

Mine closure case studies of orphaned and abandoned mines in Canada©

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Abstract

This paper focuses on the current state of orphaned and abandoned mines in Canada, the achievements realized under the National Orphaned/Abandoned Mines Initiative (NOAMI) and those of jurisdictions active in the initiative, and future challenges and opportunities in Canada.

NOAMI's multi-stakeholder nature offers public servants, environmental non-governmental organizations, Aboriginal organizations and the mining industry a forum to discuss issues and barriers associated with clean-up and remediation of orphaned and abandoned mine sites. Their convergence of interests and common commitment have created a successful and unique approach to influencing public policy and addressing issues related to orphaned and abandoned mines.

Since NOAMI's inception in 2002, provinces and territories in Canada have taken significant steps to address issues for orphaned and abandoned mines, whether in response to emerging regulations or through voluntary and proactive initiatives. The potential for new orphaned and abandoned mines is low due to changes in regulatory regimes. However, finding new and innovative ways of managing and rehabilitating existing orphaned and abandoned mine sites remains a priority for the provinces and territories.

Jurisdictions' work on orphaned and abandoned mines has created social, environmental and economic benefits, including job creation, local cultural engagement and preservation, and the reduction of environmental hazards and safety risks. Jurisdictional activities have also provided NOAMI and other national and international organizations with invaluable information on the management of orphaned and abandoned sites through contributions to workshop presentations and case studies. Since 2002, the jurisdictions have spent close to C\$ 1 billion addressing these issues.

Some of the jurisdictional success stories over the past six years will be highlighted, which will reflect many different approaches and partnerships.

1 Introduction

The National Orphaned/Abandoned Mines Initiative (NOAMI) was created in 2002 based on recommendations put forward at a multi-stakeholder workshop on abandoned mines. NOAMI is guided by a committee with representatives from the Canadian mining industry, governments, environmental non-government organizations and Aboriginal Canadians. Together, they assess issues and make recommendations for collaborative implementation of remediation programs for orphaned and abandoned mines across Canada.

NOAMI's activities are jointly funded by the federal, provincial and territorial governments and mining organizations, and administered by the secretariat at Natural Resources Canada. Funding for NOAMI was about C\$ 100,000/year in the first few years, but increased to C\$ 350,000/year when the program was expanded in 2005.

Tasks groups undertake in-depth analyses of issues and provide recommendations and advice to the committee. Over the past six years, NOAMI's task groups have worked diligently to address issues on building a national inventory, community involvement, legislative and institutional barriers to collaboration, funding approaches, a jurisdictional legislative review, and mine closure. Activities and publications from

these task groups are posted on the NOAMI website (<http://www.abandoned-mines.org>) and summarized below.

1.1 Building a National Inventory

A national inventory of orphaned and abandoned mines based on compatible inventories from each province and territory is under development. Several federal agencies and all Canadian provinces and territories with a history of mining maintain inventories of mining and exploration sites that pose a risk to human health, safety, and the environment.

A report of Canadian and international jurisdictional inventories provided recommendations for a NOAMI inventory (Cal Data Ltd., 2005). Based on analysis of the options, NOAMI determined that the inventory should include all inactive mineral sites, be web-based and have a map interface. Natural Resources Canada was selected to host the Internet map portal based on their expertise in maintaining sites that map active mines and resource-dependent communities using MapGuide-based technology. Development of NOAMI's web-based national inventory of orphaned and abandoned mines is well underway. The inventory acts as a portal to existing inventories maintained within the provinces, territories and federal agencies. As the level of detail and completeness of these inventories varies from jurisdiction to jurisdiction, the portal is designed to integrate compatible elements and introduces standardization, provides single-window access to information and facilitates adding more detailed information in the future. At present, work is progressing to incorporate mineral site features into the existing NOAMI database and web portal. Once developed, the national inventory will be launched and made public.

