

Managing Orphaned and Abandoned Mines – A Canadian Perspective

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Abstract

The legacy of orphaned and abandoned mines, including environmental liability, human health concerns, and the cost of clean-up and long-term monitoring and maintenance is a serious issue facing Canada and many other countries. Orphaned or abandoned mines are those for which the owner cannot be found, or is financially unable or unwilling to remediate the site. These mines can pose environmental, health, safety and economic problems for communities, the mining industry and governments.

The National Orphaned/Abandoned Mines Initiative (NOAMI) was formed in 2002 at the request of the Canadian Mines Ministers, and based on recommendations put forward at a multi-stakeholder workshop, Orphaned and Abandoned Mines in Canada, held in Winnipeg in 2001. The workshop determined the key issues associated with orphaned/abandoned mine sites, and laid down a series of guiding principles and objectives that apply to NOAMI as it exists today.

NOAMI is guided by a multistakeholder Advisory Committee that brings together representatives from the mining industry, federal, provincial and territorial governments, non-governmental organizations and Aboriginal Canadians. NOAMI's activities are jointly funded by the federal, provincial and territorial governments and industry and are administered by a secretariat at Natural Resources Canada.

NOAMI does not directly fund or clean-up orphaned and abandoned mine sites. Rather, the members of NOAMI assess issues and make recommendations for collaborative implementation of remediation programs and policies for orphaned and abandoned mines across Canada. The program examines two aspects of orphaned and abandoned mines – issues surrounding remediation and long-term management of existing sites, and best practices to prevent the occurrence of future abandonments. A pan-Canadian effort, NOAMI has made significant progress in the past 15 years in fulfilling this mandate. The achievements of NOAMI and its jurisdictional partners are demonstrated in the NOAMI studies, which reflect different approaches and partnerships towards remediation of orphaned and abandoned mines.

1. Introduction

The legacy of orphaned and abandoned mines, including environmental liability, human health concerns, and the costs of clean-up and long-term monitoring and maintenance is a serious issue in many countries, including Canada. Orphaned or abandoned mines are those for which the owner cannot be found, or is financially unable or unwilling to remediate the site.

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The most serious environmental issues for orphaned and abandoned mines are acidic drainage and metal leaching from underground workings, open-pit mine faces and workings, waste rock piles, and tailings impoundment areas. When these contaminants enter the receiving environment, they can cause much damage. Public health and safety hazards result from mine openings, mine wastes, abandoned infrastructure and subsidence. Policy and financial implications include fiscal responsibility, cost of reclamation and long-term management, funding and jurisdictional liabilities and possible re-use of the land (for future mining, recreational activities, etc.).

Mining has been central to the Canadian economy for nearly 150 years, and Canada is a supplier of mineral commodities worldwide. The long history of mining in Canada has resulted in a large number of abandoned sites; the estimate is more than 10,000 abandoned sites (Mackasey, 2000). These sites vary widely with respect to size, features, and requirements for rehabilitation. In the past, mines became “abandoned” because there were no legislative mechanisms in place to make mine owners accountable for selection and design of a mine site, through to its closure and decommissioning. Furthermore, there was little understanding of the physical and environmental hazards that could be involved in walking away from a site. Today, mining legislation in all Canadian jurisdictions requires the preparation of mine closure plans that describe how mine sites should be rehabilitated throughout their lifecycle, and how they will be decommissioned when mining activities cease.

There are significant differences between closure and management of orphaned and abandoned mines, operating mines, and new mines. An important concept is that cost-effective prevention of acidic drainage/metal leaching and other potential environmental impacts is primarily accomplished in the assessment and design phases. As shown in Figure 1, with time, the costs to implement preventive technologies or strategies dramatically increase. Closure planning during the mine design stage provides an opportunity to design for closure more effectively. As many legacy sites did not include closure planning (it was not a regulatory requirement); dealing with remediation of these sites in the present time can be very costly.

The National Orphaned/Abandoned Mines Initiative (NOAMI) was formally established in 2002 at the request of the federal, provincial and territorial mines ministers in Canada. The groundwork for the initiative was laid out in 1999 when a number of stakeholders put forward requests to the Canadian Mines Ministers to establish a joint industry-government working group, assisted by other stakeholders, to review the issue of orphaned and abandoned mines. The Ministers supported this initiative, and requested that a multistakeholder workshop be organised to identify key issues and discuss priorities for action.

This workshop, which was held in Winnipeg in 2001, determined the key issues for remediation of orphaned and abandoned mine sites, identified common ground among various communities of interest, and identified processes for moving forward. Operating principles and a series of guidelines were laid down at the workshop, which still apply to NOAMI as it exists today.

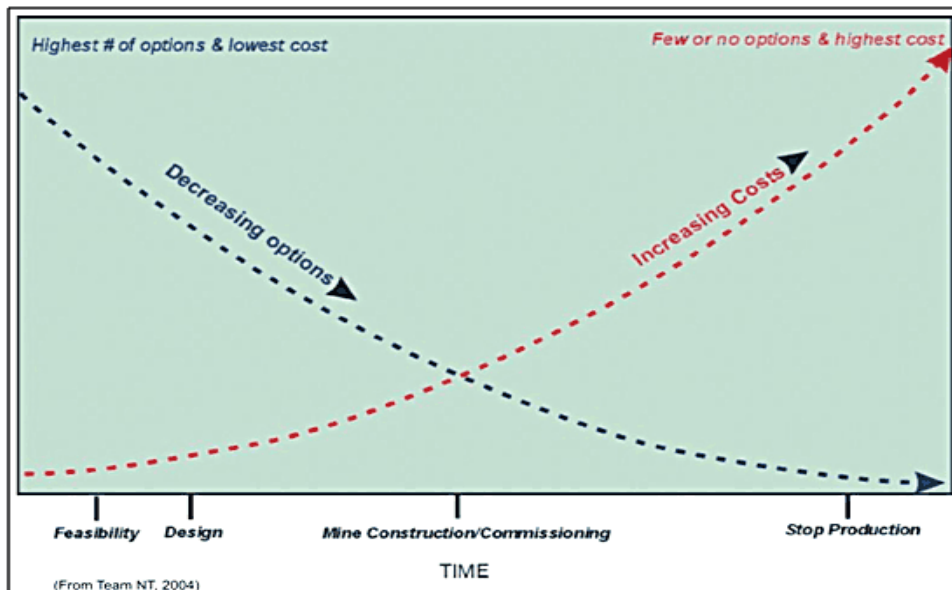


Figure 1. Options and cost over time (from the GARD Guide, INAP 2009)

NOAMI is guided by a multistakeholder advisory committee that brings together representatives from the Canadian mining industry, federal, provincial and territorial governments, non-governmental organisations and Aboriginal Canadians. Together, they assess issues and make recommendations for collaborative implementation of remediation programs and policies for orphaned and abandoned mines across Canada. The NOAMI Advisory Committee takes direction from the federal, provincial and territorial mines ministers and in turn, reports progress annually to the Energy and Mines Ministers Conference. NOAMI’s activities are jointly funded by the federal, provincial and territorial governments, the Mining Association of Canada and the Prospectors and Developers Association of Canada and are administered by a secretariat at Natural Resources Canada.

