advanced mineral exploration, provide a summary of the proposed activities including size/volume of sampling, areal extent, and the footprint of exploration activities. For a mine development, provide the "life of" mine plan through closure and reclamation as well as a brief summary of the various options that the proponent proposed during the environmental assessment. List all of the project components, as more detailed descriptions of each component will be required in section 5.

5.0 Permanent Closure and Reclamation

5.1 Definition of Permanent Closure and Reclamation

This section should include the following definition of permanent closure:

"Permanent closure is the final closure of a mine site with no foreseeable intent by the existing proponent to return to either active exploration or mining."

Permanent closure indicates that the proponent intends to have no activity on the site aside from post-closure monitoring and potential contingency actions. Permanent closure does not, however, preclude the proponent or another party from pursuing opportunities at the existing site or in the area at a time beyond the foreseeable future.

Proponents should indicate whether any components will require passive long-term care and the expected timelines for relinquishment.

5.2 Permanent Closure and Reclamation Requirements

Describe details for each individual project component. Project components should be categorized as follows unless proponents provide a rationale for a different categorization:

- underground mine workings
- open pit mine workings
- waste rock and overburden piles
- tailings containment areas
- buildings and equipment
- mine infrastructure
- transportation routes
- landfills and other waste disposal areas
- water management systems.

For each project component include, at a minimum, the following subsections.

Project Component Description

Provide a description of each project component, including proposed components and historical components no longer in use. Provide the details of the project component (e.g., dimensions, footprints, and relative locations on a site map) with accompanying figures, maps, and photos as appropriate. Each component should be presented in separate subsections for clarity. The descriptions should also include the lifespan and current status (operating, permitted, temporary closure, and any progressive reclamation completed, etc.) of each component.

For example, for an open pit mine, describe mining methods and facilities in order to illustrate how ore and waste rock were/are removed and what the pit geometry will be at closure (reference dimensions with plan and cross section views) including access points and any geotechnical stability issues and exposed rock types. Describe (quantify) dewatering requirements during operations and how this will differ from closure requirements. For an underground mine, describe mining methods and facilities in order to understand how ore and waste rock will be/were removed and what final geometries of the adit-tunnel system will be. Provide a map showing elevations and dimensions of all openings to surface including portals, adits, and tunnels; describe (quantify) dewatering requirements during operations and how these will differ from closure requirements.

Pre-Disturbance, Existing, and Final Site Conditions

Using maps, photos, photo mosaics, etc. as appropriate, describe (compare and contrast) the pre-development (or pre-disturbance), existing, and projected final site conditions. Illustrate all relevant water bodies (including watershed boundaries), topographic modifications (e.g., waste rock or tailings storage areas, etc.), and vegetation changes. Describe any important or unique environmental conditions (i.e., atmospheric, physical, biological, chemical, and/or social) for the project component that will have a bearing on closure. Accurate and transparent depiction of final site conditions can be critical to good engagement; 3-D representations are encouraged.

Closure Objectives and Criteria

This section of the CRP should list the closure objectives and closure criteria for each project component. Conceptual CRPs and early interim CRPs may include minimal or limited closure criteria as these take time to develop. Any uncertainties related to closure objectives and criteria must be noted along with a reference to the reclamation research plan associated with each.

A table may be helpful during certain stages of the project to illustrate the relationship between closure objectives, selected closure activities, closure criteria, reclamation research, and closure monitoring. The content of these tables may depend on the planning stage. During the initial development of objectives, it may be helpful to document preferences discovered during engagement activities. It is important to note that the timeframe to successfully achieve closure criteria may be short-, medium-, or long-term.

Consideration of Closure Options and Selection of Closure Activities

This section presents alternatives analyses of various closure options, including a discussion of various risk scenarios and any unique or novel closure situations for the component under discussion. This would include, for example, the development of closure options for a complex mine that has more than one open pit in which one pit may close prior to the closure of the other open pits. In this case, an early closure date for one pit may occur prior to a full evaluation of all closure options for the other open pits. The alternatives analysis should clearly demonstrate the pros and cons of each option.

Following the analysis should be a determination of the selected closure activity, with the rationale for the selection of the closure activity and reason(s) for the rejection of other options. This section is dynamic in that modifications will likely occur over time from development of the conceptual CRP through to interim CRPs and the final CRP.

Engineering Work Associated with Selected Closure Activity

This section should describe all demolition, construction, or other engineering work that will be necessary to close and reclaim each project component. As closure planning progresses, proponents should be able to provide a logical sequence and timing of the works (i.e., re-grading comes before revegetation). The conceptual CRP and the first interim CRP are not expected to have a great deal of detail regarding engineering work that will be taken on as part of closure but should provide supporting information for their proposed work to prove the proposed technology or engineering will be successful.

Predicted Residual Effects

This section contains an assessment of any potential negative residual effects that may remain after the completion of the reclamation. Provide results of any risk assessments that were conducted to identify or address the residual effects. Include a discussion on how any residual effects currently predicted to occur at the end of closure and reclamation compare to stakeholders' preferences or the company's commitments made during the environmental assessment (if one has occurred).

Uncertainties

Proponents should identify important uncertainties that arise during closure planning including uncertainties associated with the risks of various closure options and how to select the best closure activity, how to best implement a selected closure activity, how to define closure criteria, how Traditional Knowledge will inform closure planning, and more.

Indicate how each uncertainty will be addressed—whether through specific reclamation research (including Traditional Knowledge research), an engineering study plan, or other means. Proponents should include reclamation research plans in appendices as they develop. The appendix section of this template has a description of the content of reclamation research plans.

Post-Closure Monitoring, Maintenance, and Reporting

The primary purpose of post-closure monitoring is to determine whether closure criteria have been met, and therefore that closure objectives and the closure goal have been achieved. The implementation of a successful monitoring program, which will likely begin during the exploration stage and continue during operations through post-closure, will help the proponent demonstrate that relinquishment can occur.

The proponent should provide a description of what (e.g., fugitive dust, stream flow, wildlife and aquatic life movement, etc.) will be monitored and why. For interim and final CRPs, identify the sampling locations, frequencies, and duration. This section should also include a description of any maintenance activities that will occur post-closure and how monitoring and maintenance activities will be reported.

Contingencies

The proponent must describe what it will do if it becomes apparent that the selected closure activity will not be successful in meeting closure criteria and objectives. List possible contingencies, and identify the preferred contingency with rationale.

6.0 Progressive Reclamation

Progressive reclamation takes place prior to permanent closure to reclaim components and/or to decommission facilities that no longer serve the project. Planning for progressive reclamation should begin during the design stage and continue throughout the life of the mine, using the best skills, techniques, and technologies consistent with those ordinarily applied by mines in the NWT, and as recommended by licensed professional engineers in the NWT.

Progressive reclamation can take advantage of cost and operating efficiencies by using the resources available from an operation to reduce the overall reclamation costs. It also provides valuable information on the effectiveness of certain closure activities that might also be implemented during permanent closure. Progressive reclamation enhances environmental protection by minimizing the duration of environmental exposure and shortens the timeframe for achieving the closure objectives and meeting the closure criteria. It can also reduce the financial liability of the site and allow the return of portions of the security deposit.

Progressive reclamation should align with the overall stated closure objectives. Any completed and upcoming progressive reclamation will also be discussed in the annual CRP progress report.

As the operation evolves through the different stages of the closure and reclamation planning process to final closure and reclamation, refinements to the CRP will reflect completed elements, lessons learned, and outstanding issues. While this section mostly pertains to mine sites, advanced exploration sites should include any relevant information in the subsections below.

6.1 Definition of Progressive Reclamation

This section should include the following definition of progressive reclamation:

"Progressive reclamation takes place prior to permanent closure to reclaim components and/or decommission facilities that no longer serve a purpose. These activities can be completed during operations with the available resources to reduce future reclamation costs, minimize the duration of environmental exposure, and enhance environmental protection. Progressive reclamation may shorten the time for achieving closure objectives and may provide valuable experience on the effectiveness of certain measures that might be implemented during permanent closure."

6.2 Opportunities for Progressive Reclamation

This section calls for details of any progressive reclamation and expected relinquishment that will occur during the life of the project. It should include the location and areal extent of the work, a description of the planned reclamation activities, and any planned monitoring that will be required. The level of detail in this section should increase as commencement of progressive reclamation approaches.

Describe any monitoring activities that will occur to assess progressive reclamation to ensure the attainment of the closure objectives and closure criteria. These may include components of an existing monitoring or surveillance network program.

Proponents should contact Board staff to discuss which submissions will be required with respect to progressive reclamation activities.

6.3 Completed Progressive Reclamation

This section is a summary of all progressive reclamation activities that have occurred at the site, including their locations. It includes a list of reports (e.g., reclamation completion or performance assessment reports) submitted to the Boards that describe any reclamation that has occurred. It is here that proponents describe any lessons learned from progressive reclamation that will inform closure planning at the site.

7.0 Temporary Closure

Temporary closure occurs when an advanced mineral exploration or mining operation ceases with the intent of resuming activities in the near future. Temporary closure could be due to an unplanned closure or a planned closure of certain facilities in a complex mining project. The proponent should propose the duration for what constitutes temporary closure at their particular operation.

During temporary closure, proponents must maintain all operating facilities and programs necessary to protect humans, wildlife, and the environment, including necessary environmental monitoring. Proponents need to ensure appropriate financial resources are available to continue environmental monitoring and reporting during

temporary closure. Care and maintenance staff should be present at the site and in sufficient number and expertise to care for the site and any potential problems that may arise. Sufficient equipment and supplies should be available on site for any maintenance or reclamation activities that may need to take place.

7.1 Temporary Closure Goal and Closure Objectives

In this section, proponents state the closure goal and closure objectives of temporary closure if these differ from those for permanent closure.

7.2 Temporary Closure Activities

Temporary closure activities for each individual project component should be selected to ensure the closure objectives are met. At a minimum, the following activities should be included and implemented during times of temporary closure:

- Secure and restrict access to the site, buildings, and all other structures to authorized personnel only;
- Guard or block all openings and post warning signs;
- Continue all physical, chemical, and biological treatment and monitoring programs according to water licences, land use permits, and land lease conditions in order to maintain compliance.;
- Secure all waste management systems;
- Conduct an inventory of chemicals and reagents, petroleum products, and other hazardous materials and secure appropriately or remove if required;
- Record fluid levels in all fuel tanks and monitor regularly for leaks or remove from the site;
- Store hazardous waste at an approved on-site waste management facility prior to shipping for off-site disposal to an appropriately registered receiving facility;
- Relocate all explosives to the main powder magazine and secure, dispose of, or remove from the site;
- Stabilize all waste rock piles, ore stockpiles, tailings, waste water and other containment structures and maintain in an appropriate manner (including regular geotechnical inspections);
- Inspect drainage ditches and spillways and maintain regularly (e.g., seasonally depending on snow and ice accumulation and melting) during the closure period and include as part of geotechnical inspections;
- Inspect facilities and infrastructure regularly; and
- Keep the security deposit up-to-date.

7.3 Temporary Closure Monitoring, Maintenance, and Reporting

Proponents must describe any monitoring activities that will occur during temporary closure to ensure the CRP's closure objectives and all water licence conditions
are met.

7.4 Temporary Closure Contingency Program

The proponent must describe how they would handle unforeseen events or conditions during temporary closure if the response would differ from normal operations. Proponents must explain the effects on any monitoring activities and how they would address any such effects.

7.5 Temporary Closure Schedule

In this section, proponents should:

- Describe the anticipated timing and sequence of events preparing for and occurring during temporary closure;
- Provide descriptions of temporary closure activities for each project component;
- Use charts or tables if the nature of activities is complex; and
- For planned temporary closure, estimate how long the closure will last and provide the approximate end date of the closure period.

8.0 Integrated Schedule of Activities

It is important that the Boards are confident that a proponent's planned schedule of activities will result in timely and successful closure and reclamation. Proponents need to provide a component-specific schedule that depicts operations, closure dates, and expected start and end times for selected closure activities. This schedule will include any progressive reclamation, initiation, and completion of research (including pilot studies), timeframes for meeting closure criteria and monitoring and reporting phases. For interim and final CRPs, a Gantt-type chart or equivalent may assist in depicting temporal sequences of multiple tasks and identifying critical paths (i.e., those that would impede the progress of inter-related tasks or the overall project process).

Boards recognize that schedules are subject to change as mine plans adapt over time. Proponents should therefore discuss schedule uncertainties based on, for example, extent and success of progressive reclamation, temporary and permanent closure, research and studies, and upset conditions.

9.0 Post-Closure Site Assessment

The proponent should provide a description or study design of how the residual environmental impacts of the project as a whole will be assessed once they have completed the selected closure activities.

10.0 Financial Security

The proponent should:

- Provide estimates of total liability associated with permanent closure (including post-closure monitoring programs and activities);
- Break down costs associated with each component;
- Use tables where appropriate; and
- Present the estimate to match the timing of closure and reclamation activities as depicted with the schedule provided in section 8.0 (For general information on security see Part 1, subsection 1.3).

11.0 References

This includes documents and reports that support the characterization of baseline environmental data (e.g., terrestrial studies, hydrology and aquatic studies, and climate and air quality studies), geochemical analyses and predicted ARD/ML potential, and any relevant engineering work related to support the CRP.

Appendices

All CRPs should include the following appendices:

A) Glossary of Terms and Definitions – The definitions section should include discipline-specific technical terms (e.g., processed kimberlite, esker, dewatering) and key closure and reclamation planning terms (e.g., closure goal, closure objectives, closure criteria, etc.) explained in plain language.

B) List of Acronyms, Abbreviations, Units, and Symbols

C) Record of Engagement – This is a table that outlines all engagement specific to closure that has occurred; it must include any issues identified by the engaged parties and how the company has addressed them or modified the project in response.

