

## LONG-TERM MANAGEMENT OF TAILINGS AND TAILINGS DAMS AT DECOMMISSIONED MINING PROPERTIES

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**ABSTRACT:** Recent additions to government legislation addressing mine closure issues and responsibilities, together with several recent unfortunate and significant failures of tailings containment systems have necessarily focussed industry and the public's attention on the long-term, even perpetual, requirement for management of tailings. A serious question now facing the mining industry and government is how these waste facilities can best be safely managed to ensure protection of human health and the environment in the long term. There are probably several viable alternatives, depending upon the actual specifics of the particular site. One option is considered to be management by a specialist third party contractor. In March 1998, Rio Algom Limited was presented with an opportunity to test third party management of a group of mine facilities situated in the Elliot Lake area, comprising of 11 mine sites and 7 closed and decommissioned tailings management areas with 5 active effluent treatment plants. This paper presents the approach to managing liability, cost and risk under third party management with a focus on facility inspection and maintenance programs.

### INTRODUCTION

Events such as the 1990 failure of the Matachewan tailings into the Montreal River, news reports of children gaining access to abandoned mine workings and more recent unfortunate and significant failures of tailings impoundments around the world have focused the public's attention on management of mining properties during operations and after the mines have closed. Industry has recognized the need for fundamental standards for managing the inevitable liabilities resulting from the mining process. The mining industry has initiated and participated in establishing management system guidelines for tailings and mine properties as evidenced by the Mining Association of Canada's *A Guide to the Management of Tailings Facilities* (September 1998) and the Canadian Dam Association's *Dam Safety Guidelines* (September 1997).

The mining industry is also faced with the fact that ore bodies have a finite life. The closed property, even when properly decommissioned, can present a significant liability to the owner. Decommissioned properties may require human and financial resources for a considerable length of time to enable monitoring programs to demonstrate physical and chemical stability. In cases where the mining company has no other operating mines in the area, the owner faces a considerable challenge in maintaining effective management of the sites with no local infrastructure. Over time, as older properties are mined out and

others are developed, the number of dormant properties a mining company holds will increase, requiring a corresponding increase in management resources focused on non-producing properties. A serious question now facing the mining industry and government is how these facilities can best be safely managed to ensure protection of human health and the environment in the long term.

With the closure of Stanleigh Mine in mid-1996, Rio Algom lost its last operating mine in Elliot Lake, leaving 11 inactive mine properties in the area to manage. At that time, the mine sites had requirements for capital-intensive site reclamation activity to address demolition, site remediation, shaft closure and tailings management. These closure activities were scheduled for implementation over a 4 to 5 year period. Several of the sites would require active effluent treatment for periods ranging from an estimated five to ten years for the flooded tailings impoundments, to an estimated 75 years for the collect and treat sites. At the close of the active decommissioning phase, the facilities requiring care, maintenance, monitoring and reporting include:

- > 11 mine sites with 90 shaft caps
- > 7 waste management areas (WMAs) with 65 dams, dykes, berms and 20 spillways/control structures
- > 2 seepage containment pumping systems
- > 5 effluent treatment plants (ETPs)
- > 1 slaker

In evaluating the workload and manpower needs, it was apparent that there was a short-term decommissioning requirement, followed by a long-term care and maintenance requirement. The short-term needs could be met quite easily with the existing in-house organization. The difficulty was seen in the logistics of the long-term demands and particularly the significant liabilities.

In considering the provisions for providing the long-term care needs, the possibility of contracting this work out to a specialist contractor was seen as a potentially viable and interesting option. In the current case study, contracting out was also viewed as an avenue to establish a third party delivery agent and demonstrate such a management option should the company wish to eventually transfer the properties to the Crown.

## **CONTRACTING OUT**

While mining companies may have different approaches to closure, decommissioning and ongoing site management, it is likely that they share the following primary objectives.

- > Regardless of their individual approach, the site owner must provide comprehensive management of decommissioned minesites at minimum cost while ensuring regulatory compliance and professional tailings management. Also critical, is public acceptance that the facilities are being adequately managed, pose no threat to the environment and do not increase exposure to risk and liability.
- > As a mining operation is closed out and the company focuses its resources on new properties, the owner may desire a strategy to disengage from the decommissioned site and community. While maintaining control and responsibility for the site, the company may wish to decrease its role in the community to a level reflecting the reduced long-term activity.
- > Faced with the possibility of ownership of increasing numbers of non-producing properties, some owners may seek an avenue for eventual transfer of ownership of the decommissioned properties to the Crown or to a third party.