Over the past fifteen years, NOAMI has made significant contributions to the state of knowledge of orphaned and abandoned mines in Canada and approaches for addressing them. These works are outlined in the “*NOAMI 2002-2008 Performance Report*” (NOAMI, 2009) and the “*NOAMI 2009-2015 Performance Update*” (NOAMI, 2015). NOAMI activities, publications and reports, are available on the NOAMI website: www.abandoned-mines.org.

The NOAMI program examines two aspects of orphaned and abandoned mines – issues surrounding remediation and long-term management of existing sites, and best practices to prevent the occurrence of future abandonments. In the initial years of the program from 2002 to 2008, the work focused primarily on the remediation and policies for existing abandoned sites; the later years (2009 to present) examined strategies to prevent future abandonments, and built on aspects covered in the early years.

2. Work of NOAMI and Products – The Early Years

NOAMI, by itself, does not directly fund or clean-up orphaned and abandoned mine sites. NOAMI has no budget for this, nor does it have a mandate for this type of work. Instead, NOAMI examines the legislative, policy and program framework in Canada for addressing the issue of orphaned and abandoned mines, and makes recommendations for improvements. NOAMI's multistakeholder model of collaboration is an ideal structure for this undertaking. NOAMI provides a forum for partners to discuss barriers and issues for the remediation of orphaned and abandoned mine sites.

When NOAMI was established in 2002, task groups were created to work on the following key issues identified at the Winnipeg 2001 workshop:

1. Web-based Inventory
2. Community Engagement
3. Legislative and Institutional Barriers to Collaboration
4. Funding Approaches
5. Jurisdictional Legislative Review

Communication, the sharing of information and knowledge, underpins all the activities carried out by the NOAMI program.

Program summaries for the task groups are provided below.

2.1 Web-based NOAMI Inventory

One of NOAMI's objectives has been the development of an inventory of orphaned and abandoned mines based on compatible inventories from each province and territory. All Canadian provinces, territories and several federal agencies with a history of mining, maintain their own inventory of mining and exploration sites that pose a risk to human health and safety or the environment. However, there is a large discrepancy in the level of detail and coverage of these inventories across Canada. An added challenge relates to variations in the way that hazards or features are defined or categorized, and which hazards are included in any particular inventory.

Research and compilation of information on abandoned mines is necessary to assist in sound decision-making, cost-efficient planning and sustainable rehabilitation. Such information is also necessary to ensure transparency of decision-making and access to information by governments, civil society, industry and other stakeholders.

The first step towards building the inventory was to reach consensus on the definitions and terminology to be applied to orphaned and abandoned mine sites. The definition of "orphaned" and "abandoned" mines or sites varies among jurisdictions in Canada. A primary criterion for the inventory was to develop a set of definitions under which information from all jurisdictions could be defined and compiled. In addition, many of the existing inventory definitions, which

could be in conflict, had to be avoided. A comprehensive review of Canadian and international efforts to inventory orphaned and abandoned mine sites, along with high-level definitions, were documented in “*Capacity Building for a National Inventory of Orphaned/Abandoned Mines in Canada*” (Cal Data Ltd., 2005). The proposed definitions were developed to be independent of most existing definitions, and would provide a framework in which the existing definitions could be linked.

Following this work, in 2009 NOAMI decided to classify each site according to the environmental hazards each presented to the public and the environment. The feature-based classification system used for the NOAMI inventory was adapted from the four-class ranking of hazards developed for the province of Ontario’s [Abandoned Mines Information System \(AMIS\)](#). Each site is classified into one of four categories (Class A, B, C or D) based on the degree of potential risk each poses to the public and the environment. Class A sites represent the highest concern, while Class D sites pose little risk.

To obtain a Canada-wide perspective, the NOAMI inventory was designed to bring together and build on the strengths of the individual inventories, but allow for gaps in coverage, detail and standardization. A web-based approach was developed to provide users with a tool that offers a single-window access to the data from multiple jurisdictions. A web portal is used, whenever possible, to provide users with a link to the original data source. The site includes an interactive user-friendly map to display the orphaned and abandoned sites, along with their feature-based or status classifications. A key consideration for the jurisdictions was to ensure that the system does not affect their current operational status, and would accommodate inclusion of more detailed information or updates in the future. The inventory is available to the public at www.noami.org.

2.2 Community Involvement

An objective of NOAMI is to develop means to foster community involvement in decision-making about closure and reclamation standards, and to ensure that targeted end-use and reclamation standards are acceptable to local communities. In 2003, NOAMI published a report titled “*Lessons Learned on Community Involvement in the Remediation of Orphaned and Abandoned Mines - Case Studies and Analysis*” (NOAMI, 2003a). Case studies related to community involvement were completed for three abandoned Canadian mine sites (Giant Mine, NT; Deloro Mine, ON; and Mount Washington Mine, BC), along with experiences in community involvement at abandoned mines in the United States. To reflect a diversity of perspectives, the report findings were based on personal interviews with key contacts in the community. These mines entail more complicated issues than most orphaned and abandoned mines. The case studies illustrate the importance of effective community involvement to decision-making. The lessons learned from these studies were developed into guidelines published in the brochure “*Best Practices in Community Involvement: Planning for and Rehabilitating Abandoned and Orphaned Mines in Canada*” (NOAMI, 2003b).

The brochure presents eleven guiding principles developed to support community involvement in policy development, site management and process administration:

- Communication
- Inclusiveness
- Representation
- Fostering Confidence in Decision-Making
- Information Dissemination & Communication
- Participation and Representation
- Resources and Assistance
- Facilitation
- Integration
- Consistency of Involvement
- Respecting Local Cultures

These principles can be used as a template for use by governments, industry, local communities and other parties for the development of policy and citizen engagement plans prior to, during and after the rehabilitation of mine sites.

As part of other studies, NOAMI will continue to examine ways to foster meaningful community involvement and engagement in abandoned mine remediation and closure.