D) Lessons Learned from Other Projects – In this summary table of relevant on-site closure issues/concerns that have been dealt with successfully or unsuccessfully, the proponent should focus on those lessons that would have direct application to managing project closure and reclamation. This table could take the following form:

Development	Activity Which Led to Lesson	Lesson Learned	Management Result
Ekati Diamond Mine - NWT	Infrastructure development in caribou migration paths	Potential for caribou passage to be impeded or for caribou to be injured/ killed by infrastructure exists	Provided wildlife access ramps on on haul roads; constructed inukshuks around perimeter of site
Brewery Creek Mine - Yukon	Revegetation of reclaimed slopes	On-going fertilization over a period of three years was more important than rate of seed application	Adjusted future revegetation programs to include maintenance fertilizing for additional years to develop stability and self-sustaining vegetation cover
Polaris Mine and Nanisivik Mine - Nunavut	Management of hydrocarbon- contaminated materials	Placement of hydrocarbon-contaminated materials in the underground workings	Hydrocarbon contaminated materials stabilized by encapsulation within the permafrost zone

E) Reclamation Research Plans - Interim CRPs will require reclamation research plans that may include engineering studies and/or focussed research to address uncertainties. Proponents should follow the outline below and note that the level of required detail is higher for research that will occur prior to the next version of the closure plan as described below.

1.0 Uncertainty – The uncertainty is defined as an outstanding question on how the proponent will address a physical, biological, chemical, social, cultural, geographical, or other aspect of the mine through the research or study. This section describes the uncertainty that the proponent will address.

2.0 Research/Study Objective – This section states the purpose and desired outcome of the research/ study. It includes a description of how the research/study will resolve the uncertainty.

3.0 Overview of Tasks – This section describes the tasks necessary to complete the research/study as follows:

3.1 Completed Tasks – In this section, proponents provide a summary of the completed research/ studies along with a summary of the relevant results and any lessons learned. This provides the basis for assessing which data and information are still required.

3.2 Remaining Tasks and Scopes of Work – Here, the proponent provides a list of the remaining tasks along with either a detailed or conceptual level scope of work. For the remaining tasks that will commence prior to the submission of the next version of the interim CRP, more detail is expected. For those remaining tasks that will commence after submission of the next version of the CRP (more than three years away), only a conceptual scope of work is required. In both subsections, the scopes of work should be sufficiently detailed in order for the Board and other stakeholders to determine if the reclamation research will provide the needed information early enough to complete the CRP in a timely manner.

Also included should be the rationale for the timing, sequencing, and prioritization of the work to be completed.

4.0 Linkages to Other Research/Studies – This section identifies how this research/study project is linked to and affected by the results from other research plans or engineering studies.

5.0 Project Research Schedule – Provide a schedule for the remaining tasks. Include a description of how the timing of the research links to mining operations throughout the life of the project.

6.0 Costs – This section lists the expected costs for the research/study plan activities.

7.0 References – This is a list of references for completed research/studies.

Part 3 – Technical Considerations for Effective Closure and Reclamation

3.1 Introduction

This section of the Guidelines provides a summary of technical aspects that need to be considered during the planning and designing stage of mine site closure and reclamation. Although specifically developed for mine sites, many of the technical items outlined below are applicable to advanced mineral exploration sites and the proponent should consider them to ensure a smooth transition from the advanced mineral exploration phase to mine development. The two technical categories are:

1. Common site-wide mine closure and reclamation considerations (section 3.2); and
2. Individual project component closure and reclamation considerations (section 3.3).

All mines are unique and have project-specific challenges and issues that may arise during operation. Proponents of mining operations need to be prepared to plan for site-specific needs and are cautioned not to consider only those items that are presented in this document. The information provided in this section is not exhaustive. The intent is to provide initial guidance on how to effectively plan for the closure and reclamation of a mine site. Proponents should ensure that they draw on a suitable level of expertise to prepare CRPs. Additional reference and guidance documents are listed in Appendix A. The technical considerations will be organized under the following headings that are further described below:

- Closure Objectives (for individual project components only – section 3.3)
- Closure and Reclamation Planning Considerations in Mine Design
- Closure Options
- Northern Limitations and Considerations
- Post-closure Monitoring

3.1.1 Closure Objectives

Closure objectives describe what the selected closure activities are aiming to achieve; they must be measureable, achievable, and allow for the development of closure criteria. More information on closure objectives (including information about engagement on this issue) is provided in Part 1, subsection 1.1.3.

Proponents should develop closure objectives during preparation of the conceptual CRP (i.e., during the project assessment and approval phase). Closure objectives may be more general in the earlier stages of the project and can be made more specific once there is more certainty about how the project develops and the results of reclamation research and ongoing engagement are available.

Closure objectives should be developed for each project component; however, some objectives may repeat across a number of components, while others may differ from component to component. As an example of the latter case, wildlife access may be limited or prevented for one project component but encouraged for another.

In recognition that proponents may benefit from assistance with developing closure objectives, AANDC and the Boards have prepared examples of closure objectives for each project component. These example objectives (see section 3.3) are not exhaustive and will not apply equally to all mines. Proponents should use these objectives as a starting point and tailor them as needed to reflect input from stakeholders, physical or chemical conditions, project history, reclamation research, and other site-specific factors.

When developing closure objectives, proponents should closely follow the closure principles of chemical stability, physical stability, no long-term active care requirements, and future use (including values and aesthetics). Ultimately, the proponent must design the objectives to ensure that they will achieve the closure goal for the site (see Part 1, section 1.1).

3.1.2 Closure and Reclamation Planning Considerations in Mine Design

The mine design needs to incorporate closure and reclamation planning considerations to best identify processes and forces that may act upon the project components following closure and reclamation and ensure they are factored into design and operation.

Key considerations when designing for closure include integrating both Traditional Knowledge and other scientific information, making use of the best available information and technology, promoting environmental protection, and applying the precautionary principle in the absence of conclusive information.

The proponent must design, operate, close, and reclaim the site to minimize or eliminate the risk of negative impacts on the environment, wildlife, and humans. There should be no necessity for ongoing intervention or operations, other than periodic inspections and minimal maintenance, following closure and reclamation. Designing for a walk-away scenario and eliminating long-term active care requirements is particularly important in the NWT due to the isolation of mine sites and high transportation and mobilization costs.

Designing for closure aims to achieve the following:

- Project components are constructed in such a way that they achieve or can readily be modified to achieve the closure objectives and closure criteria;
- Closure and reclamation costs are part of closure planning, and these costs are borne by the proponent to provide adequate financial security to cover the cost of reclamation over the life of the mine to ensure closure criteria can be met;
- Closure and reclamation planning interacts regularly with planning for the development and operation of the mine site to ensure that operations do not unnecessarily increase the workload for reclamation or effectively compromise what might otherwise be promising closure options; and
- Progressive reclamation activities are incorporated into the mine's operation.

3.1.3 Closure Options

Closure options are potential activities that proponents could take to ensure that progressive and post-closure reclamation meets the stated closure objectives. These should utilize and adhere to the best available practices and technologies suitable to the site for each of the mine components.

Because progressive reclamation activities occur during operations, they can take advantage of cost and operating efficiencies by using the resources available at the mine site. This reduces the overall closure and reclamation costs and demonstrates actual site-specific results under real field conditions. The result is enhanced environmental protection, a shortened timeframe for achieving the closure objectives, and a reduction of financial security requirements and related uncertainties. Post-closure reclamation activities occur once mining operations have ceased indefinitely.

For certain project components, many of the closure options suggested could be initiated during either the progressive or post-closure timeframe and are thus grouped together. Where a clear distinction exists for carrying out progressive or post-closure options, they are listed separately within those categories.

3.1.4 Northern Limitations and Considerations

This section describes closure aspects that are unique to the NWT and to the North in general. Proponents should carefully consider and investigate these aspects during closure and reclamation planning and design as schedules for construction, operations, and subsequent closure and reclamation will be affected by the location, climate, water environment, terrain, permafrost conditions, and potential effects of climate change. Sources of additional literature are included in the references section.

Location

Mine sites in the NWT are often located in remote areas with restricted accessibility, limited road access, and/or seasonal access. Boat or barge access may be available for coastal projects, while other operations may be restricted to light aircraft and/or winter roads.

There are few large communities in the NWT and it is typical that project sites can be several hundred kilometres away from the nearest community. The location of the site will often dictate the project's feasibility, and proponents need to factor in the potential high costs when planning for closure and reclamation.

Climate

The climate of the NWT is characterized by long, dark, cold winters and short, warm summers with extended hours of daylight. Lakes and rivers remain frozen for most of the year, and the annual total precipitation is generally low. When temperatures rise, snowmelt adds to the spring freshet in a relatively short period and can result in rapid erosion.

Climatic factors can also limit the site's accessibility, thus affecting reclamation activities or schedules. Periods of ice freeze and thaw may limit accessibility where operations utilize open lakes for aircraft landing in the summer and frozen ground or water for airstrips and roadways in the winter. Harsh weather conditions such as extreme cold, fog, and storms may also dictate site accessibility.

Water Environment

Lakes, rivers, and other water bodies in the NWT are relatively pristine and can be sensitive to minor environmental changes such as a change in the lake- water chemistry. The effects of water body reactions from environmental changes are not fully understood; however, water does play a vital role in Aboriginal cultures, as hunting and fishing continue to be important parts of Aboriginal life, thus it needs to be carefully considered.

Vegetation Environment

The degree and extent of vegetation cover in the NWT is variable, and results from vegetation research in tundra, subarctic, and arctic regions are limited. There is little information regarding seed production, plant community changes with succession, or the native plants best used for developing communities on disturbed sites. There is also a lack of sufficient volumes of early plant colonizers to propagate for stabilization of large disturbed sites.

Terrain

The geological and geographic setting varies greatly across the NWT and may govern the degree of natural resources that are available for reclamation purposes. For example, much of the Precambrian Shield that dominates parts of the NWT has only a veneer of soil cover of generally less than two metres. Consequently, construction materials suitable for reclamation activities may not be readily available on site or may be difficult to obtain. The supply will also be limited in regions affected by permafrost.

Topography and local surface conditions may also dictate the accessibility of a site. Mountainous regions can limit site access, and potential seismic activity may require additional planning considerations. The degree of vegetation, boulder, and water cover at a given site are other factors to consider in closure and reclamation planning.

Permafrost

Permafrost is ground that remains at or below zero degrees Celsius for a minimum of two consecutive years. It may consist of bedrock, unconsolidated sediments (gravel, sand, silt, or clay), organic materials (peat), and ground ice.

The presence of permafrost at a mine site requires additional considerations with respect to project planning and closure and reclamation. It is therefore important to understand what permafrost is, where it is likely to occur, and how it can affect mine infrastructure and reclamation activities. Permafrost

may also be used to physically and chemically stabilize disturbed sites (e.g., waste rock storage areas and dam construction).

Permafrost is present throughout Canada and can be classified by zones that represent varying degrees of permafrost coverage. Temperature (mean annual ground temperature) also characterizes permafrost, and it can vary by several degrees across the NWT. Thickness of permafrost can also vary from tens of metres in the southern NWT to hundreds of metres on the northern tundra. Permafrost derives its geotechnical significance from the presence of ground ice, which varies in amount depending on the soil type and geological and thermal history of the environment. Proponents should consider these characteristics of permafrost in the context of planning the development, management, maintenance, and closure and reclamation of the operation.

Climate Change

Proponents should consider the possible effects of climatic change at mine sites in the NWT, as the area has experienced climate warming during the late 20th century. The long-term effects of climate change on the annual temperature range, total precipitation, seasonal variation, variability of precipitation, evaporation, permafrost degradation, changing ice conditions, and hydraulic routing are difficult to predict. Consequently, where individual project components have a medium or high potential for environmental impact if failure occurs, it is necessary to select design parameters based on conservative interpretation of historic records and consideration for the changes that may occur in the future to minimize the level of anticipated risk (e.g., for the construction of dams and tailings storage areas, etc.).

Long-term changes in vegetation, or those simply induced by human disturbance, can influence permafrost temperature and terrain and infrastructure stability. Changes in water temperatures are also important factors that can be affected by climate change as they can interact with permafrost to influence the stability of frozen core structures and shorelines.

Climatic changes may lead to permafrost degradation and the melting of frozen-cored structures; instigate natural disasters such as flooding, landslides, or increased incidence of forest fires; alter wildlife habitats and migration routes; and affect the viability of winter roads.

3.1.5 Post-Closure Monitoring

Post-closure monitoring will be required to confirm the success of the closure objectives once operations cease indefinitely. Closure criteria will assist in the development of post-closure monitoring programs and will provide clear interpretation of monitoring results.

If it is determined that closure objectives were not met for individual project components (as demonstrated by the closure criteria not being met), the proponent will need to implement ongoing monitoring, maintenance measures, and possibly contingency plans. Where a catastrophic event or natural disaster occurs prior to relinquishment, additional monitoring and maintenance may be necessary. Proponents should consider establishing monitoring programs with involvement from local Aboriginal communities.

If closure criteria are achieved, then a cessation in monitoring activities for the reclamation of an individual project component may be approved by the Boards. However, if risks to the site remain, additional monitoring may be necessary. When closure criteria have been achieved and verified by Inspectors for specific components, the proponent is then eligible to request the appropriate reduction in their security deposit.

3.2 Common Site-Wide Mine Closure and Reclamation Considerations

Below is guidance on closure and reclamation considerations that may be common to several project components. Since these common site-wide considerations pertain to more than one project component, specific closure objectives will not be listed in this section but rather will be recorded under the appropriate project component in section 3.3.

The following site-wide mine closure and reclamation considerations are described below:

- Acid rock drainage and metal leaching
- Revegetation
- Contaminated soils and groundwater
- Physical and geotechnical stability.

These site-wide considerations do not require closure objectives. However, the proponent needs to develop closure objectives for each project component.

3.2.1 Acid Rock Drainage and Metal Leaching

Acid rock drainage (ARD) is a general term applied to any acidic leachate, seepage, or drainage arising from the weathering of undisturbed or excavated geological materials (rocks and soil) containing sulphide minerals or their weathering products. Weathering reactions intensify due to the acidity generated by the oxidation of sulphide minerals, which results in the release of elements from rocks and soil. Under the prevailing acidic conditions (low pH), metals released from the solid phase (rocks, soil) remain in solution and this is referred to as metal leaching (ML). While most metals are mobile (remain in solution) under acidic conditions, some metals are only mobile under neutral or alkaline conditions.

