

# **The Rehabilitation of Ontario's Kam Kotia Mine: an Abandoned Acid Generating Tailings Site**

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## **Abstract**

The Ontario Ministry of Northern Development and Mines (MNDM) has begun the rehabilitation of the Kam Kotia Mine site. This site is located within the municipality of Timmins, in northeastern Ontario, Canada, and is considered to be the worst abandoned mine site within the Province.

The site was originally mined for base metals in the early 1940's and eventually ceased production in 1972. During that time 6 million tonnes of sulphide rich tailings were deposited into three tailings areas, two of which were unimpounded. The tailings are currently located on more than 500 hectares of land and produce acid mine drainage that has severely impacted one river, is impacting on another and could potentially be threatening the ground water in the area. Currently the projected rehabilitation costs for the site are approximately C\$40 million, but it is expected that the final amount could be higher.

Under a four year, \$27 million fund for rehabilitating Crown owned abandoned mine sites throughout Ontario, a rehabilitation plan for the Kam Kotia Mine site has been developed. The plan provides a five-phased approach, with each phase being of a distinct and unique benefit to the site and taking approximately one year to complete.

To date, MNDM has committed \$14 million in order to conduct the first two phases of the five-phased rehabilitation plan. Phase "A", which involved the construction of a lime treatment plant and a new engineered impoundment structure, was completed in July 2002. The Phase "B" work, which saw the relocation of the unimpounded south tailings to within the new impoundment structure constructed during Phase "A", was conducted during the winter of 2002/03.

The remaining three phases of rehabilitation will be completed as funds are available.

## **Introduction**

The Kam Kotia Mine, which is located within Robb Township in the northwest part of the City of Timmins, Ontario, Canada, was mined for copper, zinc and secondary silver and gold. The mine was originally developed in the 1940's under the Federal Government's War Minerals program. Subsequent to the ending of that

program, the mine was operated by a commercial operator intermittently, finally ceasing operations in 1972. Since then, the mining and surface rights of most of the site have reverted to the Crown, leaving the responsibility of rehabilitation in the public realm.

In addition to physical hazards located on the site, there were about 6 million tonnes of high sulphide tailings located within three distinct tailings areas – much of which was unimpounded and covered more than 500 hectares. Acid Mine Drainage (AMD), and leached heavy metals, produced from all three of the tailings areas has had a large impact on the surrounding lands and waters. In addition, there have also been issues with dusting, aesthetics and physical mine hazards, such as the main shaft, an open pit and a thin crown pillar.

The three tailings areas located on the Kam Kotia Mine site are referred to as follows: a) the “North Unimpounded Tailings” or “NUT” located in the northeast area of the site, b) the “North Impounded Tailings” or “NIT” located in the northwest area of the site, and, c) the “South Unimpounded Tailings” or “SUT” located in the southern area of the site. (See Figure 1 for a site plan.)

For many years the area to the south of the mine site has been known as the “south kill zone”. This is an area in which virtually all vegetation has been destroyed by the site’s AMD. Acidic drainage from the SUT area into the Little Kamiskotia River, which is to the south of the site, has resulted in the severe impacts on the biota of that river, with its waters at a pH of 3 or lower.

The areas to the north and northeast have been similarly impacted by contaminated drainage from the NUT area and the Kamiskotia River to the north of the mine site has been heavily impacted. (See Figure 2 for a view of the NUT tails and one of the acidic seeps.)

In response to rising concern over impacts to the local environment from the contaminated drainage from the site, and the possibility of the contamination of groundwater in the area, MNDM contracted a consortium of firms, headed by SENES Consultants Limited, in the year 2000. The SENES Consortium was to develop a plan to rehabilitate each of the environmental and health and safety hazards on the site.