1.2 Community Involvement

NOAMI examines and develops ways to foster meaningful community involvement and engagement in decision-making for abandoned mine remediation. In particular, workshops and case studies provide valuable lessons to ensure that local communities accept targeted end-use and rehabilitation standards. A study on community involvement at three Canadian orphaned and abandoned mine sites illustrates the importance of effective community involvement in decision-making (NOAMI, 2003a). The "lessons learned" from these studies were developed into guidelines, and published as a pamphlet intended for use by parties involved in remediation planning (NOAMI, 2003b). A project is underway to build the capacity of local communities to engage in abandoned mines remediation. A modular resource compendium was developed for such areas as community engagement, environmental concerns, legal and corporate matters, funding and partnerships, decision-making and Aboriginal issues. This material was piloted and evaluated through a series of interactive workshops and focus groups. The next step involves development of a facilitated toolkit to accompany the resource compendium that communities can adapt for involvement in remediation processes.

1.3 Legislative and Institutional Barriers to Collaboration

A better understanding is needed of the governmental barriers that prevent third parties from collaborating on clean-up activities and addressing associated liabilities related to orphaned and abandoned mines. A study was undertaken to examine regulatory or institutional barriers, liability disincentives and collaborative opportunities in Canada and internationally regarding voluntary abatement, remediation, and rehabilitation of abandoned mines. Emphasis was placed on four approaches: voluntary reclamation; legislation; permit blocking; allocative versus joint and several responsibility; and non-compliance registries (Castrilli, 2002). Approaches to overcome these key barriers were developed and further integrated into a subsequent review on jurisdictional legislations (Castrilli, 2005).

1.4 Funding Approaches

Typically, orphaned or abandoned mines revert to the Crown with their remaining environmental liabilities and inadequate or nonexistent securities to finance remediation. There is a need to identify alternate funding approaches and preferred options for the remediation of orphaned and abandoned mines across Canada that could be adapted to meet the varying needs of each jurisdiction. In 2003, a report was produced that outlined and recommended a variety of funding approaches for consideration in the cleanup or management

of liabilities related to abandoned sites (Castrilli et al., 2003). The report concluded that no single funding approach would constitute a complete solution; a combination of approaches will likely be required. A subsequent workshop further explored the issue and developed recommendations. A key recommendation was the development of a plain language toolkit. A toolkit was completed that outlined various options and was illustrated with case studies that could serve as a resource document for the jurisdictions to help guide the establishment of other funding options for remediation of the abandoned sites (Cowan Minerals, 2006).

1.5 Jurisdictional Legislative Reviews

In 2003, the Mines Ministers asked NOAMI 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. A series of guidelines and a checklist with associated questions were developed to facilitate a focused review of the legislative/regulatory/policy frameworks as they apply to orphaned and abandoned mines sites across Canada (NOAMI, 2004).

The checklist was intended to provide a consistent and co-ordinated approach to the completion of a review of 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). The framework set out in the guidelines was addressed in the subsequent jurisdictional legislative review (Castrilli, 2005).

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.

The report 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.

1.6 Mine Closure and Release

NOAMI recently identified new initiatives to pursue over the next several years, including an examination of the legislative tools and policy approaches across Canada to ensure that currently operating mines can be closed properly so that they do not become abandoned mines in the future. The goal of all Canadian mining jurisdictions is to promote responsible mining, while avoiding future orphaned and/or abandoned mines. To achieve this goal, clear regulatory processes are required that provide guidance to successfully “close” an active mine as well as address issues of environmental liability and responsibility for mine closure for both mine operators and regulators. These processes should also provide certainty to the public and to the various levels of governments who manage liabilities and risk related to mine closure and land management.

A plain-language guidance document is under development by Cowan Minerals that will examine the main components related to mine closure and post closure site management. Existing legislation, regulations, and practices and release requirements for closed mines in Canadian and international jurisdictions will be examined. The document will address long-term monitoring and maintenance liabilities, as well as the transfer of mining lands back to government through the issuance of a release. This document is intended to provide a starting point for jurisdictions to develop their own specific policies related to this issue, and to provide additional information to those jurisdictions that currently have a policy in place.