To develop appropriate CRPs, the ARD/ML potential of pit walls, tailings, overburden material, and other mine-related materials such as paste backfill, should be considered and evaluated in detail. For example, permanently exposed walls may act as a continuous source of contaminants. Flooding of pit walls or stored materials such as process waste (tailings) that have been exposed may cause the dissolution and release of accumulated oxidation or weathering products. The geochemical assessment of ARD/ML potential can be complex and involve some long-term tests taking months or years to complete. Therefore, understanding the potential of ARD/ML in the early stages of mine planning and design (and continuing to enhance this understanding during the life of the mining operation) will ultimately improve the design of the closure options in the CRP and ensure minimization of the risks from ARD/ML occurrence.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts with respect to the control and treatment of ARD/ML:

- Develop plans for impact prevention, material characterization, material handling, waste disposal, site reclamation, site water management, monitoring, and maintenance.
- Consider modifications in mining and mineral processing (e.g., avoid mining of high sulphide ores, use gravity/floatation instead of cyanidation for extraction) to minimize the impacts on the environment.
- Assess methods that can be used to prevent ARD/ML at the site, including:
  - limiting exposure to oxygen (e.g., water covers, dry covers, water saturation);
  - chemical or physical intervention (e.g., coating to limit sulphide exposure, using bactericides to reduce catalyzed oxidation reactions, blending or layering different materials to increase the distribution of buffering minerals, using alkaline additives, adding covers);
  - isolating acid generating materials (e.g., segregating materials for controlled disposal, backfilling waste rock or tailings into the underground workings or into the open pit, encouraging cold temperatures and/or permafrost to reduce reaction rates); and
  - dry stacking filtered tailings or storing paste tailings on the surface to minimize potential future migration of contaminants from the area.

- If physical control measures are used to manage a chemical problem, they should be designed to reduce the extent of the chemical risk rather than only contain or isolate the chemical problem (i.e., prevent the chemical reaction resulting in ARD from occurring, as opposed to simply collecting any runoff).
- Select a comprehensive set of geochemical analyses that characterize the various (waste) materials and then determine their potential for ARD/ML.
- Run static and kinetic ARD/ML prediction tests (e.g., acid base accounting, laboratory tests with humidity cells and columns, field tests with bins and piles) along with field tests and monitor site seepages from mine waste water.
- Evaluate the use of cover systems, diversion ditches, and berms to minimize exposure to surface water (infiltrations and runoff) and atmospheric oxygen.

Closure Options

Closure options for progressive and post-closure reclamation to address ARD/ML may include, but are not limited to, the following:

- Flood underground mine workings.
- Control acidic and contaminated water at the source; prevent contaminated water flows.
- Divert or intercept surface and groundwater from potential sources of ARD/ML.
- Prevent or reduce water infiltration into materials stored above ground that could generate ARD/ML, by installing cover systems or seals.
- Utilize freezing conditions (ground or air) to limit the formation and discharge of leachate.
- Place potentially acid generating materials completely under water or underground if appropriate.
- Place potentially acid generating rock within the centre of the waste pile to encapsulate it by other host rock and/or permafrost if local conditions permit and if no other options for disposal are viable or available.
- Mitigate consequences of ARD by the use of treatment systems, preferably for in-situ conditions.
- Utilize passive system treatment options such as:
  - chemical (e.g., open limestone channels, adsorption, and mineral precipitation in settling ponds and along flow paths);
  - biological (e.g., sulphate reduction and precipitation of metal sulphides in natural wetlands); and
  - Physical (e.g., particle settling in sedimentation ponds or along flow paths; filtration).
- Utilize active system treatment options such as:
  - chemical (e.g., chemical treatment involving neutralization or mineral precipitation; ion exchange and adsorption);
  - biological (e.g., sulphate reduction and precipitation of metal sulphides in bioreactors; phytoremediation); and
  - physical (e.g., membrane filtration).

Northern Limitations and Considerations

Proponents should consider the following items when developing reclamation plans to address ARD/ML issues at northern mine sites:

- There is limited long-term experience with ARD/ML mitigation measures in northern environments. However, there is a large body of knowledge on best management practices and technologies to draw upon.

- Chemical reaction rates are often much slower due to very low temperatures; this delays the effects of potential ARD/ML which could benefit the selected mitigation measures.
- While low temperatures will slow chemical weathering processes during a large part of the year, there is also a large seasonal flush of accumulated contaminants during spring melt. Moreover, due to the scale of the waste rock piles after closure, infiltrating water from precipitation may not freeze in the voids, resulting in increased drainage with poor water quality.
- There is increased oxygen solubility with decreasing water temperatures.
- Chemical reactions are dependent on the presence of water, which implies that reactive materials will remain inert during a considerable part of the year when freezing conditions with little precipitation prevail. However, there is evidence of acid generation reactions at temperatures below zero degrees, so cooling rock or tailings below zero does not guarantee cessation of acid generation.
- Reduced water during the colder months will minimize the quantity of contaminated water that requires treatment.
- Once ARD/ML is being generated in the North, there is potential for serious environmental impact, because many lakes in the NWT have low background levels of metals.
- The available cost-effective mitigation and treatment options will be limited, given the distances and transportation costs.
- Aspects of ARD/ML prediction, prevention, control, and mitigation methods unique to cold climate environments include:
    - effect of unfrozen water in tailings that can act as a transport mechanism for contaminants;
    - effect of freezing point depression by process reagents and concentration of various ions and cations;
    - design and use of practical cover systems in permafrost zones for various design purposes, including permafrost encapsulation;
    - chemical reaction rates or incomplete oxidation reactions of stored materials under cold climatic conditions;
    - scaling of laboratory test results performed under standard conditions (e.g., kinetic tests) to the field scale when it involves predicting the performance under cold climatic conditions; and
    - effects of cold climatic conditions on the efficiency of in-situ treatments such as lime addition and passive wetland treatment.

Post-Closure Monitoring

Post-closure monitoring with respect to ARD/ML is conducted to ensure that the potential for ARD/ML is minimized, or if ARD/ML is present, that the impacts are minimized or mitigated. Monitoring should also confirm that long-term maintenance will not be required. Specific activities may include, but are not limited to, the following:

- Inspect the physical and geotechnical stability of the mine site to ensure that no erosion, slumping, or subsidence will occur that would cause exposure of potential acid generating material to atmospheric conditions (water, oxygen).
- Inspect any preventative and control measures (e.g., cover systems) to ensure that they operate according to their design specifications (minimize exposure to water and oxygen).
- Confirm that there is sufficient water supplied to maintain an appropriate water depth in designed water covers.

- Compare predicted water quality and measured water quality.
- Evaluate existing monitoring locations and frequency on a site-by-site basis and make adjustments where necessary. This may involve creating new monitoring locations where possible contaminated drainage is generated, or removal of existing monitoring stations where drainage can be integrated into the water management system or released into the environment.

3.2.2 Revegetation

Revegetation of impacted areas on a mine site may include natural revegetation from colonization by native plants or enhanced revegetation where vegetation is planted for specific purposes such as erosion control, regulation of near surface moisture conditions, or aesthetics. Due to the geographic diversity present throughout the NWT, a broad range of vegetation types and conditions exists. In more northerly locations, vegetation is sparse and generally limited to short shrubs and lichen. In more southerly locations, particularly below the tree line, vegetation is generally more abundant in variety and robust in size. As such, revegetation (whether natural or enhanced), and its potential impact on the reclamation of individual project components should be given site-specific consideration.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts with respect to revegetation:

- Determine baseline ecological conditions prior to disturbance.
- Conduct local soil assessments to determine whether organic supplements should be used (e.g., peat, biosolids) if enhanced revegetation measures may be required.
- Include native plant collection and propagation methods, successional processes, and final plant communities that provide biodiversity and sustainability to reclaimed sites in the research plan.
- Consider bioengineering (use of living organisms or other biological systems for environmental management) approaches to stabilize soils, control erosion, and enhance natural re-vegetation.
- Consider approaches that include, but are not limited to, the use of wattle fences, live gravel bar staking, and rough and loose staking to stabilize embankments.
- Conduct studies to characterize the local climate, temperature, precipitation, and wind as they relate to vegetation growth.
- Strip, stockpile, and properly cover organic and fine-grained soils from disturbed areas (such as open pits, waste rock piles, infrastructure, and tailings facility footprints) consistent with the need to maintain permafrost and to keep for future use during progressive reclamation.
- Record volumes of soil strippings for later consideration in closure and reclamation planning.
- Consider revegetation of waste rock piles through slope stabilization and enhancement with finer grade materials.

Closure Options

Closure options for progressive and post-closure reclamation with respect to revegetation may include, but are not limited to, the following:

- Contour, scarify, and seed areas using seed mixes or cuttings from native vegetation to establish vegetative cover.
- Consider using organic stockpiles as a seed bank.

- Avoid the introduction of non-native species to establish vegetative cover for project components. The Boards may consider the use of non-native species (e.g., for emergency erosion control) on a case-by-case basis.
- Incorporate a gravel layer (capillary break) within a cover system to control or limit upward migration of pore water of underlying mine wastes to prevent contaminant uptake in vegetation.
- Apply stripped/stockpiled soil or growth medium to a depth sufficient to maintain root growth and nutrient requirements.
- Use organic materials, mulches, fertilizers, or other temporary soil amendments to assist with developing a self-sustaining system.
- Establish appropriate temporary or permanent wind breaks where necessary to establish vegetation.
- Transplant vegetation that would otherwise be lost to mine disturbance where feasible.
- Select native vegetation that has a low potential for metal accumulation.
- Use plants that neither attract or repel wildlife to create a neutral landscape.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans that include revegetation efforts at northern mine sites:

- Revegetation success may be limited (rate of growth, areal coverage, species) due to northern climatic conditions including, but not limited to, cold mean daily temperature, short frost free period, slope aspect, short growing season, low availability of moisture and nutrients, amount and timing of precipitation and runoff, and exposure to wind.
- Succession of vegetation species in the North is generally slow.
- Management of soil stockpiles for final reclamation needs to consider impacts of the northern climate. Examples include: permafrost aggradation into soil stockpiles; difficulty dealing with frozen stockpiles during the short, warm months; and nutrient production during the storage period by having stock piles laid out to increase their surface area.
- Use of fertilizers in northern environments has the potential to impact downstream water bodies.
- There may be a lack of viable/suitable soil and seed sources.
- There may be limited peat inventories on any given site, so effective stockpiling during stripping/construction is critical. Avoidance of undisturbed peat sources will minimize impacts on ecological and ground thermal regimes.
- Vegetation may not be appropriate for controlling erosion due to length of time required for the vegetation cover to develop.
- Information resources on revegetation of mine sites in the North (e.g., species, seed collection and availability, soil development) may not be as readily available as at southern sites.
- Consider the effect of vegetation on near-surface permafrost (e.g., tall shrub vegetation catches snow and may impact near-surface ground temperatures). This may be a concern if establishing tall shrubs on a tailings cover system that is designed to promote permafrost aggradation.

Post-Closure Monitoring

The purpose of post-closure monitoring for revegetated sites is to ensure that closure objectives related to indigenous vegetation growth, wildlife habitat, and physical and chemical stability are being met. Actions that proponents should take to monitor revegetation may include, but are not limited to, the following:

- Inspect revegetated areas periodically following initial planting until vegetation is successfully established and self-sustaining in accordance with closure criteria.
- Conduct soil analyses for nutrients and pH until the vegetation is successfully established and self-sustaining in accordance with the agreed criteria.
- Monitor metals uptake in vegetation and conduct risk assessments if needed to determine if uptake poses unacceptable risk to human, wildlife, and environmental health.
- Monitor areas where growth of vegetation may be impacting the ground thermal regime.
- Monitor growth rates and succession of vegetation species.
- Monitor expansion of growth areas outside planted zones and determine if the impacts are beneficial or detrimental to performance of selected closure activities.
- Monitor for propagation of non-native or undesirable species.
- Inspect vegetated areas that may be obscuring possible cracks and other problems on dams and embankments.
- Inspect root systems of vegetation that are colonizing the surface of cover systems to observe if they are contained within the growth medium (e.g., soil, rock fill) and are not penetrating underlying cover materials.
- Consider appropriate maintenance (brushing) options if vegetation encroachment (deep rooting species) results in disruption of cover materials.
- Identify excessive vegetation stress or poorly established areas and implement contingency measures if required.
- Monitor wildlife use of revegetated areas to determine if viable wildlife habitat has been created.
- Where necessary, re-plant and add amendments to ensure long-term revegetation success.
- Depending on the extent of the revegetation effort, consider passive monitoring approaches including aerial surveillance and remote sensing.

3.2.3 Contaminated Soils and Groundwater

Fuel, chemicals, tailings, ore-associated metals, and other substances can contaminate soils and groundwater through accident or failure of management systems.[13] Contaminated groundwater refers to all water below the ground surface that the aforementioned substances have contaminated. Reclamation of contaminated snow and ice follow the same principles for contaminated soils; however, impacted snow and ice should be reclaimed immediately upon discovery (prior to melting).

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project in order to minimize post-closure reclamation efforts and impacts with respect to contaminated soils and groundwater: [14]

- Consider environmental practices/operating procedures that eliminate or reduce the use of harmful substances or require materials less detrimental to the environment.
- Contain potentially environmentally harmful products (such as fuel and other chemicals) in properly designed (lined) facilities to limit the environmental impacts should an uncontrolled release occur.

[13] The Canadian Council of Ministers of the Environment (CCME) *Canada Wide Standards Phase I-III Environmental Site Assessments* are a recognized method for identifying and delineating impacted areas.

[14] Refer to AANDC's *Guidelines for Spill Contingency Planning* (2007) for additional design considerations and general information.

- Consider diverting surface water flow (using ditches, swales, or berms) around active storage facilities and/or impacted zones to reduce infiltration, groundwater contamination, and contaminant mobilization.
- Construct land farm or soil treatment pad/ facilities in an appropriate location.
- Identify optional treatment and remediation technologies (destruction, immobilization, separation).
- Consider dusting, and its control, during the design of any tailings storage facility.