2.3 Legislative and Institutional Barriers to Collaboration

NOAMI wanted a better understanding of the legal and institutional barriers that prevent third parties from collaborating on clean-up activities and addressing associated liabilities related to orphaned and abandoned mines. NOAMI examined the efficacy of various approaches in a background study titled “*Barriers to Collaboration: Orphaned and Abandoned Mines in Canada*” (Castrilli, 2002). This report examined regulatory or institutional barriers, liability disincentives and collaborative opportunities for voluntary abatement, remediation and reclamation of orphaned and abandoned mines in Canada and selected international jurisdictions. Particular emphasis was placed on four approaches: 'Good Samaritan' legislation; permit blocking; allocative versus joint and several responsibility; and non-compliance registries.

The report findings provided background for a multistakeholder workshop held in 2003 “*Legal and Institutional Barriers to Collaboration Relating to Orphaned and Abandoned Mines*” (Versteeg, 2003). Workshop objectives were to identify the key barriers that are inhibiting governments, the private sector and voluntary organizations from effectively financing and administering the remediation of problematic abandoned and orphaned mine sites in Canada, and to begin to develop approaches to overcome these barriers. The presentations detailed experiences, in both Canada and the U.S., on existing and alternative legal and administrative mechanisms that have been used to address the issue. Approaches to overcome these key barriers were developed, and subsequently integrated into a review on jurisdictional legislations (Castrilli, 2005).

2.4 Funding Approaches

Another objective of NOAMI was to identify funding approaches and preferred options for the remediation of orphaned and abandoned mine sites across Canada that could be adapted to the needs of each jurisdiction. Typically, orphaned and abandoned mines revert to the Crown with their remaining environmental liabilities, and inadequate or non-existent securities to finance remediation. A report titled “*Potential Funding Approaches for Orphaned/Abandoned Mines in Canada*” (Castrilli and Watson & Associates, 2003) was prepared that outlined a variety of funding approaches to be considered for the clean-up or management of liabilities related to orphaned and abandoned mine sites. Advantages and disadvantages of each approach were evaluated and preferred options were recommended for consideration by governments. This report concluded that no single funding approach was a complete solution; a combination of a number of approaches would likely be required.

A multistakeholder workshop on “*Assessing Liabilities and Funding Options*” was held in 2005 that further developed funding approaches and related issues for orphaned and abandoned mine sites (Stratos Inc., 2006). A roll-up discussion identified gaps and future priorities for NOAMI. One recommendation was to produce a plain language toolkit of funding options, outlining a series of options and illustrated with case studies. This would be a resource document for use by jurisdictions across Canada to help guide the establishment of potential funding options for the remediation of orphaned and abandoned mine sites. This funding “toolkit” was completed and released in 2006, titled “*Rehabilitating Abandoned Mines in Canada: A Toolkit of Funding Options*” (Cowan Minerals Ltd., 2006).

2.5 Jurisdictional Legislative Review

In 2003, NOAMI was asked by the Mines Ministers to complete a set of guidelines for a jurisdictional legislative review that could be used by jurisdictions to evaluate their own policies with respect to collaboration, liability and funding. The work was conducted by NOAMI with a view to ensuring that approaches across jurisdictions are consistent, transparent, coordinated and efficient. A series of guidelines and a checklist with associated questions were developed to facilitate a focused review of the existing legislation and related policies and practices that relate to orphaned and abandoned mine sites as well as contaminated and operating sites (where relevant to legacy issues). A study was undertaken using the guidelines laid out in the report “*Guidelines for Legislative Review*” (NOAMI, 2004).

Consultation with all the jurisdictions was undertaken to ensure that existing legislation, policies and practices were identified and verified. A synthesis of the jurisdictional analysis was completed that included an assessment of gaps, limitations, barriers and opportunities, along with a summary of observations. Recommendations to address remediation of orphaned and abandoned mines were drawn from previous NOAMI reports on legislative barriers to collaboration and potential funding approaches.

In 2005, the publication titled “*Report on the Legislative, Regulatory, and Policy Framework Respecting Collaboration, Liability and Funding Measures in relation to Orphaned and*

Abandoned, Contaminated, and Operating Mines in Canada” (Castrilli, 2005) was released. This report is often referred to as the “*Jurisdictional Legislative Review*”, and is an invaluable reference material on Canadian legislation, regulations and programs in relation to orphaned and abandoned mines, contaminated sites and operating mines in Canada.

3. Return of Mine Lands - A Multi-phased Project

One of the NOAMI’s guiding principles is that “work toward eliminating future abandonment must continue, including the tightening of regulatory approaches.” In 2009, NOAMI began to examine the legislative tools and policy approaches across Canada to ensure that current operating mines can be closed properly so that they do not become abandoned mines in the future. The committee members have long recognized the need for a clear policy framework for mine closure, long-term liabilities and return of mining lands to the Crown. Such a framework would address the closure and post-closure of mine sites and their long-term management and related liabilities, in a manner that details the responsibilities of the mine owner/operator and government regulatory agencies. The policy framework would examine the questions surrounding the transfer of mining lands back to the Crown through the issuance of a release, including questions of when and under what conditions should such as return be possible (Holmes and Stewart, 2011; Gardiner *et al.*, 2015)).

It is recognized that once a mine is closed, the owner/operator may wish to return (relinquish, give-up, surrender, abandon, exit) the site back to the Crown for various reasons. The owner may not wish to carry the property on their books forever, and the ongoing liabilities need to be reported in corporate financial reports. Ultimately, the owner is going to vanish through business closure or some other mechanism, and the mineral right leases or permits will expire. In the long term, the lands will revert to the Crown, either on managed terms or through unplanned abandonments. Jurisdictions not wishing to receive abandoned lands and their associated liabilities need to have some agreed upon procedure in place to accept lands (Cowan Minerals Ltd, 2013).

3.1 Mine Closure and Management of Long-term Liabilities

NOAMI commissioned a study on mine closure and management of long-term liabilities titled “*The Policy Framework in Canada for Mine Closure and Management of Long-Term Liabilities: A Guidance Document*” (Cowan *et al.*, 2010). The document examined major components related to mine closure and post-closure site management, which can include long-term maintenance and monitoring, financial assurance, relinquishment¹ and institutional care. A valuable reference tool, the report presents a policy framework, together with recommendations for preventing further accrual of abandoned mine hazards.

¹ Return of mining lands is interchangeably used with relinquishment in NOAMI reports.

A relevant finding was that while processes of closure planning and provision of financial assurance are well-developed and consistently applied across Canada, policy around long-term management of sites beyond closure, including methods to return mining lands to the Crown, is almost non-existent.

A key message of the report was:

Jurisdictions should have a managed relinquishment process, which is clear and unfettered. Hitherto closure plans have been prepared on a “design for closure” basis. This should specifically include when and why relinquishment is not acceptable to the jurisdiction. It is suggested that a more forward-looking approach be embraced and that a “design for relinquishment” approach be adopted. (Cowan et al., 2010).