The owner could meet some of these objectives by maintaining a long-term presence at the decommissioned site to manage the care and maintenance program and associated risks using their own staff and resources. Alternatively, the mining company may contract the on-going care and maintenance, risk management and operations to a third-party specialist company. When considering the third party option, the issues of risk and liability management require special consideration.

Regardless of whether the owner contracts out or provides site management with internal resources, the owner retains full liability for the sites. In Ontario, owners may be able to transfer the liability to the government if the parties can reach an appropriate financial agreement. In addition to the environmental risks associated with tailings and other site features, there are other risks, more managerial in nature, that must be addressed by the owner.

Over the long term, as the workload diminishes and becomes routine in nature, the owner may not be able to attract or retain competent staff to manage and operate the sites. The owner's ability to reduce ongoing costs may be limited due to the necessity to maintain a minimum critical level of staffing, training, succession, and presence in the community, even though the workload may decrease. As well, corporate control may become increasingly difficult as the level of local knowledge diminishes due to retirements and changes in personnel, and corporate energies are focused elsewhere to projects designed to sustain and grow the company.

To be successful in the long run, a specialist professional company dedicated to management of decommissioned sites will have to demonstrate its ability to manage the environmental and technical risks so that the liability, although retained by the owner, is professionally managed. The contractor has a vested interest in managing risk effectively as the future of the contractor's company is at stake. This concern with risk management may translate into reduced liability for the owner.

The specialist contractor may have the added attraction of being able to reduce the owner's "managerial" risks discussed above. Managing a number of sites could allow the contractor to offer challenging careers to employees and maintain their interest with exposure to different operations, systems and regulatory regimes. The contractor should be able to reduce ongoing costs by sharing manpower and resources between sites as the workload at a particular site decreases. A specialist company should be able to retain and train staff specifically for managing decommissioned minesites who will be able to stay abreast of new technical developments world wide. By having a number of sites over which to allocate the cost of maintaining this expertise and specialized training, the contractor should be able to ensure that leading edge technology and expertise are applied to each site at a lower cost than could be achieved by a single owner with a small number of sites. The contractor's management structure and systems can be developed specifically for and focused on management of dormant minesites. By allocating specialist senior management and overhead costs over several operations, a contractor should be able to provide the mine owner with a cost effective and focussed management system.

Contractor project management and accounting systems can be designed specifically to identify and track the costs associated with site management. Such systems will provide the contractor with the information to administer tight budgetary control, identify cost-saving opportunities and undertake very realistic cost-benefit analyses. Over time, the contractor's invoices provide the owner with a very accurate and transparent cost history, potentially reducing ongoing financial assurance requirements by reducing contingencies for uncertainties.

Finally, demonstrated successful use of a contractor may facilitate the transfer of properties to the Crown by providing a proven vehicle, both in terms of performance and cost, for delivery of the care and maintenance service.

## **THE ELLIOT LAKE CASE STUDY**

### Scope of Work

Upon completion of decommissioning activities in the Elliot Lake area, Rio Algom Limited will retain ownership of 11 rehabilitated mine sites, 7 WMAs (4 flooded, 3 vegetated), 5 ETPS, a lime slaker and associated facilities. One WMA requires no further active treatment, three require relatively short-term active treatment (5 to 10 years) and two require longer-term collection and active treatment (75 years). Elements of the programs designed to meet the long-term operating and care and maintenance requirements of these sites include:

- > Security and property management;
- > Operation and maintenance of water management systems and effluent treatment plants;

- > Inspection and maintenance of tailings dams, control structures, access roads, service buildings and pipelines, fences, signage, and mine opening covers;
- > Management of site services ( e.g. hydro, water, sewage, solid waste disposal);
- > Management of subcontractors (e.g. snow removal, road maintenance, lime haulage, analytical services);
- > Environmental and compliance monitoring and data management;
- > Preparation of regulatory and internal reports; and
- > General management, procurement and accounting services.

To ensure comprehensive management of the decommissioned sites, the scope of services also incorporates a strong management function. In the current case study, responsibilities of the contractor are broadly defined as

*To operate, maintain and manage the minesites, waste management areas, effluent treatment plants and related facilities in a competent and professional manner to ensure they continue to meet the requirements of current legislation, the specifics of the license or permit for the plant and Rio Algom policies.*

The current legislation, licenses, permits and Rio Algom policies become defining documents for the scope of work and have been incorporated as schedules to the contract.