Closure Options

Closure options for progressive and post-closure reclamation for contaminated soils and groundwater may include, but are not limited to, the following:

- Excavate and remove contaminated soil and place into a designated and properly managed containment area onsite (e.g., land farm); in some cases, subsequent treatment and off-site disposal may be necessary.
- Treat contaminated soil without excavating (in-situ) where possible using appropriate technologies such as bioremediation, soil leaching, and washing; or excavate and remediate (ex-situ). Energy-intensive treatment options such as thermal desorption may be considered.
- Immobilize contaminants in soil (e.g., cement solidification, lime/silicate stabilization, etc.).
- Consider encapsulation of contaminated materials within permafrost (e.g., in underground mines or waste rock piles) provided monitoring instrumentation is in place to confirm near-freezing temperatures are maintained at depth.

Northern Limitations and Considerations

Proponents should consider the following items when developing their closure and reclamation plans with respect to contaminated soils and groundwater at northern mine sites:

- There may be climate challenges with respect to bioremediation of hydrocarbon-contaminated soils in the North (e.g., short, cool summers reduce the opportunity for bioremediation).
- The presence of frozen soil may reduce the downward migration of contaminants, but it will enhance the overland transport of spills in winter.
- Frozen soil is not an impermeable barrier to contaminants (research has shown that permafrost, like bedrock, can contain faults, fractures, and fissures that serve as reservoirs for certain contaminants such as free-phase petroleum hydrocarbons), and it may need to be excavated and treated.
- Seasonal deep freezing, particularly in low moisture content materials, may affect contaminant transport in groundwater.
- Frozen ground, either natural or enhanced, may be a way to assist containment in the short term; however, the influence of unfrozen water, air-filled voids, and altered ground thermal regimes due to disturbance and climate change should all be considered.
- The movement of surface water and groundwater during spring melt is complicated by the thawing of the active layer.
- Some processes generate a large amount of heat, which may cause permafrost degradation (an insulating pad constructed to reduce heat loss may be required) and enhance the ability for contaminants to migrate both vertically and laterally into the soil or groundwater.

- Groundwater sampling using monitoring wells is complicated by permafrost and deep seasonal freezing. The technical feasibility of using groundwater monitoring wells in permafrost regions can be aided by the installation of a heat trace in the well to permit melting of any ice in the well prior to sampling.
- Due to the remoteness of many northern mine sites, removal of contaminated soils and treatment of contaminated groundwater can be logistically difficult (expensive and seasonally dependant).
- When proponents alter the ground surface or construct facilities, especially buildings with heated floors, they should anticipate changes to ground thermal regimes.

Post-Closure Monitoring

The purpose of post-closure monitoring of contaminated soil and groundwater remediation areas is to ensure successful remediation such that the area is not a significant source of contamination and is compatible with future uses. Monitoring activities may include, but are not limited to, the following:

- Regularly analyze trends in monitoring data to assess the effectiveness of selected closure activities.
- Visually monitor the physical stability of former contaminated soil excavation or containment sites (watching out for signs of erosion or thermal degradation of permafrost).
- Collect sufficient confirmation samples to ensure the complete removal of impacted soils or the successful treatment of impacted groundwater.
- Where complete contaminant removal is not possible and risk management approaches are implemented to minimize exposure (i.e., pathway control, limiting receptor access), undertake periodic reviews to assess their effectiveness.

3.2.4 Physical and Geotechnical Stability

In order to maintain the effectiveness of the selected closure activities for landforms that remain on-site following mine closure, the physical and geotechnical stability of these landforms must be preserved. As such, designs need to be sufficiently robust to withstand potentially detrimental processes which relate to physical stability such as erosion (wind, water, waves) during extreme climatic events and processes which relate to geotechnical stability such as slope instability (i.e., related to high pore pressures or seismic loading), settlement, and permafrost degradation. Examples of landforms that may remain on site following closure include covered tailings and waste rock, remnant earthfill dams, dikes that may be breached to restore drainage, spillways excavated into soil and rock, and portal plugs constructed of soil or rockfill.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts with respect to physical and geotechnical stability of landforms:

- Minimize the number of landforms required at closure, especially those retaining water.
- In order to improve post-closure stability of landforms, the following measures should be considered:
  - characterization of current and future permafrost conditions;
  - reduction of thaw or promotion of freezing by insulating with natural materials, convection cooling, and in some cases mechanical/artificial ground freezing. Thawing of ground ice may lead to instability due to thaw consolidation or rapid erosion due to thawing of ice-rich permafrost;
  - designing landforms to ensure compatibility with future use of the site;

- designing landforms for geotechnical stability during operations and closure, including taking into account appropriate seismic values and safety factors; and
- employing drainage measures, including pumping from relief wells at the toe of a slope or installation of horizontal drains.

Closure Options

Closure options for progressive and post-closure reclamation with respect to physical and geotechnical stability of landforms that will remain on site post-closure may include, but are not limited to, the following:

- Design landforms, such as covered tailings and waste rock, to maintain long-term stability.
- Design landforms to blend in with surrounding landscape features.
- Implement construction controls such as surveys, material quality control, compaction control, and instrumentation monitoring.
- Develop design criteria for dams, spillways, and cover systems that consider operational and closure scenarios.
- Use closure and reclamation design criteria for dams, spillways, and cover systems that consider, but are not limited to, the following:
  - All stability analyses should be based upon conservative estimates of material strengths and seismic accelerations.
  - Stability analyses should consider angle of friction and cohesion values obtained at critical moisture contents for the materials, if the structure is unfrozen.
  - The character and shear strength of all structural components including rock, soil, liners, and sub-grade soils or rock should be presented in the site characterization and baseline data of the design report, and all relevant test work should be fully documented.
  - Stability analyses should consider all kinematically possible failure modes and solifluction should be addressed for slope stability and cover system designs where frost susceptible soils are involved.
  - Give consideration to the potential for long-term changes in material strength due to weathering, frost action, degradation, seismic events, chemical changes, and thermal changes.
  - Design, construct, and maintain all dams and associated structures as stated in the procedures and requirements set out in the Dam Safety Guidelines published by the Canadian Dam Association.
  - Incorporate a gravel layer (capillary break) within a cover system to control or limit upward migration of pore water from underlying mine wastes.
  - Design spillways so they include consideration of the effects of water diversion structure failure during the critical design events.
  - Demonstrate the stability of structures and facilities that will remain on site post-closure during frozen, thawing, and fully thawed conditions.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans that involve maintaining physical and geotechnical stability of landforms at northern mine sites:

- Several factors influence ground thermal conditions (including microclimate and proximity to surface water bodies) which dramatically influence permafrost extent and temperature. Detailed characterization of ground thermal regimes is recommended for every site.

- Thawing of ground ice, particularly in ice-rich permafrost, is a leading cause of instability in permafrost regions. This may include existing slopes, foundations (of waste rock piles, roads, airstrips, stream channels, and dikes), cut slopes, and borrow pits.
- The long-term deformation of potentially frozen soils, in either the foundation soils or landform itself, is possible.
- Consider implications of freezing of drainage structures and landforms and thermokarst erosion along drainage structure banks. This includes surface drainage structures, such as ditches and culverts, and buried drainage landforms in dykes and waste rock piles.
- The use of geosynthetic materials, which have a finite life span, may not perform well in the North.

Post-Closure Monitoring

The purpose of post-closure monitoring for physical and geotechnical stability is to ensure that remaining landforms are safe for humans and wildlife and compatible with future use. Monitoring activities may include, but are not limited to, the following:

- Maintain a consistent monitoring record from a constant point of observation from construction through to post-closure.
- Inspect landforms to ensure there are no ongoing deformations that could lead to instability or unsafe conditions or could compromise the effectiveness of selected closure activities or the post-closure use of the site.
- Employ remote sensing techniques to assess large-scale deformations of individual project components being reclaimed (e.g., settlement of tailings disposal area).

3.3 Individual Project Component Closure and Reclamation Considerations

Closure and reclamation considerations are discussed below for the following nine individual mine components:

3.3.1 Underground Mine Workings

3.3.2 Open Pit Mine Workings

3.3.3 Waste Rock and Overburden Piles

3.3.4 Tailings Containment Areas

3.3.5 Buildings and Equipment

3.3.6 Mine Infrastructure

3.3.7 Transportation Routes

3.3.8 Landfills and Other Waste Disposal Areas

3.3.9 Water Management Systems

Under each of the following headings is guidance for the individual project components (see section 3.1 for a discussion of each heading):

- Closure Objectives
- Closure and Reclamation Planning Considerations in Mine Design
- Closure Options for Progressive and Post-closure Reclamation
- Northern Limitations and Considerations
- Post-closure Monitoring

It should be reiterated that the intent of the Guidelines is to outline how to effectively close and reclaim an advanced mineral exploration or mine site in the NWT; it is not a comprehensive list of prescriptive measures. Every mine site is unique, and CRPs will be specific to each site and its associated individual project components.

3.3.1 Underground Mine Workings

Underground workings, as well as the surface expression of these workings, can include shafts, raises,

surface openings, portals, adits, declines, and, in some cases, subsidence or other surface disturbances.

Closure Objectives

Examples of objectives for the closure and reclamation of underground mine workings are as follows:

- Access to underground workings from surface openings has been limited, for the safety of humans and wildlife.
- Uncontrolled surface water infiltration into underground workings has been minimized.
- Underground workings have been stabilized so that there is no surface expression of underground failure.
- Controls that prevent collapse, stress transfer, and flooding of adjacent mines are in place.
- Contaminated mine water from underground workings is not and will not become a source of contamination to the surface environment, nearby taliks, surface water, or groundwater.
- Areas surrounding mine openings are suitable for future use targets.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for underground mine workings:

- Minimize the number of mine openings to the surface.
- Include long-term geotechnical and geothermal stability in the design of mine openings and crown pillars.
- Develop a ground stability monitoring plan.

Closure Options

Progressive reclamation options for underground mine workings may include, but are not limited to, the following:

- Remove hazardous materials from the underground when they are no longer required.
- Reclaim mine openings when mine operations are complete in individual areas (prior to development of ice plug).
- Progressively backfill underground mine workings.
- Progressively plug and flood portions of the mine workings as necessary to control the generation of acid rock drainage.
- Install a hydraulic bulkhead where necessary to control water movement and infiltration.
- Use fencing and other barricades only in temporary closure situations until operations restart or until implementation of a longer-term option. Signage may be required in the short term, prior to implementation of the final closure and reclamation plan, to warn of potential underground hazards.
- Use inukshuks, large boulders, waste rock mounds, etc. to deter wildlife where appropriate. (Seek guidance from local communities and Elders.)

Post-closure reclamation options for underground mine workings may include, but are not limited to, the following:

- Backfill [15] both vertical and horizontal mine openings with inert materials (e.g., overburden, waste rock, paste, etc.) to prevent access to the underground mine workings.

[15] Where possible, backfilling with inert materials is generally the best option to permanently seal vertical mine openings, provided proper construction practices are followed to prevent bridging of backfill materials. Note some vertical openings will be open to such a depth that backfilling will not be practically possible. In the case of wood-lined shafts, backfilling may be susceptible to future settlement when the wood decays, and as such, future maintenance may be required. Backfilling shafts and raises with demolition waste is not acceptable due to the potential for bridging and future settlement upon collapse of the bridged materials.

- Re-grade the surface of portal and adit backfill plugs to establish natural drainage patterns and blend in with the surrounding topography; or re-contour the surface to prevent natural surface and groundwater flow from becoming contaminated by mine water, where appropriate.
- Leave rockfill/earthfill mounds over backfilled vertical openings (such as raises) to accommodate minor amounts of future settlement of the backfill.
- Care should be taken to ensure proper grading and sealing such that surface water run-off does not enter openings if undesired.
- Seal adit openings using concrete,[16] polyurethane, foam,[17] steel, rockfill, or by collapsing a section of the adit to control access for situations where water quality issues are not a concern; wooden barricades are only suitable for temporary closure.
- Consider use of compressed, recycled tires to block access to non-vertical mine openings.
- Construct a reinforced concrete wall or a plug of weakly cemented waste if the barricade is for access control only.
- Flood and plug workings to control acid generation and associated reactions if appropriate (engineered designs should consider hydrostatic heads and rock mass conditions).
- Construct fill pillars to retain long-term structural stability after mining activities cease.
- Permanently support boundary pillar if practical and necessary.
- Crown pillars over stopes and underground mines may require stability assessment to determine risk of collapse in closure (could result in access creation to underground).
- Use ditches or berms as barricades except in areas of continuous permafrost; where continuous permafrost exists, consider inukshuks, fencing, or some other method.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for underground mine workings at northern mine sites:

- Permafrost may enhance stability to the workings when freezing conditions are maintained.
- An ice plug may have developed in the underground workings in close proximity to the mine opening, especially if the mine workings have been abandoned or were inactive prior to closure. Ice plugs will prevent effective backfilling for closure and are unreliable in the long-term to provide structural support.
- A change in local topography (e.g., re-contouring) may influence ground thermal regimes as a result of snow accumulation that in turn may lead to ponding and permafrost degradation.
- Flooding may result in instabilities due to the loss of the strength associated with ground thaw in areas of permafrost.
- In areas with permafrost, warm air or water flow into the underground openings will affect the thermal regime and may affect the stability of the rock mass surrounding the opening.

[16] Concrete seals can be constructed over mine openings as long as they meet the design criteria outlined in the NWT *Mine Safety Regulations*. Concrete has a finite design life and will require replacement. The seals should remain accessible for future inspection. Sulphate resistant cement may be required depending on mine water geochemistry. In cases where the mine workings behind the plug are to be flooded, it is advisable to provide pressure relief/drainage measures at controlled locations where water quality can be monitored.

[17] Proponents may wish to consider polyurethane foam plugs as an alternative option to be considered for approval for sealing of some mine openings. The design life of polyurethane foam plugs is typically 30 years (they are susceptible to degradation by ultraviolet light and heat). They may not have weight bearing capacity and may only be appropriate for vertical installations.

- Depending on the amount of groundwater circulation and local heat balance, thermal regimes may be conducive to freeze-back in areas of degraded permafrost.
- Underground mines located in permafrost may extend into the subpermafrost aquifer, depending on the depth of permafrost in the area. This may allow water from the unfrozen aquifer to migrate into the mine openings or, alternatively may permit water from the mine to migrate into the unfrozen aquifer.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to the reclamation of underground mine workings is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Visually inspect reclaimed openings for signs of physical deterioration or settlement.
- Vary the frequency of inspections, with increased frequency following construction and decreased frequency upon establishment of stable conditions.
- Check for surface expression (subsidence) of underground failure.
- Test underground mine water quality and monitor volume from controlled discharge points of workings to ensure water quality is as predicted.
- Identify unanticipated mine-related drainage discharge points (volume and quality).
- Install thermistors where appropriate to monitor the ground thermal regime in permafrost areas.
- Establish special monitoring provisions for mines that have become flooded and are retaining water under pressure by means of plugs. These provisions can include visual inspection, piezometers, seepage measurement weirs, and sampling to check water quality parameters.
- Inspect areas surrounding mine openings to ensure they are suitable for future use targets.
- Inspect passive water treatment systems for maintenance requirements.