1.7 Sharing Information and Knowledge

Orphaned and abandoned mines are a topical issue in Canada and around the world, and the public needs to be kept informed. 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. NOAMI workshops are focussed on a key issue (i.e. legislative barriers, funding options) or are based on a central theme (i.e. best practices, risk assessment). Efforts are made to include affected communities in these workshops, and to ensure a sectoral balance of industry, government,

environmental non-government organizations and Aboriginal peoples. The workshops maintain a focus on facilitated multi-stakeholder dialogue and expert discussion panels to develop key recommendations and a “toolbox” of options to help NOAMI move issues forward.

In addition to workshops, NOAMI facilitates information sharing through documents such as the NOAMI Nugget (newsletter), and other bulletins, which 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. NOAMI reports are also available on the website and can be downloaded for free.

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 Post-Mining Alliance, International Council on Mining & Metals (ICMM), National Association of Abandoned Mine Land Programs (NAAML - U.S.), United Nations Environment Programme (UNEP), Sernageomin (Chile) and Fundacion Chile have developed projects or approaches for management of abandoned sites.

2 Jurisdictional Highlights

Provinces, territories and Indian 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 close 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 from several jurisdictions will be given and additional information on jurisdictional activities and partnerships is available in NOAMI's 2002-2008 Performance Report (NOAMI, 2009).

2.1 Province of British Columbia (BC)

The BC Crown Land Restoration Branch (formerly the Contaminated Sites Branch) was formed in response to the 2002/2003 Report from the Office of the Auditor General that was critical of management of contaminated sites in BC. Since 2001, BC has committed over C\$ 229 million to identify and clean-up the province’s contaminated sites. There are an estimated 2,000 or more contaminated sites throughout the province; the majority of them are former mining sites. While there are currently no partnership funding programs in BC with the mining industry, and no Voluntary Reclamation (aka "Good Samaritan") programs, the work of NOAMI provides a starting point for advancing these key policy areas. The Crown Land Restoration Branch website (BC MAL, 2010a) and the recently released Crown Land Restoration Program Biennial Report 2010 (BC MAL, 2010b) outline the activities of the program since its inception.

Crown Land Restoration Branch manages contaminated sites for BC, assists in policy development and identification of priority sites. For the last two years a Risk Ranking Methodology that looked at human health and environmental risk was used to prioritize the sites. The approach involves two steps. First, samples are collected and analysed from the various exposure pathways. This information is fed into a spreadsheet, which generates various measures of potential risk to human health and the environment; sites that pose the highest risk in human health and the environment from contamination were given the highest priority. The information is presented at a workshop wherein expert practitioners are convened to assess the results and recommend a management action appropriate for each site.

British Columbia's Ministry of the Environment has a contaminated sites database for crown land, which is continually updated (BC MOE, 2010). A total of 72 sites have been investigated since the inception of the program and 10 sites have been fully remediated. Currently there are 18 sites classified as priority contaminated sites warranting further investigation and study. The Yankee Girl Mine Tailings Project is one of the largest remediation programs undertaken by the Crown Land Restoration Branch. Completed in 2009, it was the result of five years of concerted effort by the Crown Land Restoration Branch and community members to develop and implement a plan that suited the needs of the community. The project adopted collaborative and innovative approaches towards clean-up site. A total of C\$ 6.1 million was spent on

remediation of the Yankee Girl Mine Tailings Project and some additional funds will be required to long-term monitoring and maintenance of the site.

Tailings abandoned in a metal mine processing area near the town of Ymir created a potential risk which was given a high priority in the ranking system. The metal-contaminated waste material was deposited onto the banks of the Salmo River and Ymir Creek and subsequently spread over a two-hectare area. Options to clean up the site were evaluated in consultation with the community of Ymir, and a detailed remediation plan was developed. The remediation plan included mixing the tailings with lime and consolidation into a single area, adding an engineered cover surrounded by a flood erosion protection barrier, construction of a passive treatment system and site re-vegetation.