#### Contractor Risk Management

The process of contracting out provided Rio Algom with the opportunity to identify critical elements and requirements of site risk management and to decide which of these should be managed by the contractor. These elements and requirements were incorporated into the contract with development, implementation and maintenance becoming the responsibility of the contractor. MWM has worked with Rio Algom Limited in the development and implementation of cost-effective risk management programs and procedures for the Elliot Lake sites. Each program is founded on basic quality management principles, but is designed to focus on site specific risk reduction and liability management objectives. These site management programs include the development, implementation, documentation and continual improvement of site-specific:

- > Operating manuals and formalized training programs for each tailings management facility and associated effluent treatment plants;
- > Maintenance programs and associated parts/inventory database for each effluent treatment plant, lime slaker, seepage collection system and related support facilities;

- > Facility inspection programs for all sites including dams, dykes, spillways, shaft caps, access roads, service water/seepage pipelines, electrical transmission lines, vegetation, fences, signage and all other infrastructure associated with the care and maintenance of tailings facilities; and
- > Site-specific emergency response and contingency plans for each facility addressing situations such as power outages, reagent supply interruption, equipment failure, dam failure, spills, etc.

A registry of licences, permits, industry standards, regulatory and client requirements for each of the sites has been established along with a procedure whereby the MWM Compliance Supervisor reviews incoming documents to ensure that appropriate changes are made to site management programs. MWM reviews site management programs annually for compliance with applicable legislation and industry standards. Each program includes quality control and quality assurance components with designated responsibilities. In addition, MWM will conduct an annual failure modes and effect analysis with operating staff to identify operations requiring revisions to their risk management plan.

In the current case study, MWM staff and Rio Algom Limited have worked together to develop and implement a Remote Plant Monitoring and Control Network (RPMCNC) for the five remote tailings effluent treatment plants and lime-slaking operation. The automated plants are networked via telemetry to a central personal-computer based Supervisory Control and Data Acquisition (SCADA) system. Operating personnel use the network to monitor plant operations, control reagent additions, and collect and record plant operating data. The risk of undetected upset conditions is reduced through the incorporation of an alarm and dial-out component which provides 24 hour a day monitoring and response for all plant operations. Implementation of the system has enabled the number of plant operators to be reduced from five to two, and the lap-top based technologies enable off-hour operating control from the operator's residence, thus reducing call-out and overtime costs. Risk management is also improved through the accessibility of real-time data and historic trends available at the central office and, after hours, at the operator's residence. These data assist the operators in evaluating on-going operations, planning contingencies and improving response to upset conditions.

Risk and cost reduction have also been accomplished in the environmental monitoring programs through the implementation of the Envista™ environmental data management system. This system provides an integrated, process-oriented and requirements-driven approach to the collection, long-term storage and management of required environmental and operating information. The audit trail, data validation, and control limit components of Envista™ reduce risk by reinforcing environmental management system accountability and accuracy to ensure the integrity of the database and compliance with government regulations and client environmental policies. Costs can be reduced through stream-lined reporting and scheduling module support of work load redistribution.

### Facility Inspection Program

The MWM facility inspection program at Rio Algom's Elliot Lake facilities is a site-specific, requirements-driven formal due-diligence inspection program based on a formal review of licence, Certificate of Approval and other regulatory requirements and incorporates elements of the Canadian Dam Association and Mining Association of Canada guidelines. It focuses on the monthly, semi-annual and annual inspection and maintenance requirements of the waste management areas and mine sites and is designed to complement the daily and weekly requirements associated with the effluent treatment and waste management area operating programs. The objectives of the program are

- > To provide adequate warning of abnormalities in the performance of a tailings dam or any other structure for the impoundment of tailings and to carry out corrective actions.
- > To provide information for the assessment of the waste management facilities' structural and environmental performance.
- > To identify non-routine maintenance requirements.
- > To ensure the performance of routine maintenance and instrumentation monitoring.

Procedures, schedules, and reporting forms associated with the program are all designed to clearly define, communicate and document requirements and associated responsibilities for each element of the program. The program, in conjunction with appropriate training, is designed to standardize the quality of information being collected while enabling a flexible workload distribution amongst a small and versatile staff. The program includes:

- > Written inspection procedures;
- > Annual requirements review;
- > Annual site-specific inspection schedule;
- > Site-specific inspection forms for each of four inspection program components;
  - Dams, dykes, spillways, flow control structures;
  - Dam instrumentation;
  - Shaft caps; and
  - Mine site and WMA roads, signs, pipelines, channels;
- > Corrective action follow-up documentation; and
- > Annual professional engineer inspection and review of dam instrumentation.

The written facility inspection procedures clearly define the program objectives and identify responsibilities for delivery of each component of the program. The procedures also provide the general principles for the inspection frequency applied to each component of the program as well as providing guidance on the standardized terminology to be used in recording the required observations. Instructions are provided for

the completion and submission of report forms, data entry, and reporting of maintenance items requiring follow-up action.