3.3.2 Open Pit Mine Workings

Open pit mine workings may include quarries, side hill cuts, and major trenches in areas where mining has occurred. Sand and gravel mines are not specifically addressed in the Guidelines, although some of the principles outlined below may also apply.

Closure Objectives

Examples of objectives for the closure and reclamation of open pit mine workings are as follows:

- Access has been limited, for the safety of humans and wildlife.
- The open pit mine workings and pit shorelines are physically and geotechnically stable.
- Generation of poor water quality from open pits has been minimized, including that from ARD/ML.
- Water quality in flooded pits is safe for humans, aquatic life, and wildlife.
- Migration and discharge of contaminated drainage has been minimized and controlled.
- The future use target for the pit area, if applicable, has been met.
- Original or desired new surface drainage patterns have been established.
- For flooded pits, in-pit aquatic habitat has been established where practical and feasible (including riparian habitat and vegetation where appropriate).
- Emergency access and escape routes from flooded pits for humans and wildlife are in place.
- Pit fill rate, lower water levels in nearby water bodies/watercourses, and any breaching of dikes does not cause adverse effects on fish,

fish habitat, wildlife safety, or water levels in nearby water bodies/watercourses.

- Dust levels are safe for people, vegetation, aquatic life, and wildlife.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for open pit mine workings: [18]

- Insulate overburden slopes with rockfill to enhance stability and minimize erosion and permafrost degradation.
- Excavate rock and soil slopes that will remain above final predicted pit water level to their final stable slopes prior to deepening pit.
- Characterize the ground thermal regime in the pit walls.
- Ensure storage and treatment facilities are in place prior to stripping of the open pit where overburden and/or overburden melt-water quality is poor.
- Divert surface drainage to minimize pit water handling and treatment requirements until the pit water reaches acceptable standards for discharge to the environment after closure.
- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.

Closure Options

Progressive reclamation options for open pit mine workings may include, but are not limited to, the following:

- If multiple pits are excavated, sequentially backfill pits with waste rock and/or tailings as operations proceed.
- Alternatively, create pit lakes to manage, treat, or store mine-site water if backfilling is not feasible.
- Map exposures of mineralized rock in walls as they become apparent and conduct ARD/ML assessments.

Post-closure reclamation options for open pit mine workings may include, but are not limited to, the following:

- Backfill open pits with appropriate materials (e.g., waste rock, tailings) and use a cover system to mitigate the environmental impacts of the underlying mine waste backfill.
- Flood the pit (consider accelerated filling if natural filling requires an extended period of time).
- Allow gradual slope failure of pit walls involving rock masses, or re-slope pit walls, if possible.
- Block open pit access routes with boulder fences, berms, and/or inukshuks (seek guidance from local communities and Elders). Measures used to block access should be set back sufficiently such that their effectiveness will not be negatively impacted by slope instability of pit walls.
- Cover slopes with rockfill thick enough to provide insulation or stabilization to minimize erosion or permafrost degradation.
- Stabilize exposed soil along the pit crest or underlying poor quality bedrock that threatens to undermine the soil slope above the final pit water level. Use vegetation as necessary.
- Plug drill holes.
- Maintain a controlled access/egress ramp down to water level for flooded pits.
- Contour to discourage or encourage surface water drainage into pits where appropriate.

[18] Refer to AANDC's *Northern Land Use Guidelines: Pits and Quarries* (2010) for additional considerations.

- Cover exposed pit walls to control ARD/ML reactions where necessary and possible.
- Collect water in the pit that does not meet the discharge criteria for treatment (active treatment is not acceptable for the long- term).
- Establish in-pit aquatic habitat where feasible (including riparian habitat and vegetation where appropriate).

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for open pit mine workings at northern mine sites:

- Changes in the permafrost, seasonal frost conditions, and groundwater regimes may ultimately affect physical stability and site water balance.
- Thaw in permafrost regions is a critical consideration where slumping and sediment release could result in failure of upper pit slopes.
- In permafrost areas, there is the potential for initiating permafrost degradation by excavating trenches or ditches if adequate thermal and erosion protection is not present.
- Snowdrifts in pits may alter the hydrology.
- High evaporation rates may exceed input rates for reclaimed pit lakes.
- Poor visibility of pits during winter travel (mostly by snow machines) could be hazardous.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to the reclamation of open pit mine workings is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Monitor physical and geotechnical stability of remnant pit walls.
- Monitor the ground thermal regime in pit walls and backfill materials to confirm achievement of design objectives.
- Monitor water level in pit to confirm closure objectives regarding fish, fish habitat, and wildlife safety are being achieved.
- Sample water quality and quantity at controlled pit lake discharge points.
- Sample quality of groundwater seeping from pit walls to assess potential for contamination of pit water due to melting permafrost and ARD/ML from pit walls.
- Identify and test unanticipated areas where water management is an issue (either water quality or seepage).
- Inspect integrity of barriers such as berms, fences, signs, and inukshuks.
- Monitor wildlife interactions with barriers to determine effectiveness.
- Inspect aquatic habitat in flooded pits where applicable.
- Monitor dust levels.

3.3.3 Waste Rock and Overburden Piles

This component comprises waste rock, overburden, and low-grade ore material that may be extracted for the development and operation of the mine and supporting infrastructure. Typical placement for waste rock and overburden is in piles for permanent storage, unless used in the construction, operation, or closure of the site.

Closure Objectives

Examples of objectives for the closure and reclamation of waste rock and overburden piles are as follows:

- Generation of poor water quality from waste rock piles has been minimized, including that from ARD/ML.
- Surface runoff and seepage water quality is safe for humans and wildlife.
- The pile is physically and geotechnically stable for human and wildlife safety in the long-term.
- The risks of erosion, thaw settlement, slope failure, collapse, and the release of contaminants or sediments have been minimized.
- The size of the pile's footprint has been balanced with its height, taking into account future use targets, physical stability, wildlife and human access, and other factors.
- Piles are blended with current topography and revegetated as necessary to be compatible with wildlife use and/or meet future use targets.
- Dust levels are safe for people, vegetation, aquatic life, and wildlife in the long-term.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for waste rock and overburden piles:

- Select the location and design for waste rock, overburden, and ore stockpiles to complement the desired closure objectives and selected closure activities.
- Consider impacts on wildlife habitat post-closure when selecting initial location and design.
- Characterize and segregate potentially acid generating materials for controlled disposal or cellular pile construction.
- Characterize and segregate inert waste rock and overburden materials for potential use in reclamation.
- Construct waste rock piles and overburden piles in lifts with slopes where individual lifts can be set back to provide long-term stability.
- Construct rockfill toe berms to contain overburden stockpiles and maintain stability.
- Select sites that avoid low-strength foundations, or take into account appropriate design measures (reduced slope angles, reduced slope heights, etc.).
- Construct runoff and sediment collection ponds for use during operation and possibly for the initial portion of the closure phase until seepage water quality is proven to be acceptable and stable.
- Consider drainage patterns and watershed boundaries when locating and designing waste rock and overburden piles.
- If placing waste rock piles in drainage paths is unavoidable, consider measures to minimize contact of clean water with contaminated materials.
- Consider locating a waste rock or overburden pile site within the same drainage catchment as the proposed tailings containment area.
- Consider using open pits as a collection point for impacted runoff from waste rock and overburden piles.
- Control surface water on overburden stockpiles to prevent erosion.
- Locate waste rock piles in areas where it is possible to minimize run-on volumes, such as the upper portion of the watershed.
- Construct internal drains to prevent mounding of the water table.

- Consider use of seepage collection berms in permafrost environments.
- Consider how convective cooling will affect the ground thermal regime of the waste rock pile.
- Consider future use of the area to determine location, height, access, etc.

Closure Options

Progressive reclamation options for waste rock and overburden piles may include, but are not limited to, the following:

- Design and operate waste rock piles during construction to promote permafrost aggradation, if desired.
- Characterize geochemical attributes of waste rock during deposition.
- Backfill into underground mine workings or open pits.
- Access cover (e.g., from overburden piles) and distribute to areas requiring revegetation or backfilling.

Post-closure reclamation options for waste rock and overburden piles may include, but are not limited to, the following:

- Consolidate waste rock in underground mine workings or open pits as part of reclamation efforts of those components.
- Re-grade waste rock to a stable landform and leave in place if it is possible to prove that material is geochemically inert and will not provide a source of contamination due to ARD/ML processes.
- Re-grade waste rock and construct a cover system on the surface to limit generation and migration of contaminants from waste rock and overburden piles.
- Re-grade surface of waste rock and overburden piles to flatten the overall slope, or construct a toe berm to enhance stability.
- Remove weak or unstable materials from slopes and foundations.
- Off-load materials from the crest of the slope.
- Leave waste rock piles composed of durable rock "as is" at the end of mining if there is no concern for deep-seated failure or erosion and if the future use targets can be achieved.
- Place a riprap insulation/stabilizing layer.
- Encapsulate waste rock in permafrost and utilize ambient air temperatures to encourage permafrost aggradation within the waste rock pile and cover system.
- Place potentially acid generating rock underwater or underground if viable.
- Place potentially acid generating rock within the centre of the waste pile so permafrost can encapsulate it if conditions permit and underwater or underground disposal are not viable options.
- Construct collection systems to collect contaminated runoff or leachate.
- Construct diversion ditches to divert uncontaminated runoff.
- Install horizontal drains, or pump leachate from relief wells at the toe of the slope.
- Passively treat contaminated waters (active treatment is not acceptable for the long term).
- Revegetate using native species, or use other bioengineering measures (use of living organisms or other biological systems for environmental management) to reduce surface erosion, provide physical stability, and meet future use targets.

- Re-slope, contour, and/or construct ramps to provide safe wildlife passage.
- Use inukshuks or other mitigations to deter wildlife where appropriate (seek guidance from local communities and Elders).

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for waste rock and overburden piles at northern mine sites:

- Permafrost aggradation into overburden and rock piles can occur in permafrost regions.
- Introduction of ice and snow into rock piles during construction may lead to instability if thawing occurs.
- Convection cooling in waste rock piles may freeze the interior of the rock pile and the underlying foundation. Although this may be beneficial, it is important to note climate change has the potential to result in the release of ARD in the very long-term due to thawing and subsequent water infiltration.
- Freezing of drainage control measures due to extremely cold and long freezing seasons may adversely affect both surface and subsurface drainage.
- Thawing of permafrost in the foundation may cause instability.
- Collection ditches in permafrost environments are generally not desirable due to thermal disturbance. Seepage collection berms are generally preferable.
- Waste rock dumps and overburden stockpiles may alter wildlife routes or mobility; actions to improve safe wildlife passage may be required.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to reclamation of waste rock and overburden piles is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Periodically inspect areas where stabilization measures may be required.
- Periodically inspect (by a geotechnical engineer) to assess stability and performance of waste pile and cover systems, including possible sampling and testing of cover materials.
- In the case of water covers, monitor to ensure that there is sufficient water supplied to maintain an appropriate water depth.
- Periodically inspect diversion ditches and berms.
- Examine ground conditions to confirm predicted permafrost conditions are being established.
- Check thermistor data for thermal conditions within waste piles to confirm predicted permafrost aggradation/encapsulation where applicable.
- Test water quality and measure volume from controlled discharge points of workings to confirm that drainage is performing as predicted and not adversely affecting the environment.
- Identify unanticipated water discharge areas (include volume and quality).
- Monitor revegetation activities such that they meet technical needs (e.g., maintaining physical stability), aesthetic needs (e.g., blends with surroundings), and future use targets, and do not impact the effectiveness of selected closure activities or become a source of metals due to uptake.

- Monitor wildlife use to determine if safe passage is occurring.
- Monitor dust levels to ensure they meet criteria.

3.3.4 Tailings Containment Areas

Tailings containment areas include: mine tailings; embankments such as dams or dykes that retain tailings or non-compliant water related to the tailings and slurry; surface paste; and dry stack facilities. Containment areas may contain mixed materials including tailings, waste rock, domestic treated sewage, or collected surface water in varying quantities and chemistry. Typically, tailings containment areas are the last point of control for the site water management system where discharge to the environment occurs. Proponents should have a good understanding of the contributions to the tailings containment area to predict the volumes and quality of effluent that may need management after operations.

Closure Objectives

Examples of objectives for the closure and reclamation of tailings containment areas are as follows:

- Dust levels are safe for people, vegetation, aquatic life, and wildlife.
- Remnant embankments and surfaces of tailings containment areas are physically and geotechnically stable in the long-term.
- Piles blend with local topography and vegetation, where appropriate.
- Effluent discharge impacts on downstream ecosystems are minimal and align with designated future uses.
- The threat that the tailings containment area becomes a source of contamination (e.g., tailings migration outside of contained area, contamination of water outside of contained area) has been minimized or eliminated.
- The risk for the occurrence of ARD/ML has been minimized.
- The risk of catastrophic and/or chronic release of tailings into the surrounding environment has been minimized.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for tailings containment areas:

- Select the appropriate site location; tailings containment areas should be located towards the upstream end of the drainage catchment to minimize the volume of water that must be diverted around the facility and the volume of runoff that has to be handled from the adjacent slopes.
- Minimize environmental impacts by locating tailings containment areas within the same drainage catchment as other project components such as open pit and waste rock piles. (This will also improve water use and treatment efficiencies.)
- Locate tailings containment areas within water bodies or watersheds that have been naturally impacted by drainage from mineral deposits, if the natural areas are deemed as negatively impacting the environment.
- Design required dams and dykes for long term stability (i.e., 1000 years) using appropriate design parameters and benign materials.
- Use a mill process that removes reactive materials from the tailings or recycles water back to the mill (e.g., cyanide recycling loop, gravity floatation process, etc.).
- Use a treatment method to remove contaminants from supernatant.