Figure 1. Old Side Channel, Yankee Girl, British Columbia. Before and after Remediation.

The cleanup was conducted using a number of innovative approaches, including the use of waste by-products from the nearby pulp mill. A lime by-product was used to neutralize the tailings, which reduced project costs and shipments of commercial lime needed from Vancouver. Another waste material, a nutrient rich pulp mill residual, was used as a key component of the passive treatment system. Pilot tests demonstrated this material to reduce metal concentrations by a further 95%.

Further community involvement in the project included a massive planting effort in the spring of 2009 with community members planting a wide variety of trees, shrubs and grasses. Long-term, regular monitoring of the area will be conducted to ensure water quality and risks to human health or the environment are no longer a concern. The major factor that made the Yankee Girl project so challenging was its close proximity to a residential community. However, this also contributed to its success - active community involvement allowed the site to be developed in a way that would provide desired recreational use.

2.2 Province of Manitoba

Mining has helped build and expand communities across Manitoba and continues to play a significant role in the economic well-being of many communities, particularly in the north of the province. Like the rest of Canada, Manitoba is also dealing with the legacy of mines that were abandoned decades ago and continue to pose health and safety concerns.

Manitoba's Orphaned/Abandoned Mine Site Rehabilitation Program was established in 2000 in response to the Mine Closure Regulation that Manitoba adopted in 1999. More information on the orphaned and abandoned mines program is available at the website (MB IEM, 2010). The Regulations require that environmental liabilities incurred during mining operations be financially secured to cover future remediation costs. In addition, mine closure plans and financial security must be filed and approved prior to a permit being granted for a new mine operation. The Mine Closure Regulation is currently undergoing a formal review to ensure that its requirements remain relevant and consistent with the government policies and programs.

The program's mandate is to address public safety and environmental concerns associated with orphaned and abandoned sites. The program received initial funding of C\$ 2 million in order to address safety issues and identify environmental concerns at five high priority sites: Lynn Lake, Sherridon, Gods Lake, Snow Lake and Baker Patton. Environmental and risk assessments were completed at these sites by consultants retained by the Province. Inspections and identification of hazards were also completed at an additional 148 orphaned and abandoned sites. Based on these inspections and preliminary engineering work, a total of 31 sites were considered to be high hazard sites and these sites were prioritized for rehabilitation and have had long-term rehabilitation plans developed that will see these sites remediated by 2012.

As of March 2010, the Province has spent over C\$ 50 million on orphaned and abandoned mine site rehabilitation. Rehabilitation has been completed at 15 sites including Baker Patton, one of the high-priority sites, and the remaining high-hazard sites. Community involvement is an important element of the work carried out by contractors for the provincial government. At the high-priority Sherridon site, the three-year, C\$ 34.5 million contract includes a 10% set-aside and a training allowance for local First Nation and northern communities. These provisions are common practice for all government contracts given by the Orphaned/Abandoned Mine Site Rehabilitation Program. Manitoba's Orphaned and Abandoned Mine Site Rehabilitation Program is the subject of a paper that can be found in these proceedings (Priscu et al., 2010).

2.3 Province of Ontario

Ontario has a long history of mining, which has been responsible for much of both the economic and the social growth and development of the province. However, historically the focus of the owners of those mines, as well as the legislation itself, has been on removing the mineral commodities from the ground at a profit, and not on the rehabilitation of the mine features once mining had ceased. While companies may not have closed out the site in a manner that meets today's standards, some of these lands have already reverted to the Crown. Ontario reports that there are currently more than 5,700 known abandoned mine sites located within Ontario, containing more than 16,400 documented mine features. Of these, approximately 4,000 sites could potentially be hazardous to public health and safety and to the environment. Current cost projections indicate that approximately C\$ 500 million will now be required to properly rehabilitate all of Ontario's abandoned mine sites, with approximately C\$ 200 million required for sites on Crown lands.