Site-specific inspection requirements and schedules are reviewed and changes documented on an annual basis as part of the inspection program. The annual requirements review is a site-specific systematic review of changes to licences, regulatory requirements, industry standards, and internal operating policies that may effect the inspection requirements. "Annual Requirement Review" reports are used to document changes in requirements and track implementation of program and schedule changes. The annual schedule is a site-specific inventory of items requiring inspection and the frequency of inspection required. It forms the basis for the site-specific inspection forms and provides a tool for auditing inspection schedule implementation. The annual review of the inspection schedule provides an opportunity to adjust the requirements and inspection frequencies to reflect changes in operating conditions.

Customized inspection forms have been developed for each of the four inspection program components identified above. Inspection elements common to all four components include:

- > Date and time of inspection;
- > Name of inspector;
- > Weather conditions;
- > Comment section for additional information; and
- > Signature block for inspector and supervisor.

The inspection forms incorporate standardized information requirements featuring designated key words and quantitative information requirements for each of the four inspection components. The combination of standardized information and site-specific requirements provides an inspection form that clearly identifies inspection requirements and supports consistent collection of information. Information quality initiatives are further supported through the direct incorporation on the form of key words. The key words are defined in the written procedures and training programs are used to support consistent usage.

Each inspection form is further customized through the incorporation of a listing of site specific observation requirements and a site map highlighting features relevant to the particular inspection component. Site specific observations are used to document and ensure additional inspection effort at potential problem areas. Examples may be frequent beaver activity at a given spillway or road culvert, or more complete descriptions of known seepage pathways. Direct incorporation of these observations on the inspection form also facilitates workload distribution through elimination of repeat site visits and broadening the labour pool by ensuring that site knowledge is readily available to all trained inspectors.



Upon the completion of the inspection, it is the responsibility of the inspector to complete the inspection form and report items requiring follow-up action on the site-specific "Outstanding Corrective Action Report". Maintenance requirements and other follow-up requirements from all four inspection components for a given site are recorded on the same report. The Operations Supervisor uses this report in planning maintenance activities. Completed items are transferred to the "Completed Corrective Action Report" forming an annual significant maintenance record for each of the sites.

As part of the facility inspection program, dams, dykes and spillways associated with the WMAs are inspected on an annual basis by a professional engineer. The engineer reviews dam instrumentation readings and maintenance activities and makes recommendations for changes in the maintenance, inspection and other programs related to dam stability and WMA integrity.

The structured framework of the facility inspection program developed by MWM enables us to demonstrate regulatory compliance and due diligence to both the client and regulatory agencies. The standardized forms and procedures have facilitated workload distribution and enabled integration of inspection activities with operating and environmental functions. The program provides the added benefit of a maintenance and inspection database upon which to base future maintenance and inspection frequency decisions.

## **CONCLUSION**

### **Mine Waste Management**

The facility inspection program developed and implemented by MWM for Rio Algom's Elliot Lake sites was commended for its completeness as part of the third party performance review of the Quirke waste management area. This external review of the program confirms that management systems developed and implemented by a third party contractor can be designed to adequately address risk management issues associated with contracted care and maintenance.

This is one example of how the experience with the Rio Algom contract has satisfied MWM that they can effectively manage operating risks and costs associated with dormant minesite care and maintenance. The project has demonstrated that programs and management systems developed support environmental, health and safety performance in compliance with regulatory and client standards while identifying opportunities for risk reduction. MWM now faces the business challenge of demonstrating to the mining industry their ability to achieve client-driven risk management and cost reduction objectives. The ultimate success of third party management of dormant minesites will be evaluated by the ability to secure similar contracts at other sites.

### Rio Algom Limited

The initial contract for services with MWM provided for a year long implementation period during which time systems and procedures could be developed to facilitate complete transfer of responsibility for management and operation of all of the closed mining facilities in the Elliot Lake area. This implementation proceeded very satisfactorily so that effective with the commencement of year two of the contract March 1, 1999, responsibility for the complete management, operation, and maintenance of all of Rio Algom's closed mine facilities has been contracted to MWM (Phase II).

Rio Algom's site experience to date indicates that the contracting out of the management and operation of closed mining facilities to a specialist contractor appears to be both viable and cost effective and provides the opportunity for the owner to significantly reduce the resources which must be dedicated to the on-going management and care of closed mine facilities. Further evaluation of this will be undertaken as the contract proceeds into Phase II and beyond.