- Manage dust concerns by water and/or soil covers.
- Consider placing potentially acid generating rock or leachable materials into containment areas that will be permanently flooded, capped, or frozen.
- Separate potentially acid generating materials for controlled disposal elsewhere or blend with alkali material to control ARD/ML.
- Assess water chemistry and physical properties of the tailings to determine suitable closure and reclamation options.

Closure Options

Progressive reclamation options for tailings containment areas may include, but are not limited to, the following:

- Use smaller individual cells where smaller volumes of tailings can be placed, dewatered, consolidated, and then progressively reclaimed rather than reclaiming the entire tailings containment area at end of project life.
- Modify process near end of operations to produce benign tailings for use as cover material.
- Consider final surface grade requirements as tailings placement nears completion to reduce overall cover material volumes.

Post-closure reclamation options for tailings containment areas may include, but are not limited to, the following:

- Stabilize embankments by removing weak or unstable materials from slopes and foundations and/or construct toe berms to flatten overall slope.
- Breach water retention dams and drain impoundments to avoid post-closure impoundment of water, where possible.
- Use a natural body of water that has sufficient storage capacity to hold the tailings, and allow a natural unimpeded flow via the drainage outlet if a permanent water cover is used. (This may not be viable if the supernatant water quality does not meet discharge water quality standards.)
- Increase freeboard of embankment and/or upgrade spillway to prevent overtopping and to prepare for possible erosion of embankment by extreme precipitation events.
- Relocate and/or deposit tailings into underground mine workings or into flooded pits, depending on water quality considerations.
- Flood tailings to control acid generation and related reactions.
- Cover tailings with a cover system to control ARD/ML processes and migration of contaminants.
- Construct a cover system to prevent surface erosion and create a stable landform in the long-term.
- Promote neutralization reactions by use of alkaline materials for covering acidic tailings.
- Divert non-contact runoff away from the tailings facility to avoid contamination.
- Promote freezing of tailings mass into permafrost if suitable conditions exist.
- Collect waters that do not meet the discharge criteria for treatment. (Active treatment is usually not acceptable for the long term.)
- Remove structures and decant towers, pipes, and drains where they already exist.
- If they are irremovable, plug decant towers, pipes, and drains with high slump (relatively liquid concrete which will flow to fill all voids) or, preferably, expansive concrete.

- Avoid using diversion structures and ditching, especially in permafrost soils.
- Where diversion dams and channels are necessary, maintain them indefinitely to meet long-term stability and hydraulic design requirements.
- Provide a frost protection cap for the phreatic surface for water-retaining dams.
- Ditch, berm, fence, or use alternative methods, if compatible with future use plans, to deter access of motorized vehicles.
- Establish native vegetation, soil, riprap, or water cover to control erosion.
- Use vegetation or coarse rock to aid in re-establishing the original ground thermal regime.

Northern Limitations and Considerations

Proponents should consider the following when developing closure and reclamation plans for tailings containment areas at northern mine sites:

- The tailings cover system design needs to take account of ice/water depth, wave action, and ice scour where the cover system interacts with surface water bodies.
- Ice scour and ice pans that freeze to shallow tailings can influence water quality from suspended sediments.
- Water level fluctuations in adjacent water bodies will have impacts on the ground thermal regime, particularly along the shoreline.
- Permafrost may aggrade into the tailings. Freeze-back of thawed tailings needs to be properly monitored and accounted for.
- Freezing of tailings during winter months may generate a series of layers of frozen and unfrozen tailings, particularly on the beaches, if the deposition is greater than the seasonal depth of the active layer. The impact to long-term stability and water release should be considered and managed.
- Tailings placement under winter conditions may result in entrained ice, which may melt in the long-term and may adversely impact stability of surface measures.
- Assessment of long-term climate change is necessary for dams reliant on frozen cores.
- Unflooded tailings may freeze over time, concentrating residual contaminants in the unfrozen brine; cryoconcentration can result in the eventual release of small volumes of more contaminated fluids.
- Physical disruption of cover systems may occur because of localized frost heave over time.
- There may be loss of containment capacity or space due to ice entrainment or build up within the tailings. This could be avoided with appropriate management of the tailings containment area (e.g., by moving the discharge pipe frequently).
- Wind erosion of tailings may be more significant in some areas of the North due to higher rates of sublimation and limited tree/vegetation cover.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to reclamation of tailings containment areas is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Conduct periodic safety and stability reviews of structures that remain after closure.
- Inspect seepage collection systems for water flows and assess seepage water quantity and quality.

- Inspect and maintain dam structures and/or spillways associated with flooded tailings over the long-term.
- In the case of water covers, ensure that the minimum water cover design thickness is achieved and that freeboard amounts are respected for inflow floods.
- Monitor the ground thermal regime in embankments and tailings deposits where the design utilized permafrost.
- Continue to monitor climatic conditions post-closure, including air temperatures and precipitation, to confirm design assumptions regarding hydrology and air temperatures (particularly for selected closure activities utilizing permafrost) and related site climate conditions.
- Monitor pond-water level and quality to confirm predicted performance.
- Evaluate/confirm success of revegetation activities in meeting technical needs (maintain physical stability), aesthetic needs (blends with surroundings), and future use targets (does not become a source of metal uptake for humans or wildlife).
- Assess dust dispersion and vegetation uptake due to wind dispersion of tailings.

3.3.5 Buildings and Equipment

Mine site buildings comprise any surface or underground structures built to support mining activities and may include, but are not limited to, the following:

- ore processing/concentrator plant/crusher facilities/conveyor galleries
- concentrate storage sheds
- head frames
- maintenance shops
- offices
- warehouses
- fuel tanks
- fuel tank farms
- assay and analytical labs
- process reagent and explosive storage
- boiler houses
- power generation plants and camp facilities.

Mine equipment comprises any equipment used on site in support of mining activities and may include, but is not limited to, all surface and underground mobile equipment, shaft installations, distribution piping, and conveyors.

Closure Objectives

Examples of objectives for the closure and reclamation of mine buildings and equipment are as follows:

- Surface areas occupied by mine buildings are restored to pre-disturbance conditions or to a condition compatible with future use targets, to the extent possible.
- Buildings and equipment are not and will not be a source of contamination to the environment or a safety hazard to humans and wildlife.
- The pre-mining ground cover is re- established (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for mine buildings and equipment. [19]

- Locate buildings on bedrock or thaw-

stable soil foundations to minimize need for foundation preparation and disturbance of terrain.

- Use inert waste rock pads placed on top of ground/tundra surface for structures having low foundation loads such as camps, offices, and warehouses.
- Select locations that will have minimal impact on wildlife habitat and therefore require minimal reclamation efforts.
- Design and locate heated structures to ensure no negative impacts to the underlying permafrost (e.g., degradation).
- Design and operate facilities so that possible contamination does not migrate below structures such as ore processing plants or concentrate storage sheds.
- Where possible, use sustainable and low toxicity building materials.
- Where possible, use portable or modular buildings so that they can be completely removed from the site following closure.

Closure Options

Progressive reclamation options for mine buildings and equipment may include, but are not limited to, the following:

- Recycling or reusing building materials and equipment where possible to reduce waste and importation of materials to site.

Post-closure reclamation options for mine buildings and equipment may include, but are not limited to, the following:

Mine Buildings

- Dismantle all buildings that are not necessary to achieve the future use target.
- Raze/level all walls (including re-bar) to the ground surface.
- Remove foundations where possible, or cover with natural materials to blend into natural surroundings. Cover materials should be conducive to vegetation growth (this may include lichen) where possible.
- Remove floor structures over basements and cellars.
- If disposing on site, decontaminate building materials (free of any batteries, fuels, oils, bulk process chemicals, or other deleterious substances), and use toxicity characteristic leaching procedure testing to confirm suitability for non-hazardous disposal.
- Cut, shred, crush, or break demolition debris to minimize the void volume during disposal.
- Maintain photographic records of major items placed into landfills, as well as a plan showing the location of various classes of demolition debris (e.g., concrete, structural steel, piping, metal sheeting, and cladding).
- Remove and dispose of concrete in an approved hazardous waste landfill if it contains contaminants that may pose a hazard over time.
- Where approved, break or perforate concrete floor slabs and walls to create a free draining condition in order to establish vegetation.
- Backfill/grade all excavations to achieve the final desired surface contours to re-establish the original drainage or a new acceptable drainage.
- Backfill excavations in permafrost to limit permafrost degradation.

[19] Refer to AANDC's *Northern Land Use Guidelines: Camp and Support Facilities* (2010) for additional considerations.

- Control dust emission during demolition of buildings that contain or contained asbestos, lead paint, hazardous chemicals, or other deleterious material.
- Assess storage containers for leaks or contamination during removal.
- Remove buried storage tanks to prevent subsidence, and salvage mill components and scrap steel where possible.
- Remove hazardous waste to an approved on-site waste storage facility prior to shipping for off-site disposal.

Equipment

- If possible, transport equipment off the site for reuse at other locations. This may include sale or salvage to local communities if sufficient interest exists.
- If sale or salvage of equipment is not possible, dispose of decontaminated equipment in an approved landfill or as recommended by the regulatory authorities.
- If disposing on site in a proper facility, decontaminate equipment prior to disposal (free of any batteries, fuels, oils, or other deleterious substances).
- Cut, shred, crush, or break demolition debris to minimize the void volume during disposal.
- Leave non-salvageable and non-hazardous materials and equipment from underground operations in the underground mine upon approval from the regulatory authorities. Remove all hazardous materials and fluids from equipment left underground.
- Transport hazardous materials to an appropriately registered receiving facility for recycling or disposal.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for mine buildings and equipment at northern mine sites:

- Use caution in permafrost zones where buried material can migrate to the surface years after disposal due to frost heave processes.
- Maintaining permafrost under buildings and roads may be important to ensure physical stability of the infrastructure during operation. (Heat from buildings and processing plant may be enough to affect the underlying ground conditions.)
- The physical and chemical degradation of materials left on northern sites will be slow due to cold temperatures.
- Restrictive and perhaps seasonal factors, such as transportation (ice roads, water access), climate, and hours of daylight hamper closure and reclamation activities at remote northern sites. Logistics, such as scheduling of closure and reclamation activities and disposal options, should take these limitations into account.
- Local residents and communities may identify buildings they wish to maintain for historical significance or emergency or community uses. (Ownership liability is a consideration.)

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to the reclamation of mine buildings and equipment is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Inspect remnant foundation covers to ensure settlement of backfill has not exposed remnant foundation materials such as concrete, or interrupted surficial drainage patterns.

- Inspect former excavation areas to monitor if permafrost degradation has interrupted surficial drainage patterns.
- Inspect disposal areas periodically to establish if buried materials are migrating to the surface as a result of frost-heave.
- Inspect the area for signs of residual contamination.
- Monitor vegetation to determine whether related closure objectives are or will be met.

3.3.6 Mine Infrastructure

Infrastructure may include on-site roads, winter-road right-of-ways and access, airstrips, electrical power supply systems, bridges, culverts, railways, ports, barge landings, docks, borrow pits, quarries, staging areas, fuel transfer areas, and ore-handling facilities within the mine site.

Closure Objectives

Examples of objectives for the closure and reclamation of mine infrastructure are as follows:

- Contaminated portions of infrastructure (e.g., metals or hydrocarbon-contaminated sections of mine site roads) have been remediated so they do not pose an unacceptable environmental risk.
- To the extent possible, pre-disturbance surface conditions including drainage patterns and self-sustaining vegetation growth have been re-established.
- Any remaining mine infrastructure is physically and geotechnically stable, any surface runoff and seepage water quality is safe for humans and wildlife, and the infrastructure encourages the desired wildlife movement.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for mine infrastructure: [20]

- Construct airstrips as part of site access roads to minimize the project footprint.
- Select locations that will have minimal impact on wildlife habitat and therefore require minimal reclamation efforts.
- Minimize interruptions of natural drainages.
- Construct earth fills related to infrastructure (such as road fills) out of geochemically inert materials.
- Evaluate terrain sensitivity along route alignments, potential environmental impacts, and construction mitigation requirements.
- Avoid or minimize bridge crossings.
- Where possible, use gentle slopes in road verges to facilitate wildlife passage during operation and after closure.
- Where possible, share valuable infrastructure amongst proponents or interested parties when feasible, as it is beneficial to all and may reduce the amount of land disturbed.
- Minimize the use of granular resources from eskers.

Closure Options

Closure options for progressive and post-closure reclamation for mine infrastructure are combined as they are applicable to both. They may include, but are not limited to, the following:

- Reclaim infrastructure, such as roads, as soon as mining operations no longer require them,

[20] Refer to AANDC's *Northern Land Use Guidelines: Pits and Quarries* (2010) and *Northern Land Use Guidelines: Access Roads and Trails* (2010) for additional considerations.

as long as they are not required for future reclamation or monitoring purposes.

- Remove structures including bridges, culverts, pipes, buried wires/cables, and power lines; fill ditches if no longer required and evaluate the area for potential contaminants.
- Remove or crush/backfill all underground tunnels or culverts that could act as hydraulic conduits at closure.
- Reclaim contaminated infrastructure areas such as portions of road fills contaminated by hydrocarbons or metals.
- Reclaim areas to the original topography and drainage or to a new topography or drainage compatible with future use targets.
- Scarify closed road/runway surfaces to promote revegetation of native species.
- Leave roads, airstrips, or railways intact if supported by analysis of environmental impacts and any objectives revealed from stakeholder input. (Ownership liability may be an issue.)
- Remove wildlife controls when no longer required.
- Flatten berms and slopes at the sides of roads to facilitate wildlife passage.
- Remove roads and scarify remaining surfaces to promote revegetation, where feasible.
- Stabilize borrow pits.
- Ensure there are no ARD/ML concerns from rockfill from quarries used at the mine site.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for mine infrastructure at northern mine sites:

- Maintaining permafrost under roads and pads may be important to ensure physical stability of the infrastructure.
- Permafrost may aggrade into thick road fills over the life of the operation, making removal during reclamation difficult.
- Power cables may become frozen into the ground, making their removal difficult.
- Icing of drainage measures (i.e., culverts, ditches, etc.) may lead to drainage blockages with consequent adverse impacts on other selected closure activities.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to reclamation of mine infrastructure is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Maintain access to infrastructure required to support on-going reclamation and post-closure monitoring.
- Monitor wildlife/fish use of area to ensure selected closure activities are successful.
- Monitor other land users' access and activity in the area.
- Monitor slope stability of quarries and borrow pits.
- Monitor success in terms of slope stability of cuts, erosion protection in drainage areas, and revegetation impacts.
- Monitor sediment loading downstream of access road breaches.
- Check stream-crossing remediation and any degradation associated with decommissioned roads, such as erosion or ponding of water.
- Monitor water quality downstream of remediated areas of contamination.