Building on the findings of the guidance document, a multistakeholder workshop “*Exploring the Management of Long-term Liabilities and the Return of Mining Lands to the Crown*” was held in 2011. Advice and guidance were obtained from the workshop delegates that assisted NOAMI in developing a strategic roadmap for managing long-term liabilities and issues relating to the return (relinquishment) of mining lands to the Crown. The themes of risk management, funding and legislation, and policy and regulation were explored during the workshop, and presented in the proceedings (Tunis and Associates, 2011). A key recommendation generated by the workshop participants was for NOAMI to create a decision tree to assist in determination of the return of mining lands to the Crown.

The Advisory Committee agreed that the creation of a decision tree for assessing the return of mine lands to the Crown would be a useful tool and a logical next step for this project. The decision tree would provide information and options for Canadian jurisdictions to consider in the development of new legislation, or to revise current legislation. In the past, NOAMI has used case studies to examine processes, and as tools to study factors involved in dealing with orphaned and abandoned mines. Examination of several mine sites in Canada that were successfully returned to the Crown, or closed sites that had elements related to their potential return, would provide information on processes involved and some lessons learned. The information collected from the case studies, along with other relevant documents, could be used to establish a decision tree.

3.2 Decision-making Process for the Relinquishment of Closed Mine Sites

NOAMI commissioned a two-part study, *Case Studies and Decision-making Process for the Relinquishment of Closed Mine Sites* (Cowan et al., 2013). The first part examined case studies from different Canadian jurisdictions that provided information towards relinquishment. The second part, a decision process, identified key issues and questions that needed to be addressed to determine if a site should be brought under government jurisdiction, or remain the responsibility of the operator. The decision process was not to be prescriptive; instead, it was to focus on providing guidelines for how to make good decisions. Ultimately, it will be up to each jurisdiction to decide whether they will develop a return of mine lands legislation, and if so, what elements they may wish to adopt.

Case studies were undertaken for sites in different Canadian jurisdictions: Quebec Lithium Mine, Quebec; Renabie Gold Mine, north-central Ontario; Gregg River Coal Mine, Alberta; Contact Lake Gold Mine, northern Saskatchewan; Polaris Mine, Nunavut, and Farley East Tailings Management Area, northern Manitoba. There was wide variation in the information derived from the sites due to the age and nature of the projects; changes in ownership, management and operational personnel; regulatory regimes and reporting requirements (Cowan *et al.*, 2013).

The six case studies gave rise to a series of 24 lessons learned; a dozen key ones are cited below (Cowan *et al.*, 2013):

1. Jurisdictions must have clear and well-written legislation and policies in place to facilitate the return of lands. It is necessary to have a system to receive and manage funds to ensure the viability needed to address long-term issues.
2. Where planning and procedures for relinquishment are not in place, defaulting will eventually occur at taxpayers' expense.
3. Few jurisdictions have a satisfactory funding regimen in place to deal with surrendered, or about to be surrendered lands.
4. Most jurisdictions providing for rehabilitation releases and/or relinquishment of lands do not have complete releases for environmental responsibility or liability.
5. It appears that only some jurisdictions have institutional control plans for relinquished lands, i.e. there is no administrative unit with direct responsibility for institutional issues following surrender, e.g. records maintenance, land use planning inputs.
6. Public consultation requirements/efforts are generally considered inadequate relative to current expectations, especially with regard to Aboriginal communities. Consultation requires good information on the issues and needs of impacted communities.
7. The length of post-closure monitoring periods needs greater evaluation especially where documentation/identification of features is lacking.
8. Well-defined risk assessment procedures for property returns are not available for many situations. More information on quantitative risk assessment is required to support chemical and physical stability determinations.
9. Where cutting-edge technology is involved, longer-term monitoring and scientific assessment may be expected, e.g. new schemes related to permafrost or climate change issues.
10. Effective cost-estimation procedures for long-term care and maintenance need development.
11. Storage and maintenance of mine plans and records are essential for technical assessment. Several case studies were hindered by the loss of or unavailability of (historic) documentation.
12. Provision of a final closure report detailing all completed decommissioning and reclamation work is an excellent best practice.

As noted at the NOAMI 2011 workshop, and illustrated in the report by Cowan *et al.* (2013), there are a vast array of factors to consider when developing a process for relinquishment. In addition, each jurisdiction would have its own set of parameters, as well as legislative and policy framework. Many of the parameters could be considered at different stages of the process, and would be amenable to a step-wise approach for planning. As part of a managed relinquishment process, a decision process should be created that provides guidance and clarity, and which outlines key factors that need to be assessed or developed. These steps would determine whether responsibility for the site should remain with the operator, or could be transferred to the Crown.

The five-step decision-making process (Cowan *et al.*, 2013) provides a starting point for jurisdictions developing or revising a program for relinquishment. Although national consistency would be beneficial, each jurisdiction would need to tailor the decision-making process to meet its own regulatory regime and policies.

As shown in Figure 2, the five-step decision-making process follows the natural progression from “submitting the application” through to “implementation”. For each step, consensus must be reached by the review committee before proceeding to the succeeding step, i.e., all “yes” components must be met. It is recommended that an appeal process be available through every step.

The step-wise approach provides guidance as to whether a mining property has been closed as set-out in the closure requirements and closure plan, and whether technical and financial long-term monitoring and maintenance needs have been addressed sufficiently (Cowan *et al.*, 2013).

The steps are briefly summarised:

1. *Submitting the Application*: Ensures that the proponent qualifies for relinquishment with respect to closure and post-closure plans and objectives. Specifically, the site is physically and chemically stable, and existing permits are fulfilled or transferable to the jurisdiction. All necessary parties, and affected stakeholder and Aboriginal peoples must be notified of the application.
2. *Site Assessment*: Locational and technical issues are evaluated to determine if the site is sufficiently reclaimed to meet legal requirements under the closure plan, and will meet proposed future land use requirements. Any interim monitoring requirements must be identified for evaluation.
3. *The Long Term*: Requirements for long-term monitoring, maintenance or capital replacement of rehabilitation works and associated cost estimating are evaluated. A peer-reviewed risk assessment by qualified persons is required for unforeseen events. This is a critical point in the process, as the proponent may decide to retain the properties due to prohibitive funding requirements for relinquishment.
4. *Funding*: Considers what future activities will need to be funded, their costs, and the method of fund management. All funds are provided by the proponent.
5. *Implementation*: Once a site is approved for relinquishment, the regulator must have a management system in place to manage funds, ensure the site is monitored and maintained, and manage data securely. Emergency protocols should be in place.