Ontario Ministry of Northern Development, Mines and Forestry (MNDMF) has been active in remediation of their abandoned mines since 1999. The Abandoned Mines Rehabilitation Program was created to allow MNDMF to conduct rehabilitation work on Crown-held abandoned mine sites throughout Ontario. Funding totalling C\$ 118 million has been officially announced to rehabilitate abandoned mine sites on Crown lands until 2012. Additional information on abandoned mines in Ontario can be obtained by visiting their website (ON-MNDMF, 2010a), specifically the Abandoned Mines Rehabilitation Program (ON-MNDMF, 2010b).

As of 1991, Ontario's *Mining Act* was amended to require operators of all existing mines, and proponents for all new mines, to submit a closure plan and appropriate financial assurance to ensure that adequate rehabilitation of these sites would take place upon closure. In 2000, Part VII of the Act was amended to include a new Mine Rehabilitation Code. This code placed an obligation on mining companies to progressively rehabilitate their abandoned mine sites (those which had ceased production and closed prior to 1991) to prescribed standards, and to report on the work that was completed, within 60 days. Overall, these actions essentially prevent new abandoned sites from falling into the public realm, and take clear steps toward rehabilitating the backlog of privately-held abandoned sites in Ontario.

During the first ten years of funding, C\$ 93 million was expended by the Abandoned Mines Rehabilitation Program as follows:

- Rehabilitation work has been conducted on hazards at more than 75 abandoned mine sites located throughout the Province, including three sites in the Far North. The scope of the rehabilitation work varied by site, ranging from removal of infrastructure to shaft capping, adit backfilling, installation of secure fencing, and tailings covers and revegetation.
- Several engineering studies were undertaken in order to determine an appropriate plan for rehabilitation to occur later in the program

- Site assessment reports were completed on the approximately 4,000 abandoned mine sites that had not previously been assessed
- The prioritization of all abandoned mine sites throughout the Province has been conducted. The sites were classified into three categories, which were based on the size of the site and its estimated cost of rehabilitation.
- Approximately 85% of the rehabilitation required for the Kam Kotia Mine site has been conducted, at a total expenditure to date of approximately C\$ 54 million. More information on the Kam Kotia project is available on the website (ON-MNDMF, 2010c).

Industry has long signalled interest in assisting the Crown in the remediation of abandoned mine sites to demonstrate its commitment to the environment and a sense of responsibility to the community. While a MOU between the Ontario Mining Association and MNDMF was a good start for leveraging funds and addressing abandoned mine hazards in the province, the Industry has indicated that more could be done to address the legacy of abandoned mine sites at no cost to tax payers if regulatory liability risk could be reduced for “Good Samaritans” in the industry that volunteer to take on the required rehabilitation. To achieve this, amendments to the Mining Act were passed in 2007 and MNDMF has drafted a related Regulation amendment, which has been posted for public comment on the Environmental Registry.

Once the Voluntary Reclamation (Good Samaritan) provisions are in place, persons (volunteer(s)) working on Crown-held abandoned mine sites will be able to conduct their MNDMF-approved rehabilitation work without being subject to the *Environmental Protection Act* and the *Ontario Water Resources Act* regarding other pre-existing mine features and hazards on the site. However, the volunteer(s) will still be liable under that legislation if it either causes or permits a spill on, or from, the site. Reducing regulatory barriers to conduct the rehabilitation of abandoned mine hazards will benefit all Ontarians by reducing public health and safety risks, environmental impacts, and the amount of future public spending. Industry may have the expertise, technology and equipment to allow the remediation to be conducted more efficiently and cost-effectively than if Ontario was to contract the work at public expense.

Several partnership agreements have been put in place for mine rehabilitation projects and are outlined below:

MNDMF and Porcupine Gold Mines have now completed a cost sharing agreement to address mine subsidence related issues in and around the former Hollinger and McIntyre Mine sites in Timmins, Ontario. Subsidence had become more serious since dewatering of the mines ceased, and it was believed that the sand backfill had flowed and left voids in the upper workings. A major part of the problem was that the surface rights for the mine had been previously severed and sold to private individuals, so that many of these events had occurred within the community. Together the partners invested a total of C\$ 10.7 million under this agreement to ensure the protection of the public and the rehabilitation of the most dangerous mine hazards.