3.3.7 Transportation Routes

Transportation routes may include any all-weather or winter roads, barging routes and staging areas,

and railways or pipelines used to transport ore, fuel, hazardous materials, or equipment to or from a mine site. They differ from other infrastructure in that they are generally not located on the mine site. The route may be between the mine site and a local port or community and may extend great distances (i.e., 100s of kilometres). Separate regulatory requirements may already govern transportation routes, but a coordinated approach to overall closure planning should be encouraged.

Closure Objectives

Examples of objectives for the closure and reclamation of transportation routes are as follows:

- Contaminated portions of transportation routes (e.g., metals or hydrocarbon-contaminated sections of roads) have been remediated so they do not pose an unacceptable environmental risk.
- Impacts to the environment, fish, and wildlife from localized areas of contamination that may be present along a route have been minimized.
- To the extent possible, pre-disturbance surface conditions including drainage patterns and self-sustaining vegetation growth have been re-established.
- Adverse impacts to permafrost along the route have been limited.
- Post-closure public and wildlife access has been deterred or enabled as necessary to meet designated future use of the area.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for transportation routes: [21]

- Conduct geotechnical and permafrost characterization assessments along the route to provide proper design inputs to associated infrastructure.
- Conduct archaeological assessments along the route that incorporate Traditional Knowledge to avoid disturbing significant cultural sites.
- Conduct wildlife assessments along the route that incorporate Traditional Knowledge to avoid disturbing wildlife sensitive areas such as migration routes or dens/habitat.
- Avoid, where possible, construction of infrastructure through and over thaw-unstable ground.
- Minimize the number of watercourse crossings.
- Conduct a geochemical assessment of the route to identify problematic areas that may be susceptible to ARD/ML issues if disturbed.
- Conduct a detailed surface water hydrological assessment along the route to properly design all watercourse and drainage crossings.
- Choose staging areas by considering both logistical and environmental concerns (e.g., avoid environmentally sensitive areas).

Closure Options

Closure options for progressive reclamation and post-closure reclamation for transportation routes are combined as they are applicable to both. They may include, but are not limited to, the following:

- Engage local communities to determine if some transportation routes may remain intact. (This would require transfer of liability.)
- Identify/assess areas of contamination along the route and reclaim these areas.

[21] Refer to AANDC's *Northern Land Use Guidelines: Access Roads and Trails* (2010) for additional considerations.

- If removal of infrastructure is to take place, restore drainage conditions along the route and deactivate roads to enhance revegetation to natural surroundings and to limit impact on migrating wildlife.
- Decommission any associated infrastructure such as emergency shelters or power cables located along the route.
- Mitigate any ARD/ML issues identified along the route that are associated with the construction or operation of the route.
- Remove all culverts and bridges.
- Remove all berms constructed along the sides of roads.
- Remove pipelines and rails, being careful to control any remnant contaminants inside pipelines and dispose at designated and properly designed facilities.
- Re-establish drainage to minimize erosion and the potential for sediment-loading to adjacent water bodies.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for transportation routes originating at northern mine sites:

- Transportation infrastructure is very limited in the North and may benefit proponents and the public after mine operations no longer require these roads.
- Permafrost may aggrade into thick road fills making removal/breaching difficult and time-consuming, as well as become an environmental concern if thermokarst erosion were to occur.
- Permafrost/ice-rich ground can pose difficulties to the construction and operation of infrastructure, and ponding of water or new drainage routes/ditches in permafrost terrain will likely result in significant erosion and/or thaw settlement.
- Pipes, cables, rails, and ties may freeze into permafrost and may be difficult and time consuming to remove at reclamation.
- Long-term reclamation design should incorporate climate change impacts, especially in thaw-unstable permafrost areas.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to the reclamation of transportation routes is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Monitor stability of breaches to ensure that any instabilities are not negatively impacting downstream water quality to an unacceptable level.
- Monitor water quality (surface water and ground water) downstream of remediated areas for contamination.
- Visually inspect route for indications of permafrost degradation, ARD/ML, and any associated impacts on adjacent water quality.
- Monitor the ground thermal regime to assess if permafrost aggradation or degradation is occurring and the potential impacts of these geothermal changes.
- Monitor wildlife movements to determine the effectiveness of reclaiming the site to a stable condition.
- Monitor vegetation to determine whether related closure objectives are or will be met.

3.3.8 Landfills and Other Waste Disposal Areas

A landfill is an engineered waste management facility

at which waste is disposed of by placing it on land or underground, in a manner that minimizes adverse human health and environmental effects. Landfills and other waste disposal areas may include industrial and domestic waste, sewage, chemicals, contaminated soils, hazardous waste storage, and water treatment sludge. Other waste disposal areas may include landfarms, waste management facilities, abandoned quarries, borrow pits, underground mine workings, waste rock piles, and tailings containment areas. Disposal includes the relocation and/or containment of unwanted materials.

Closure Objectives

Examples of objectives for the closure and reclamation of landfills and other waste disposal areas are as follows:

- Inadvertent access to landfill debris by humans and wildlife has been prevented.
- Waste disposal areas are not and will not become a source of contamination to the environment.
- Erosion and effects to the ground thermal regime have been controlled to ensure physical stability.
- To the extent possible, surface areas occupied by landfills and other waste disposal areas have been restored to pre-disturbance conditions or to a condition compatible with future use targets.
- The risk for the occurrence of ARD/ML and leachate (e.g., from landfills) has been minimized.
- The pre-mining ground cover has been re-established (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).
- Surface runoff and seepage water quality is safe for humans and wildlife.
- Dust levels are safe for people, vegetation, aquatic life and wildlife.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure attainment of closure objectives for landfills and other waste disposal areas: [22]

- Plan activities to limit the amount of waste generated throughout the life of the mine.
- Locate waste management facilities away from waterways to minimize environmental impacts that could result from leachate generation/migration.
- Select location and design that will have minimal impact on wildlife habitat and therefore require minimal reclamation effort.
- Divert runoff around waste disposal area with ditches or berms to minimize migration of contaminants.
- Do not excavate or cut ice-rich soils to construct a landfill.
- If gas production could occur over time, incorporate proper venting through the landfill cover into the design.

Closure Options

Closure options for progressive and post-closure reclamation for landfills and other waste disposal areas are combined as they are applicable to both. They may include, but are not limited to the following:

- Maintain an inventory of materials disposed of in the operating landfill.
- Burn domestic waste and special waste (i.e., waste oil) in an approved incinerator.

[22] Refer to the Boards *Guidelines for Developing a Waste Management Plan* (2011) for additional design considerations and general information.

- Line the waste storage/disposal area, or install secondary containment, if necessary.
- Use relatively clean soil progressively to cover landfills if the entire landfill is designed to be ultimately encapsulated in permafrost.
- Remove hazardous waste to an approved on-site waste storage facility prior to shipping for off-site disposal.
- Upon approval by regulatory authorities, dispose of specific wastes in quarries, borrow pits, and underground mine workings.
- Cover landfills with an appropriately designed cover system to limit infiltration to acceptable levels. The surface of the landfill cover should comprise erosion resistant materials, and the surface landform should be sustainable in the long-term.
- Contour/blend to match the natural topography or a new desired topography, and revegetate with native species to meet the future use targets.
- Consider surface application of a medium to facilitate revegetation.
- Remove sludge from water treatment facilities and consolidate within tailings or waste rock deposits, or transport sludge to the underground mine workings prior to reclamation of these areas.
- Cover sludge in settling ponds within water treatment facilities in-place with a cover system, provided they are not located within a natural surface water drainage path.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for landfills and other waste disposal areas at northern mine sites:

- Many northern sites do not have large, local sources of low permeability soils (such as clays) to use as a liner or as cover materials to limit infiltration.
- Landfill sites may be underlain by permafrost and permafrost may aggrade into the landfill debris over time.
- Landfills might not be permitted in areas that experience significant frost heave.
- In areas of continuous permafrost, waste materials may be encapsulated in permafrost
- Give careful consideration to the effects of climate change on the long-term stability of cover system designs dependent on permafrost for encapsulation.
- In areas of discontinuous permafrost, conventional landfill designs using an impervious liner may be more appropriate than utilizing frozen ground conditions to encapsulate the waste.
- Freezing of systems designed to collect leachate may compromise the operation of the landfill.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to reclamation of landfills and other waste disposal areas is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Test water quality and quantity to measure the success of the selected closure activities for landfills and waste disposal areas.
- Monitor the ground thermal regime (by means of thermistors) and the cover system performance to determine if permafrost has aggraded into the landfill and if the seasonal active zone remains within the cover.
- Inspect surface of landfill cover systems for cracking or slumping of the cover and for the underlying waste material's migrating to surface.
- Monitor wildlife and human use to ensure the selected closure activities have been effective

in preventing access to these areas.

- Monitor vegetation to determine whether related closure objectives are or will be met.
- Monitor dust levels to ensure they meet criteria.

3.3.9 Water Management Systems

The components of a water management system may include structures such as embankments, spillways, diversion channels, ditches and culverts, pipelines, sewage lagoons, settling ponds, and storage tanks associated with fresh water supply, in addition to the collection, treatment, and discharge of non-compliant water.

Closure Objectives

Examples of objectives for the closure and reclamation of water management systems are as follows:

- As much of the system as possible has been dismantled and removed/disposed of.
- To the extent possible, natural drainage patterns have been re-established.
- Systems have been stabilized and protected from erosion and failure for the long-term.
- Natural watercourses (e.g., adjacent rivers or streams) have been used for post-closure drainage where practical.
- Stable release of water discharge to the environment is maintained at designated discharge points (e.g., spillway outlets, outlets of tailings containment areas).
- Post-closure water quality objectives in receiving water bodies are met, and in rare circumstances where necessary, long-term water treatment is in place.
- No long-term active care is required.
- The pre-mining ground cover has been re-established (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).
- Systems are physically and geotechnically stable for the safety of humans and wildlife.

Closure and Reclamation Planning Considerations in Mine Design

Proponents need to consider the following items during the mine design stage of the project to minimize post-closure reclamation efforts and ensure the attainment of closure objectives for water management systems:

- Minimize reliance on surface water diversion structures in the long term.
- For any water management structures that may be required post-closure, select design parameters to reflect the need to maintain stability in the long term.
- Design water management systems to minimize the migration of potential contaminants.
- Construct pilot channels to assess how ice builds up in water passage channels.
- Select location and design that will have minimal impact on wildlife and aquatic habitat and therefore require minimal reclamation effort.

Closure Options

Progressive reclamation options for water management systems may include, but are not limited to, the following:

- Breach and level/re-contour embankments, dams, and culverts not required for long-term use once they are no longer needed.
- Drain and backfill all freshwater and waste sumps and collection trenches.

Post-closure reclamation options for water management systems may include, but are not limited to, the following:

- Treat non-compliant water in storage and subsequently release upon achievement of discharge criteria.
- Breach and level/contour embankments, dams, and culverts not required for long-term use. Restore the pre-disturbance drainage network to the extent possible.
- Use passive treatment systems as the preferred method for treating contaminated waters following closure if it can be demonstrated that they are effective.
- Prepare and be ready to implement a contingency plan for active treatment in the event that passive treatment does not achieve water quality compliance.
- Locate permanent spillways in competent rock.
- Drain, dismantle, and remove tanks and pipelines from the site, or fill and cover them with appropriate materials if they are approved to remain on site.
- Ensure any remnant embankments or other water management structures have appropriate erosion control measures in place to maintain stability post-closure.

Northern Limitations and Considerations

Proponents should consider the following items when developing closure and reclamation plans for water management systems at northern mine sites:

- Remote northern mine sites often have limited climate data available from which to conduct hydrological design assessments needed for water management structures.
- Collection of site-specific climate data should begin as early as possible during the project.
- Hydrological design for water management structures required in the post-closure phase should incorporate considerations for climate change impacts and not solely rely on the existing hydrological record.
- Designs should account for snowfall and snowdrifts that may accumulate in topographic lows.
- Permafrost is a significant regulator of runoff patterns, particularly during snowmelt, and closure designs should account for this impact.
- If a channel is to remain in the post-closure phase, its design should consider that ice buildup and debris in the channels may affect the flow capacity of water passages.
- It may be necessary to manage water under ice and snow conditions; this is particularly difficult during spring melt when flows can be large, ice and snow may obstruct flows, and there may be limitations to visibility and access to those flows.
- Passive treatment systems are more difficult to implement due to long periods of snow or ice cover.
- Water in the North is relatively pristine, and aquatic organisms may be particularly sensitive to water quantity and quality changes.

Post-Closure Monitoring

The purpose of post-closure monitoring with respect to reclamation of water management systems is to ensure the attainment of closure objectives. Monitoring activities may include, but are not limited to, the following:

- Periodically inspect the remaining water management structures to assess their performance.

- Continue monitoring climatic conditions at site to compare them to design assumptions (e.g., regarding storm events) and performance of selected closure activities.
- Monitor the performance of erosion protection on embankment structures, such as riprap or vegetation, and the physical stability of water management systems including permafrost integrity where applicable
- Monitor water quality, quantity, and flows to ensure system is working as predicted and water quality objectives are being met.
- Evaluate post-closure drainage patterns and confirm that they compare to pre-development patterns as described in the closure objectives.
- Inspect revegetated areas periodically following initial planning until vegetation is successfully established in accordance with closure criteria.
- Conduct ongoing inspection and maintenance of passive or active water treatment facilities associated with non-compliant mine site water or runoff discharges.
- Sample surface and groundwater if site-specific conditions dictate.
- Monitor the smell and taste of water and fish, if appropriate. (Seek guidance from local communities and Elders.)
- Monitor wildlife/fish use of area to ensure the selected closure activities are successful.