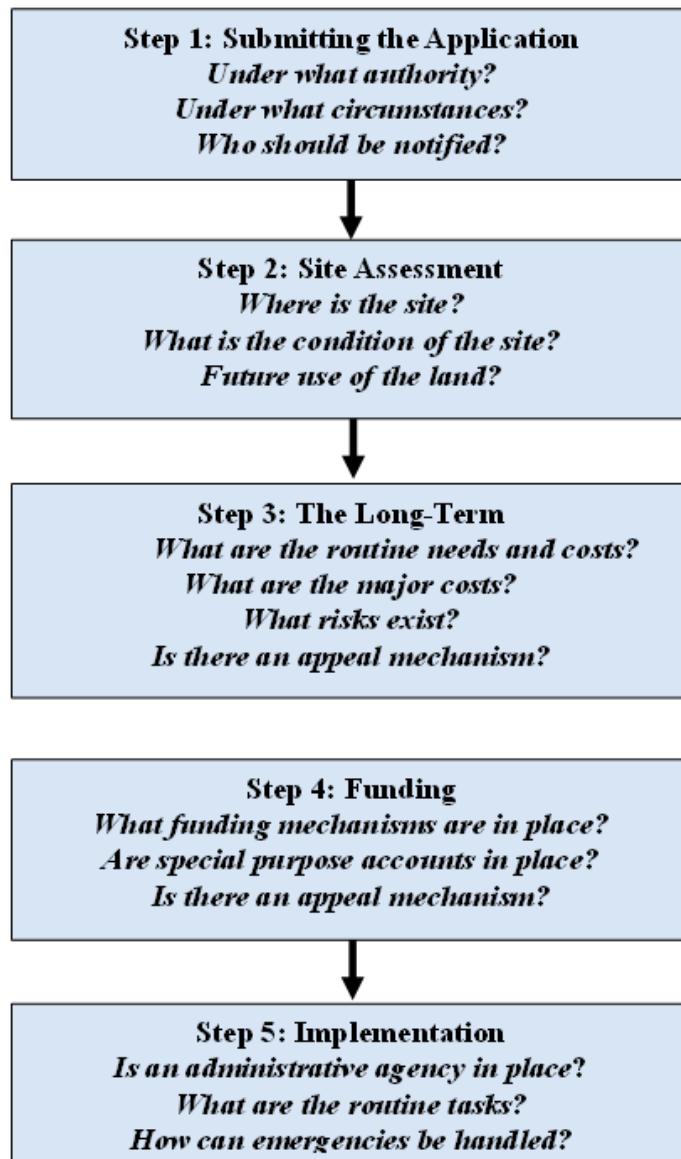


Figure 2. Five-step decision-making process (Cowan et al., 2013)

The report recommends that mining projects should be designed with the objective of reclaiming the site for relinquishment and future beneficial use; however, it is noted that relinquishment may not be possible where the environmental, social, political or financial risk/costs are too high (Cowan et al., 2013). The relinquishment process would be straightforward for fully reclaimed sites that are physically and chemically stable, and require no or minimal monitoring, care or maintenance. A more complex form of relinquishment would be needed for reclaimed sites that

will require ongoing monitoring, care and maintenance. Long-term care of these sites would need to be fully funded by the proponent and managed by the jurisdictions through some form of institutional care. Cowan et al. (2013) noted that a well-designed and well-managed relinquishment policy and program can lead to a win/win situation in many instances.

3.3 Key Criteria for Effective Long-term Stewardship

The policies and procedures for relinquishment need to be linked to the regulatory environment of the jurisdiction. A strategy needs to be in place to address the various aspects involved in the management or stewardship of relinquished sites, such as site assessment and an effective long-term monitoring and maintenance program.

NOAMI undertook a study titled “*Key Criteria for the Effective Long-term Stewardship of Closed, Orphaned/Abandoned Mine and Mineral Exploration Sites*” (Kingsmere Resource Services Inc., 2015) wherein criteria were developed to assess these sites in order to evaluate their condition. A list of site attributes was developed, along with a review of national and international best practices of the management of post-closure mine sites. The report notes that effective stakeholder engagement at every stage of the assessment is important and can result in significant benefits.

The initial step toward long-term stewardship is to assess the current state of the site. The report provides a summary of features that could exist at the site, with a focus on identifying the hazards. Before the inspection, research needs to be carried out to collect information on the site, and a site visit safety plan should be developed, containing potential hazards and mitigation controls, logistical details, and safety rules. The site inspection aspects are numerous, and include site access and condition, mine type, facilities and infrastructure, and physical and chemical hazards. To assist in this, a field report was created that can be used to record observations during the site visit.

The next step is an assessment of the level of risks posed by the identified hazards. Various types of risk are considered in the report: public safety risk and ecological and human health risk. Subsequently, a decision can be made as to whether remediation is required, and to what level. Reaching consensus on the level of risk posed by a hazard is a difficult process, and must take into account the concerns of all the stakeholders.

An effective stakeholder engagement plan must be in place to address site risks and possible remediation of that risk. The next step is site remediation; a difficult stage, as a balance must be achieved between the level of risk reduction desired by the stakeholders and the cost to achieve that level. The last step for long-term stewardship involves data keeping of the activities on the site and regular inspections by qualified personnel. To ensure the long-term stewardship of closed, orphaned and abandoned mine sites, an institutional control program is recommended.

This report builds on several of the lessons learned from the Cowan *et al.* report (2013). In addition, it addresses the first two steps laid out in the Five-Step Decision-making Process, specifically, *Step 1: Submitting the Application* and *Step 2: Site Assessment*.

3.4 Cost and Risk Estimation Study: Orphaned and Abandoned Mines

The logical next study for NOAMI to consider was *Step 3: The Long Term*. A report was commissioned *Orphaned and Abandoned Mines: Risk Identification, Cost Estimation and Long-term Management* (Kingsmere Resource Services Inc. (KRS), 2016) to address elements of long term or perpetual care. The report documented a risk identification/cost estimation framework for use as a tool to allow a wide variety of multistakeholder users to:

- Identify and characterize risks and liabilities at orphaned and abandoned mines sites;
- Review methodologies to assess the significance of identified risks and to estimate the cost(s) to mitigate the risk;
- Summarize and evaluate long-term management methods;
- Identify types of costs associated with long-term management of a site, and explore funding methods; and,
- Define major areas of potential cost underestimation/overruns, conflict and/or uncertainty and discuss ways to address these issues.