MNDMF and the Ontario Mining Association (OMA) are in the process of renewing a cost sharing agreement in which funds acquired by OMA are matched by MNDMF and are used to rehabilitate orphaned/abandoned mines of mutual interest. Since 2002, two remedial projects have been undertaken at the Kam Kotia Mine site under this agreement, including top-dressing and hydro-seeding more than three kilometres of impoundment dams at the site, and expanding the contaminated water collection pond so that spills of acidic, metal leachate bearing water are greatly reduced.

2.4 Province of Québec

In 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, in supporting industry, the government of Québec injected more than C\$ 30 million into research, closure projects, and financial assistance to rehabilitate mining waste areas. In particular, the significant efforts invested in this regard have made it possible to implement measures to protect the environment.

The Mining Act was amended in 1995, and requires any individual engaging in mining exploration or operations to submit a closure plan and a financial guarantee covering 70% of the cost of closing waste areas. The province produced a guideline document, which specifies the requirements to be complied with when

rehabilitating a mine site, including the contents of the closure plan and the steps leading to its approval by the province (QC MRNF, 1997). The financial guarantee provision is currently under review; and it is being proposed to raise the financial guarantee to 100% of the cost of rehabilitation.

In the wake of Québec's April 2006 Sustainable Development Act, the Québec government is undertaking a major plan to restore contaminated sites, chiefly mining sites, backed by long-term funding. According to a recent government inventory, more than 45 contaminated mining sites fall under Québec's responsibility. Site restoration began in 2007, and will extend over 10 years. The rehabilitation cost for all the contaminated sites is estimated at C\$ 931 million (as at March 2009) and will be entered in the financial statements as an "environmental liability". A total of C\$ 38.4 million has been spent on the rehabilitation of abandoned sites in the province since 2007.

Québec will also adopt a contaminated site management policy under which it will inventory, classify and apply standardized management to contaminated sites under its responsibility. Of the C\$ 931 million, C\$ 329 million is allocated to mining sites (\$ 198 million for actual abandoned sites and C\$ 131 million for potential abandoned sites, which are those where the probability of being handled by the government is at least 70%).

Until this new program was introduced, little funding was available to address contaminated sites. A great deal of energy has been 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 solution to the problem of stockpiling for at least some of the waste materials.

This has created a partnership approach to address some of the contaminated sites. A diverse partnership base is essential to the success of rehabilitating closed mines, and it is critical to involve partners early in the process. This innovative open approach used by the Québec government for mine rehabilitation is envied by many other Canadian jurisdictions. Five different types of partnerships have been used in Québec over the past 15 years for the rehabilitation of closed mines.

2.4.1 Partnerships between Ministries

Two provincial ministries signed a cooperative agreement to assist in the rehabilitation for the Sullivan (QC MNRF, 2005a) and Wood Cadillac mine sites (QC MNRF, 2005b)

2.4.2 Partnerships with Mining Industry

In 1996, Les Terrains Aurifères site (owned by Barrick Gold) used fine-grained neutral tailings from the government-owned Malartic Goldfield Mine located close-by as a component in the multi-layer dry cover placed over their acid-generating tailings. This type of cover is made with soils and/or other suitable particulate media and involves the capillary barrier concept, which occurs when a fine-grained material is placed over a coarser one. The difference in unsaturated hydraulic characteristics of the two adjacent materials favours a high degree of saturation on the top, fine material layer. Several Mine Environment Neutral Drainage (MEND) reports are available on the research program conducted for this site (MEND 2.22.4, 1999). This partnership arrangement saved the government C\$ 500 K.

Among the abandoned mining sites in Québec, the Manitou site, which has a surface area of more than 200 hectares, is the site that constitutes the greatest rehabilitation challenge for the province. Over the years, the effluent released from the Manitou acid-generating tailings had a major impact on the receiving environment, in particular the Bourlamaque River. This site was identified by the government as a priority site.