Appendix A - General Reference and Guidance

Below are general references to additional resources categorized under the following sub-headings: guiding concepts for mine site reclamation; communication and engagement; relevant guidance documents; and, technical considerations by topic. Additionally, relevant legislation and websites are provided.

Guiding Concepts for Mine Site Reclamation

- Aboriginal Affairs and Northern Development Canada (formerly Indian and Northern Affairs Canada), 2002. *Mine Site Reclamation Policy for the Northwest Territories*. Minister of Public Works and Government Services Canada. URL: http://www.aadnc-aandc.gc.ca/eng/1100100036038
- Aboriginal Affairs and Northern Development Canada, 2007. *Mine Site Reclamation Guidelines for the Northwest Territories*. January 2007 version, Yellowknife, NWT. URL: http://www.aadnc-aandc.gc.ca/eng/1100100024558
- Aboriginal Affairs and Northern Development Canada, 2009. *RECLAIM Cost Estimate Model, Version 6.1*. Prepared by Brodie Consulting Ltd., for Water Resources Division, Aboriginal Affairs and Northern Development Canada, Yellowknife, NWT.
- Cowan Minerals Ltd., 2010. *The Policy Framework in Canada for Mine Closure and Management of Long-term Liabilities: A Guidance Document*. National Orphaned/Abandoned Mines Initiative, Sudbury, ON. URL: http://www.abandoned-mines.org/pdfs/PolicyFrameworkCanforMinClosureandMgmtLiabilities.pdf
- Environment Canada, 2009. *Environmental Code of Practice for Metal Mines*. URL: http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CBE3CD59-1
- McKenna, G., O'Kane, M., and Qualizza, C., 2011. *Tools for Bringing Mine Reclamation Research to Commercial Implementation*. Proceedings from Tailings and Mine Waste 2011, Vancouver , BC URL: http://www.infomine.com/publications/docs/McKenna2011.pdf
- Ministry of Environment, 2008. *Guidelines for Northern Mine Decommissioning and Reclamation*, Version 6. Government of Saskatchewan. URL: http://bit.ly/KuDQ4s
- Robertson, A. and Shaw, S. Infomine e-book: *Mine Closure*. URL: http://www.infomine.com/publications/docs/E-Book%2002%20Mine%20Closure.pdf
- Wenig, M. and O'Reilly, K., 2005. *The Mining and Reclamation Regime in the NWT: A Comparison with Selected Canadian and US Jurisdictions*. Canadian Institute of Resources Law and Canadian Arctic Resources Committee. URL: http://www.carc.org/pdfs/mining49_nwtminingreclam_final_21jan05.pdf
- Yukon Government - Energy, Mines and Resources, 2008. *Yukon Mine Site Reclation and Closure Policy: Financial and Technical Guidance*. Government of the Yukon. URL: http://www.emr.gov.yk.ca/mining/pdf/final_text_ft_guidelines.pdf

Communication and Engagement

- Aboriginal Affairs and Northern Development Canada, 2005. *Report on Aboriginal Participation in Mining in Canada,* Mechanisms for Aboriginal Community Benefits. 13th Annual Report. URL: http://www.aadnc-aandc.gc.ca/aiarch/mr/nr/j-a2006/2-02760-eng.asp
- Aboriginal Affairs and Northern Development Canada, 2005. *Incorporating Community Knowledge in Mine Reclamation Planning*. Workshop hosted by Aboriginal Affairs and Northern Development Canada, May 16-17, 2005, Yellowknife, NWT.
- Mackenzie Valley Environmental Impact Review Board, 2005. *Guidelines for Incorporating Traditional Knowledge into the Environmental Impact Assessment Process*. Yellowknife, NWT. URL: http:// http://bit.ly/Pw4gW3
- Mackenzie Valley Land and Water Boards (MVLWB, GLWB, SLWB, WLWB), 2012:
  - *Draft Community Engagement and Board Consultation Policy. URL:* http://bit.ly/QKGd2t
  - *Revised Draft Community Engagement Guidelines for Applicants and Holders of Water Licences and Land Use Permits.* URL: http://bit.ly/RS4Vh2
  - *Draft Reference Bulletin: Procedural Framework for Addressing the Adequacy of Crown Consultation. URL:* http://bit.ly/SGwfz3

Relevant Guidance Documents

- Aboriginal Affairs and Northern Development Canada, 2007. *Guidelines for Spill Contingency Planning. Water Resources Division*, Yellowknife, NWT. URL: http://www.aadnc-aandc.gc.ca/eng/1100100024236
- Aboriginal Affairs and Northern Development Canada, 2009. *Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories*. June 2009 Version, Water Resources Division, Yellowknife, NWT URL: http:// http:// bit.ly/WOGvKC
- Aboriginal Affairs and Northern Development Canada, 2010. *Northern Land Use Guidelines: Access: Roads and Trails*. Land Administration, Yellowknife, NWT. URL: http://www.aadnc-aandc.gc.ca/eng/1100100023568
- Aboriginal Affairs and Northern Development Canada, 2010. *Northern Land Use Guidelines: Acccess: Pits and Quarries*. Land Administration, Yellowknife, NWT. URL: http://www.aadnc-aandc.gc.ca/eng/1100100023585
- Aboriginal Affairs and Northern Development, 2010. *Northern Land Use Guidelines: Camp and Support Facilities*. Land Administration, Yellowknife, NWT. URL: http://www.aadnc-aandc.gc.ca/eng/1319659277961
- Canadian Council of Ministers of the Environment (CCME) Canada Wide Standards. URL: http://www.ccme.ca
- Canadian Dam Association 2007. *Canadian Dam Association Dam Safety Guidelines*. Canadian Dam Association, Edmonton, AB.

- Government of the Northwest Territories, 2003. *Environmental Guidelines for Contaminated Site Remediation*. Yellowknife, NWT URL: http://www.enr.gov.nt.ca/_live/documents/content/siteremediation.pdf
- Government of the Northwest Territories and Aboriginal Affairs and Northern Development Canada, 2010. *Northern Voices, Northern Waters: NWT Water Stewardship Strategy*. Yellowknife, NWT. URL: http:// www.enr.gov.nt.ca/_live/documents/content/NWT_Water_Stewardship_Strategy.pdf
- Ministry of Northern Development and Mines, Government of Ontario, 2011. *Mine Rehabilitation Code of Ontario*. URL: http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_000240_e.htm
- Mackenzie Valley Land and Water Board, 2011. *Guidelines for Developing a Waste Management Plan*. Yellowknife, NWT. URL: http://bit.ly/VtmcgX
- Price, W.A. and Errington, J.C., 1998. *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. Government of British Columbia, Ministry of Energy and Mines. URL: http://www.em.gov.bc.ca/Mining/Permitting-Reclamation/ML-ARD/Pages/Guidelines.aspx

Technical Considerations by Topic for Mine Site Closure and Reclamation

Acid Rock Drainage/Metal Leaching

- Dawson, R.F., and Morin, K.A., 1996. *Acid Mine Drainage in Permafrost Regions: Issues, Control Strategies and Research Requirements*. Mine Environment Neutral Drainage (MEND) Program Report, 1.61.2. URL: http://www.mend-nedem.org/reports/files/1.61.2.pdf
- Mine Environment Neutral Drainage (MEND) Program – Reports and Manuals. Numerous reports related to acidic drainage from mine sites are found at http://www.mend-nedem.org/default-e.aspx
- O'Kane Consultants Inc., eds., 2012. *Cold Regions Cover System Design Technical Guidance Document*. Mine Environment Neutral Drainage (MEND) Program Report 1.61.5c. URL: http://www.mend-nedem.org
- Price, W.A. and Errington, J.C., 1998. *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. Government of British Columbia, Ministry of Energy and Mines. URL: http:// www.em.gov.bc.ca/Mining/Permitting-Reclamation/ML-ARD/Pages/Guidelines.aspx
- Reclamation Research Group, LLC., 2008. *Acid Mine Drainage and Effects on Fish Health and Ecology: A Review*. Prepared for U.S. Fish and Wildlife Service. URL: http://landkeepers.ca/images/uploads/reports/Final_Lit_Review_AMD.pdf
- SRK Consulting Inc. and Mehling Environmental Management Inc., 2006. *Update on Cold Temperature Effects on Geochemical Weathering*. Mine Environment Neutral Drainage (MEND) Program Report 1.61.7. URL: http://www.mend-nedem.org/reports/files/1.61.6.pdf
- Stratos Inc. and Brodie Consulting Ltd., 2011. *Climate Change and Acid Rock Drainage - Risks for the Canadian Mining Sector*. Mine Environment Neutral Drainage (MEND) Program Report 1.61.7. URL: http://www.mend-nedem.org/reports/files/1.61.7.pdf

Permafrost

- EBA Engineering Consultants Ltd., 2004. *Permafrost Considerations for Effective Mine Site Development in the Yukon Territory*. Mine Environmental Research Group, Yukon Government. Whitehorse, Yukon. URL: http://www.geology.gov.yk.ca/pdf/MPERG_2004_1.pdf
- French, H. M. 2007. *The Periglacial Environment.* 3rd edition, Wiley. Essex, England.
- Natural Resources Canada, 2009. *Canada – Permafrost.* In *National Atlas of Canada,* 5th ed. Ottawa, Ontario. URL: http://atlas.gc.ca/site/english/maps/environment/land/permafrost

Environmental/Climate Change

- Environment and Natural Resources, 2008. *NWT Climate Change Impacts and Adaptation Report.* Government of Northwest Territories, Yellowknife, NWT. URL: http://bit.ly/TkDejD
- Hovelsrud, G.K. and Smit, B., 2010. *Community Adaptation and Vulnerability in Arctic Regions.* 1st Edition. Springer, Guelph, Ontario. 353pp.
- Natural Resources Canada, 2009. *Climate Change Map.* In *National Atlas of Canada,* 5th ed. Ottawa, Ontario. URL: http://atlas.gc.ca/site/english/maps/climatechange
- Pearce et al., 2009. *Climate Change and Canadian Mining: Opportunities for Adaptation*. Arctic North and the David Suzuki Foundation. URL: http://bit.ly/QI3XHg

Tailings Containment Areas

- Clarkin, T. et al., 2011. *Hydrologic Closure of Mine Tailings Facilities.* Proceedings Tailings and Mine Waste, Vancouver, British Colombia. URL: http://www.infomine.com/publications/docs/Clarkin2011.pdf
- Holubec Consulting Inc., 2004. *Covers for Reactive Tailings Located in Permafrost Regions Review*. Mine Environment Neutral Drainage Program. URL: http://www.mend-nedem.org/reports/files/1.61.4.pdf
- Szymanski, M.B. and Davies, M.P., 2004. *Tailings Dams Design Criteria and Safety Evaluations at Closure*. AMEC Earth and Environmental, Vancouver, British Columbia. URL: https://circle.ubc.ca/bitstream/handle/2429/8712/05%20Szymanski%20Paper.pdf?sequence=1
- Tremblay, G.A. and Hogan, C.M. eds., 2001. *MEND Manual - Volume 4 - Prevention and Control - 4.5.2d*. Mine Environment Neutral Drainage (MEND) Program. Natural Resources Canada. URL: http://www.mend-nedem.org/reports/files/5.4.2d.pdf

Revegetation

- Access Consulting Group, 2003. *Examination of Revegetation Methodologies for Dry Stack Tailings in Northern Environments*. Mining Environmental Research Group, Government of Yukon. URL: http://www.geology.gov.yk.ca/pdf/MPERG_2003_2.pdf
- Adams, P.W. and Lamoureux, S., 2005. *A Literature Review of the Use of Native Northern Plants for the Revegetation of Arctic Mine Tailings and Mine Waste*. Prepared for the Government of the NWT. URL: www.enr.gov.nt.ca/_live/documents/content/WKSS_Northern_Plants_Re-vegetation-2005.pdf
- Clark, A. and Hutchinson, T., 2005. *Enhancing Natural Succession on Yukon Mine Tailings Sites: A Low-Input Management Approach*. Mining Environmental Research Group Report, Yukon Government, Whitehorse, Yukon. URL: http://www.geology.gov.yk.ca/pdf/MPERG_2005_3.pdf
- Naeth, A.M. and Wilkinson, S.R., 2004. *Revegetation of Disturbed Sites at Diavik Diamond Mine, NWT*. Annual Report for Diavik Diamond Mines Inc. URL: http://bitly.com/TGUba4
- Polster, D., 2011. *Towards Revegetation Sustainability Criteria for Northern Mine Closure*. Prepared for theIndependent Environmental Monitoring Agency, Yellowknife, NWT. URL: http://www.monitoringagency.net/LinkClick.aspx?fileticket=AcA9Q8u0fcM%3D&tabid=110

Waste Rock and Overburden Piles

- Caldwell, J. 2006. *State of the Art Review – Waste Rock Dumps*. URL: http://technology.infomine.com/WasteRockDumps/

Underground Workings

- Aboriginal Affairs and Northern Development Canada, 2011. *Remediation Guidelines for Abandoned Mine Openings in Northern Canada*, June 2011. Northern Contaminated Sites Program, Ottawa, Ontario.

Relevant Legislation

Closure and reclamation of advanced mineral exploration and mine sites in the NWT is subject to a number of statutes. The primary Acts and Regulations applicable in the NWT at the time of publishing the Guidelines are listed. It is incumbent upon the proponent to ensure compliance with all pertinent legislation including conditions set out in updated versions of existing policies, regulations, and guidelines.

Federal

- *Canadian Environmental Assessment Act and Regulations*
- *Canadian Environmental Protection Act and Regulations*
- *Fisheries Act and Regulations*
- *Arctic Waters Pollution Prevention Act and Regulations*
- *Northwest Territories Waters Act and Regulations*
- *Mackenzie Valley Resource Management Act and Regulations*
- *Territorial Lands Act and Regulations*
- *Transportation of Dangerous Goods Act and Regulations*
- *Aeronautics Act and Canadian Aviation Regulations*
- *Explosives Act and Regulations*

Territorial – NWT

- *Commissioner's Lands Act and Regulations*
- *Environmental Protection Act and Regulations*
- *Environmental Rights Act and Regulations*
- *Mine Health and Safety Act and Regulations*

Notes

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