Long-term management of orphaned and abandoned mine sites, as well as closed mine sites, can involve a wide range of activities. These activities will depend on the site conditions and/or the residual hazards after remediation. Key components of a program for the long-term stewardship of a site would include:

- Information management;
- Site monitoring and maintenance;
- Unforeseen events (i.e. responses when remedies or controls fail); and
- Application/enforcement of legal or other mechanisms to restrict future use.

Few jurisdictions in Canada or the world have developed a formal institutional control management framework that provides for long-term stewardship of mine sites once the operator has fulfilled their decommissioning and reclamation obligations and proven that the site is chemically and physically stable. The KRS (2016) report identifies five options for funding long-term stewardship costs, and summarizes the Institutional Control Program developed in the province of Saskatchewan (Canada), as an example of a long-term management framework and funding mechanism.

3.5 Institutional Control Program

One of the few jurisdictions with a clear process and policy in place is the “Institutional Control Program (ICP)” in Saskatchewan (SK). The ICP has garnered international attention and NOAMI has identified the program as the most advanced Canadian regulatory regime that addresses all aspects of site relinquishment.

Relinquishment of a mine site back to the Crown is the final step in the mining sequence. Once a mine site has obtained a closed status, it can be put under institutional care of a custodial authority using a controlled process. This is opposed to regulatory authorities having to assume ownership in an unmanaged process as for orphaned and abandoned mines. Under legislation of several Canadian mining jurisdictions, the government is able to issue a release, or a similar instrument, that would legally allow a mining operator to terminate its operations and responsibility for a site, with no further obligations. However, few jurisdictions other than Saskatchewan, have issued such instruments because of the lack of clarity around the process.

The ICP outlines conditions for which it will accept closed mine sites into the program, and provide for their long-term management. Similarly, SK will accept orphaned or abandoned mines into the program once the reclamation is completed, and monitoring has shown the site is chemically and physically stable (KRS, 2016).

In 2007, Saskatchewan enacted legislation to implement the ICP through the Reclaimed Industrial Sites Act (RISA) and Regulations (RISR). The ICP has two components: the Registry and the Institutional Control Funds, which includes the Monitoring and Maintenance Fund and the Unforeseen Events Fund. Records and information for accepted sites are archived in the Registry, and access is provided to both regulatory authority and the public. The Registry provides the regulatory authorities with information to ensure that the prescribed monitoring and maintenance is performed and that the site remains compliant with land use restrictions.

As a condition of acceptance into the ICP, the operator must submit a monitoring and maintenance plan that lays out the long-term requirements for the site, and the future costs associated with those requirements. The value of the future costs determines the amount to be deposited into the Monitoring and Maintenance Fund. The deposit is site-specific, and must be calculated in order to provide sufficient revenue to pay for future costs incurred in perpetuity. In addition, the operator must contribute to the Unforeseen Events Funds. This contribution must be sufficient value to cover costs associated with unforeseen events, and eventually once it builds up in value, the site would be released from this financial requirement. These funding measures ensure that future generations do not have to bear the cost of long-term management or future remediation of these sites. Of importance, is that the funds are managed by the province, but “stand alone” from provincial revenue.

The Institutional Control (IC) Program accepted six sites (one gold and five uranium) into the IC Registry in 2009 and performed the scheduled inspections on the sites in 2014. A number of sites are under assessment for acceptance in 2017 and the regulatory regime is under review to further enhance the effectiveness and sustainability of the program.

Several excellent documents on this subject have been produced by the team who developed the IC framework; these include papers by Cunningham *et al.* (2012), Hovdebo *et al.* (2015) and KRS (2016). Detailed information is available on the Saskatchewan’s Ministry of the Economy website: http://economy.gov.sk.ca?Institutional_Control-Decommissioned_Mines/Mills

3.6 Return of Mine Lands Project - Conclusion

The return of mine lands project has produced several important tools and guidance documents that will contribute to the prevention of future abandoned mines. Taken together, these projects constitute important tools that will make a major contribution towards the development of a pan-Canadian policy framework that would address all aspects of managing orphaned mine liabilities in the long term, and preventing future abandonments. NOAMI will continue to explore development of tools to assist in mine closure and relinquishment.

4. Jurisdictional Updates

Provinces, territories, and Indigenous and Northern Affairs Canada (for sites north of the 60th parallel) in Canada have made significant progress in remediation of abandoned mines in their jurisdictions. Since 2002, the jurisdictions have spent more than to C\$ 1 billion addressing orphaned and abandoned mines. Various funding partnerships and collaborative approaches have been used, and this information is invaluable and can be applied on a national and international basis (Cowan Minerals, 2006). A number of partnerships have been formed to remediate orphaned and abandoned mines in Canada. Several of these approaches are of particular relevance to NOAMI's mandate for the development of collaborative partnerships in the implementation of remedial programs.

Highlights of their work on orphaned and abandoned mines were provided by several jurisdictions for the *Mining Sector Performance Report 2006-2015* (IGWG, 2016) and excerpted below. Additional information on jurisdictional activities and partnerships is provided in *NOAMI's 2002-2008 Performance Report* (NOAMI, 2009) and the *NOAMI 2009-2015 Performance Update* (NOAMI 2015).

4.1 Federal Government – Indigenous and Northern Affairs Canada

The Northern Contaminated Sites Program (NCSP), within Indigenous and Northern Affairs Canada, was created in 1991 to manage remediation of contaminated sites across the North. In 2005, the Federal Contaminated Sites Action Plan was established by the federal government. This program committed C\$ 3.5 billion over a 15-year period for the assessment and remediation of contaminated sites under the federal government's responsibility, which includes abandoned mines in the Yukon, the Northwest Territories (NWT) and Nunavut.

As of April 1 2016, over 1,000 contaminated sites in the North have been assessed by the NCSP, of which 97 were classified as high priority for action. Remediation has been completed at 48 sites across the three territories. Work is ongoing at 76 sites, including two of the highest priority northern sites, the Giant Mine in the NWT and the Faro Mine in the Yukon. In the case of the Faro Mine, INAC works very closely with the Government of Yukon.

The Program continues to promote social and economic opportunities in the North by engaging First Nations, Inuit and other Northerners in all aspects of the site management and remediation

process and will continue to ensure that contaminated sites are managed to ensure the protection of human health, safety and the environment for all Northerners.