Many scenarios were considered for closure. Using the tailings from the Agnico-Eagle Mines Goldex project was selected as the best option for both cost-effectiveness and technical performance. The Manitou-Goldex rehabilitation project is an excellent example of sustainable development - using an innovative approach, while generating savings for the government. An agreement was signed in late 2006 between the two Québec government departments and Agnico-Eagle Ltd. The ultimate goal is that the surface of the site will be covered with the Goldex tailings and the acid-generation and acid mine drainage will be neutralised by the cyanide- and sulphide-free tailings. This will in effect raise the water table above the oxidized tailings

and prevent further oxidation of the Manitou tailings. The acidic water that is still in the old tailings will be leached out with the neutralizing water in the Goldex tailings.

Transportation of the tailings from one site to the next presents an interesting challenge. This will be done via a 23 km pipeline with the pulp at 55% solid. Two emergency tailings impoundments were constructed to reduce the risks of a spill during transport. One is a 5 Mt site located close to the mill and a second is the former East Sullivan tailings site located upstream of Manitou.

Tailings deposition at Manitou started in September 2008. Work is progressing as planned. This novel partnership approach will save the Government of Québec C\$ 8 million over the 12-year life of the mine. Of interest is that the financial contribution of Agnico-Eagle amounts to the cost of a new tailings impoundment with a 24 Mt storage capacity that would have been constructed for the Goldex project.

A similar agreement has recently been signed between Osisko Mining Corporation and the Government of Québec to use their tailings to cover tailings from an abandoned mine located in the town of Malartic.

2.4.3 Partnerships with Forest Industry

The East Sullivan mine produced copper, zinc, silver and cadmium from 1949 to 1966, leaving behind around 15 Mt of tailings and over 200,000 t of acidic waste rock. The site covers a total area of 228 hectares, of which over 200 hectares are occupied by mine waste.

The rehabilitation plan for the East Sullivan mine site included the placement of a cover over the acid-generating tailings. Coincidentally, the forest industry needed a place to store its wood waste products. Wood waste proved to be an adequate cover, and 2-metre of wood waste was placed over the tailings. This win-win partnership cost the government C\$ 9.5 million instead of the original estimate of C\$ 30 million.

Many studies were completed on East Sullivan and references to these can be found at the provincial website (QC MRNF, 2005c).

2.4.4 Partnerships with Local Organizations

The Eustis mine complex near Capelton in the Eastern Township is owned by a non-profit organization that wanted to develop the site as a historic and recreational area. The owners did not have the necessary funds to complete the rehabilitation of many of the acid-generating sites located on their land, which included the Albert Mine, Eustis 1, Eustis 2 and Eustis 3. A partnership was formed among the organization, the government and the local paper industry, which needed a place to store their wastes. De-inking sludge produced from the paper industry was used as a cover for the 4.5 ha Albert Mine site and Eustis 1. This material in combination with a compost layer was found to be an excellent growth media. This partnership saved the government approximately C\$ 1 million in remedial costs (QC MRNF, 2009).

Several other properties located in the same general vicinity were also rehabilitated using de-inking sludges from the local paper industry. Key to this rehabilitation method is that the deinking plant is located close to the mining sites resulting in low transportation costs of the material to the sites. It also reduces to a minimum the use of natural resources such as sand, tills and gravel that would otherwise required for the construction of various covers.

2.4.5 Partnerships with Aboriginal Peoples

Nunavik represents the area of Québec located north of the 55th parallel. Mining exploration activities have been ongoing for more than 70 years. An inventory completed from 1999 to 2002 identified about 300 abandoned exploration sites; 18 of these were considered top priority. A pilot study was completed at the "Blue Lake" site to help determine the feasibility of the requirement needed to clean-up abandoned exploration sites in hostile and isolated regions. In 2007, an agreement was signed to rehabilitate abandoned mining exploration sites in Northern Québec (Nunavik Region). The four partners in the agreement include the Kativik Regional Government, the Makivik Society, le Ministère des Ressources naturelles et de la Faune du Québec and the Fonds Restor-Action Nunavik, a group of exploration companies that are willing to help with the rehabilitation of old abandoned properties. The agreement will ensure that by March 31, 2012, the 18 exploration sites considered top priority will be rehabilitated. In November 2009, the total cost for the 18 sites was estimated to be about C\$ 4 million.