4.2 Province of British Columbia

The province of British Columbia established the Crown Contaminated Sites Program (CCSP) in 2003 based on a report by the Office of the Auditor General seeking improvements in the management of contaminated site. The mandate of CCSP is to identify and remediate high risk contaminated sites that are located on Crown land where no responsible person can be identified and the responsibility for remediation fall to the province. Remediation undertaken complies with the Environmental Management Act, Contaminates Sites Regulation and the Hazardous Waste Regulation. The 2016 Crown Contaminated Sites Program Biennial Report which describes the province's effort and the results achieved is available at:

http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/reports-and-presentations/biennial_report.pdf

To date 82 sites have been investigated, of which 48 have been determined to be low risk where no immediate action is required, 18 have been fully remediated, and 16 are under investigation or undergoing remediation. Orphaned and abandoned mine sites comprise about 95% of the contaminated sites within CCSP portfolio. As of March 31, 2016 the province of British Columbia has recognized contaminated sites liabilities totaling C\$ 508 million. Of this over C\$ 192 million have been spent on site remediation.

4.3 Province of Manitoba

In 2000, Manitoba established the Orphaned/Abandoned Mine Site Rehabilitation Program to address the environmental, health, and public safety concerns of orphaned and abandoned mines in the province. Within this program, 149 former mine sites were identified, including five high-priority sites, and 31 high-hazard sites. To date, 30 of 31 high-hazard sites have been remediated and work is underway to complete the one remaining site. Manitoba is now addressing lower priority sites, largely in response to communities and government concerns, and has remediated 10 low- to moderate-risk sites. As of March 31, 2016, the Province had spent C\$ 214.8 million on orphaned and abandoned mine-site rehabilitation.

Manitoba supports the rehabilitation of orphaned and abandoned mines through its programs, partnerships, community involvement and funding initiatives. Further information may be found at http://www.gov.mb.ca/iem/mines/oa_rehabilitation.html.

4.4 Province of Newfoundland and Labrador

Orphaned and abandoned mines in Newfoundland and Labrador are mostly historic and predate the province joining the Confederation of Canada in 1949; all of the sites predate the Mining Act

of 2000. These properties, ranging from exploration sites to large-scale former producing mines, can pose safety risks to the public and some have environmental issues.

Newfoundland and Labrador has spent over C\$ 30 million on orphaned and abandoned mines in recent years. In addition, they have implemented a program of dam safety reviews and repairs of tailings dams at orphaned and abandoned mines with the goal of bringing the dams to Canadian Dam Association standards.

4.5 Province of Nova Scotia

There are approximately 7,500 abandoned mine openings (AMOs) in Nova Scotia, about 2,200 of which are located on Crown land. The Abandoned Mine Opening Remediation Program was created in 2001, and as of December 2015, has invested about C\$ 760,000 to remediate the most hazardous of these openings. To date, 689 AMOs have been remediated through the program, including all the most hazardous (inescapable) mine openings. The work was conducted on 40 different mine sites.

4.6 Province of Ontario

The Ontario Abandoned Mines Rehabilitation Program helps to ensure that abandoned mine sites that once contributed to the province's economic growth do not become a lasting environmental and health concern. Ontario established its Abandoned Mine Rehabilitation Fund (AMRF) in 1999.

From September 1999 to March 2016, C\$ 142.4 million was spent on rehabilitating Crown-held mine sites. Rehabilitation has been conducted on more than 80 of the highest-priority abandoned mine sites. The largest of these sites is the Kam Kotia Mine, where more than C\$ 75 million has been spent to date.

The Abandoned Mines Information System (AMIS) is a database containing information on all known abandoned and inactive mine sites and mine hazard features located on both Crown and privately held lands within the province of Ontario. There are currently 5,762 known abandoned mine sites under Mining Act jurisdiction throughout the Province, which contain approximately 17,456 mine features. Additional information on the AMIS system can be obtained at:

<http://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearch/abandoned-mines>

4.7 Province of Saskatchewan

In 2007, the Government of Saskatchewan enacted legislation to implement an Institutional Control Program for the post-closure management of decommissioned mine and mill sites on provincial Crown land. Information on the IC Program was presented in Section 3.6.

Project CLEANS (Clean-up of Abandoned Northern Sites) is a multi-year, multi-million-dollar project aimed at assessing and reclaiming the Gunnar Mine, Lorado mill, and 36 satellite sites in

northern Saskatchewan. In 2006, the governments of Saskatchewan and Canada signed a Memorandum of Agreement to share equally in the costs to clean-up the Gunnar and satellite legacy uranium sites in northern Saskatchewan.

4.8 Province of Québec

Projects to rehabilitate mining sites have significantly increased since the beginning of the 1990's due to efforts of industry and the provincial government. During the early 1990's, the Government of Québec injected more than C\$ 30 million into research, closure projects, and financial assistance to rehabilitate mining waste areas. In April 2006, the Québec government undertook a major project to restore contaminated sites, mainly mining sites.

Quebec has explored novel approaches for site rehabilitation. Research was directed at the development of efficient, economical closure methods. In several cases, an exhaustive characterization of the site has led to the development of innovative closure approaches using various waste materials, such as forest residue, sludge from sewage treatment plants, septic tanks or paper mills, and ash from co-generation power plants. These technologies have reduced costs and offered a win/win solution to the problem of stockpiling, for at least some of the waste materials.

Different types of partnership approaches were created to address some of the contaminated sites (Tremblay and Hogan, 2010). A diverse partnership base is essential to the success of rehabilitating closed mines, and it is critical to involve partners early in the process. The innovative open approach used by the Québec government for mine rehabilitation is envied by many other Canadian jurisdictions.

In November of 2016, the Government of Quebec announced that they had allocated C\$ 620 million for the rehabilitation of contaminated sites; 80% of this amount is for abandoned mines.

5. Communications - Sharing Information and Knowledge

Sharing information and knowledge with its partners and the public is an important function of NOAMI. The collaborative activities and works of NOAMI have been recognized internationally as an excellent model of partnership in remediation of abandoned mines.

Workshops are the preferred vehicle to share information and knowledge and obtain feedback from the multi-sectoral mining community. Efforts are made to include impacted communities in these workshops, and to ensure a sectoral balance of industry, government, environmental non-government organizations, academia, Aboriginal peoples and consultancies. The workshops maintain a focus on facilitated multistakeholder dialogue and expert discussion panels to develop key recommendations and a “toolbox” of options to help NOAMI move issues forward. NOAMI workshops are focussed on a key issue or are based on a central theme and have included:

- Exploring the Management of Long-term Liabilities and the Return of Mining Lands to the Crown in Canada, 2011

- Workshop to Explore Perspectives on Risk Assessment for Orphaned and Abandoned Mines, 2008
- Orphaned and Abandoned Mines: A Workshop to Explore Best Practices, 2006
- Assessing Liabilities and Funding Options Workshop, 2005
- Legal and Institutional Barriers to Collaboration Workshop, 2003
- Orphaned and Abandoned Mines in Canada Workshop, 2001

In addition to workshops, NOAMI facilitates information sharing through documents such as the NOAMI Nugget (newsletter), and other bulletins, that are distributed electronically to a large national and international mailing list. NOAMI's website is bilingual and is regularly updated with workshop proceedings, pamphlets, announcements and newsletters. Links to national jurisdictional programs on abandoned mines are provided. NOAMI reports are also available on the website and can be downloaded for free (www.abandoned-mines.org).