This agreement to rehabilitate abandoned mineral exploration sites in Nunavik received the 2008 e3-Environmental Excellence in Exploration Award from the Prospectors & Developers Association of Canada (PDAC). The award honours companies or individuals demonstrating outstanding initiative, leadership and accomplishment in protecting and preserving the natural environment.

The Province of Québec has inspired other provinces with their proactive approach to collaboration for mine closure. These partnerships are in line with a new environmental philosophy in which private companies forge alliances with governments and local communities to ensure sustainable and responsible use of natural resources.

2.5 Federal Government

The federal government has taken action on orphaned and abandoned mine sites for which it is responsible. The 2003 federal budget identified C\$ 175 million Canadian over two years for action on 57 federal contaminated sites, some of which are abandoned mines in northern Canada (i.e. Faro Mine in Yukon, Colomac and Giant Mine in the Northern Territories). Budget 2004 reaffirmed the government's fiscal commitment to cleaning up contaminated sites by increasing spending to C\$ 3.5 billion over a 15-year period to cleanup contamination on federal lands. The government also committed an additional C\$ 500 million over the same period to cleanup sites that do not completely fall under federal jurisdiction, such as the Sydney Tar Ponds in Nova Scotia and the uranium tailings sites in Northern Saskatchewan.

The fund, called the Federal Contaminated Sites Action Plan (FCSAP), is available to federal government departments and Crown corporations to implement the polluter-pays principle, reduce overall federal liability and address human health and environmental risk through risk management and remediation.

2.6 Federal Department of Indian and Northern Affairs Canada

As the custodian of most federal lands in the North, Indian and Northern Affairs Canada (INAC) has the largest contaminated sites liability of all federal custodial departments – estimated at over C\$ 1.4 billion. INAC became involved with abandoned mines in 1998-1999 when large mines such as Giant, Faro, Colomac and others went bankrupt.

INAC's Northern Contaminated Sites Program (NCSP) has received considerable funding from FCSAP and its expenditures have increased from less than C\$ 10 million in 1999 to a budget of over C\$ 150 million today (INAC, 2009). A brief overview of INAC's work under the NCSP and a review of the Faro Mine reclamation project is the subject of a paper that can be found in these proceedings (Nahir, 2010).

3 Conclusions

The mining industry has learned the importance of planning for closure. Information on all closure aspects needs to be presented to stakeholders as a part of a successful planning process, and allows them to obtain the social licence to operate from the community. Historic mining operations that were orphaned or abandoned without closure exist all over the world and have negatively influenced the ability of mining firms to obtain authorization to operate in many areas of the globe. The perception that a new modern mine will create the same legacy must be overcome. Mine closure planning begins at the conception stage.

Guidance documents focussing on best practices for mine closure are now available from many national and international sources. NOAMI is an example of a unique multi-stakeholder partnership approach to a complex problem of national importance. The program is guided by a committee with members from different levels of government, industry, environmental non-government organizations and Aboriginals people. Examples of achievements realized in Canada are available from the NOAMI's website and from the various Canadian jurisdiction web sites.

The International Council on Mining and Metals (ICMM) has published the "Planning for Integrated Mine Closure: Toolkit" to provide guidance for a key challenge to the mining sector. The document is not a "how to"; it provides a suite of tools to consider when planning for closure and is available in Spanish and Portuguese (ICMM, 2008).

The mining industry, governments and civil society are beginning to recognize a shared stewardship for addressing and solving the problem of orphaned and abandoned mines. NOAMI's success has been largely due to its unique partnership approach to defining problems and designing ways to address them in a collaborative manner. It is important for NOAMI to continue this partnership approach in future work.

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