5.1 NOAMI's 2002-2008 Performance Report and 2009-2015 Performance Update

NOAMI's first Performance Report, covering the years 2002–2008, was a major undertaking and described the activities and infrastructure of the initiative in considerable detail. It was widely distributed in Canada and abroad, in English and French, and effectively promoted NOAMI, while showcasing the activities of Canadian jurisdictions in the remediation of orphaned and abandoned mines sites.

NOAMI released a second performance report in 2015 that covered the period 2009–2015. While the format is more focussed than that of the first report, it once again highlighted both NOAMI's major achievements, and the efforts of Canadian jurisdictions to address the potential legacy issues associated with orphaned and abandoned mines across the country.

5.2 International Linkages

NOAMI looks to develop linkages with other initiatives dealing with orphaned and abandoned mines, with the objective of sharing information and resources. Organizations such as the International Council on Mining & Metals (ICMM), National Association of Abandoned Mine Land Programs (NAAML-USA), United Nations Environment Programme (UNEP), Sustainable Mining Institute (Australia) and Sernageomin (Chile) and Fundacion Chile have developed projects or approaches for management of abandoned sites.

5.3 NOAMI - A Model of Collaboration

Mining with environmental stewardship involves not only optimizing the technical performance of mining and extraction processes so as to maximize the profitability of an operation, but also entails leaving a positive environmental and social legacy. Up until the 1970s, the focus was primarily on generating profits. Since that time, there has been a growing awareness of the need to minimize the negative imprint that mining has left on the natural environment. In the 1980s a

collective approach to problem solving emerged in Canada. The Mine Environment Neutral Drainage (MEND) program, created in 1989, was the first international multistakeholder program to develop scientifically-based technologies to reduce the effect of acidic drainage and metal leaching, a major issue for orphaned and abandoned mines. This approach allows policy decisions to be made based on sound science. Since then, this model of collaboration was used by both Canadian and international programs to address issues of national importance. For example, NOAMI adopted the MEND model to develop a policy-based program for remediation of orphaned and abandoned mine sites in Canada. The success of these programs can be attributed to several factors.

- The partnerships developed among the two levels of government, the mining industry, environmental groups, and Aboriginal Canadians working together to develop solutions to a major environmental problem.
- An extensive peer-review process, both formal and informal, that results in enhanced credibility of the information base.
- A small dedicated secretariat that coordinates activities, manages the accounting, reporting and technology transfer, and serves as the “glue” that holds the program together. The secretariat for both MEND and NOAMI is located at Natural Resources Canada, which provides much synergy between the two programs.
- The dynamic approach taken for transferring the knowledge gained during these multistakeholder initiatives.

NOAMI’s and MEND’s collaborative activities and accomplishments are recognized internationally as excellent models of partnership in addressing issues of national importance such as acidic drainage and metal leaching, and the remediation of orphaned and abandoned mines. The secretariat and committee members are invited to speak at national and international events to share Canadian expertise, knowledge and approaches to these issues. Through these efforts, a significant advancement in environmental management has been achieved, which in turn has contributed to the long-term sustainability of the mining industry and the environment.

5.4 Abandoned Mines, MEND and Acidic Drainage

Serious environmental issues for orphaned and abandoned mines are related to acidic drainage and metal leaching from underground workings, open-pit mine faces and workings, waste rock piles, and tailings impoundment areas. Since 1989, the multistakeholder Mine Environment Neutral Drainage (MEND) program has worked to develop technologies to prevent and control acidic drainage and metal leaching.

Through MEND, tremendous progress has been made in the areas of prediction, prevention and control, disposal technologies, active and passive treatment, monitoring and verification of closure technologies. A toolbox of technologies was developed to plan for, operate and decommission mines in an environmentally acceptable manner.

MEND report 3.50.1 “*Study to Identify BATEA for the Management and Control of Effluent Quality from Mines*” (Hatch, 2014) identified the best available technologies economically achievable (BATEA) to manage and control effluent from metal, diamond, and coal mines in Canada. The study provided reference information for forthcoming changes to the Canadian mining effluent regulations. The study describes the effluent management and treatment technologies and techniques currently employed at metal (base metal, precious metal, uranium, iron ore), diamond and coal mine operations in Canada. The study provides an overview of each (sub)sector’s water management and effluent treatment practices and establishes a model effluent treatment process and treated effluent quality to carry forward for use in BATEA selection.

MEND is currently undertaking a state of practice assessment of tailings management technologies. This study focuses on tailings dewatering processes (i.e., thickened, paste and filtered tailings) for surface disposal (including alternative disposal methods) and assessing their strengths and weaknesses, both physically and geochemically for Canadian projects and in environments similar to Canada. The final report should be available in mid-2017.

The transfer of information on developed technologies to partners and the public has always been an important part of MEND. A bilingual website <http://mend-nedem.org> was created in the 1990’s and underwent several major updates as technologies advanced. MEND has published over 200 technical reports, guidance documents and manuals; these are all available electronically, for free, on the MEND website. Workshops are considered the best route for timely and efficient transfer of technologies and case studies, and MEND has sponsored or co-sponsored over 40 workshops, including the hosting of three International Conferences on Acid Rock Drainage (ICARD). As a result of the efforts of MEND and other partners, our understanding of acidic drainage has greatly increased, and significant advances have been made in environmental stewardship.

Strong linkages are forged among MEND and international industry and government programs. MEND is the Canadian partner in the Global Alliance, an international partnership among organizations involved in acidic drainage research led by the International Network for Acid Prevention (INAP). A collaborative effort for the Global Alliance was the Global Acid Rock Drainage (GARD) Guide (www.gardguide.com).

However, many challenges remain and new challenges are emerging. The MEND program has a proven track record for addressing these challenges effectively, and to help ensure the long-term sustainability of both our mineral resources and the environment.

6.0 Conclusions

Over the last 15 years, NOAMI and its jurisdictional partners have made tremendous progress in dealing with issues surrounding orphaned and abandoned mines in Canada. In the initial years, from 2002-2008, the work was centered on remediation and long-term management of existing sites. From 2009 onwards, the program has examined mine closure and relinquishment, and

identified best practices to prevent the occurrence of future abandonments. The guidance documents, reports and workshops produced by NOAMI on orphaned and abandoned mines have been valuable tools for a diverse array of stakeholders, both nationally and internationally.

7.0 Acknowledgements

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