### **The Five Phases of Rehabilitation**

After considering various options to rehabilitate the site, SENES developed a five-phased approach of rehabilitation for the Kam Kotia Mine site – each of which is of a distinct and unique improvement to the site and each of which will take about one year to conduct. (See Figure 3 for a site plan showing the five phases of rehabilitation for the site.) The SENES plan predicts that the total cost to completely rehabilitate the site will total approximately \$40 million. However, the Ministry has now completed the first two phases of rehabilitation and, based on the costs experienced to date, it is now expected that the total cost to rehabilitate the site could be higher.

During Phase “A”, the first phase of rehabilitation on the site, a Lime Addition Treatment Plant, and its required infrastructure, was constructed on the site. That plant has now been operated for about a year by one of the firms that was partially responsible for the construction of the plant. This period has effectively been the plant’s commissioning period. The Lime Plant is expected to operate for at least fifty years, and much longer if the entire five-phased rehabilitation plan is not fully completed.

The other component of the Phase “A” work dealt with the construction of an impoundment dam structure within the NUT area, including the stabilization and reinforcement of the existing “North-South” dam. This newly impounded area has been designed to hold all of the remaining unimpounded tailings, which will be physically re-located to within the dam area during the subsequent phases of rehabilitation, neutralized with lime and then the impounded area will be developed as a wetland.

Phase “B” dealt with the re-location of the SUT tailings, estimated at 330,000 m<sup>3</sup>, to within the new NUT impoundment area where they were to be mixed with lime and neutralized. The completion of this work meant that there should shortly be very little new effect to areas to the

south and southwest of the mine site – the areas where there is human habitation.

A large cost saving was created by using an acid-neutralizing product called “Envirolime” to neutralize the relocated tailings, instead of the more common Hydrated lime. Although a slightly greater amount of the Envirolime was required to get the same results as the hydrated lime, the cost for the Envirolime per unit volume was less than half of that of hydrated lime. The Envirolime was also an easier product to apply to the relocated tailings than hydrated lime as it can be applied in a dry state and doesn’t tend to be as windblown due to its coarser granular form. The constituents of Envirolime are as follows: CaO 63 to 75%

MgO 1 to 8%  
SiO<sub>2</sub> 1 to 2%

The Phase “C” work will involve the relocation of the unimpounded NUT tailings that remain outside of the new NUT impoundment dam to within the NUT impoundment area.

The Phase “D” work will deal with the rehabilitation of the north and east seeps and creeks in the northeast area of the site.

Lastly, Phase “E”, the final phase of rehabilitation for the site and also probably the most costly, will be conducted. Phase “E” will involve a number of different rehabilitation components, including: a) the reinforcement of the remaining NIT impoundment structures, b) the construction of an engineered cover over the NIT tailings, c) the development of a wetlands over the NUT impoundment area, and d) the rehabilitation of the physical hazards on the site including the open pit, the crown pillar and the main shaft.

Based on the recommendations and cost projections provided by the SENES report, the Ontario government committed to complete the Phases “A” and “B”. In January of 2001, a contract was awarded to Wardrop Engineering Inc. to conduct the engineering and prepare a design plan for these two phases. Although some modifications did occur during the construction work, the Wardrop design became the basis for

the work that was conducted during the first two phases.

**Table 1:** Projected costs for each phase of rehabilitation at the Kam Kotia Mine site

Phase	Projected Cost *
A	\$4,485,000
B	\$3,285,100
C	\$8,190,000
D	\$3,372,200
E	\$11,402,300
Lime Plant Costs (e.g. operated ~50 years)	\$10,062,000
<b>Total Cost to Rehabilitate the Kam Kotia Mine Site</b>	<b>\$40,796,600</b>

\* Costs include 30% contingency.

### **Phase “A” Rehabilitation**

The Phase “A” work was tendered as three contracts in July 2001, and in September 2001, three firms were selected to conduct the work. The project management contract was awarded via tender to B.H. Martin Consultants Ltd., of Timmins, Ontario. The construction of this phase was divided into two projects.

Project 1 included the construction of the NIT interception ditch, the pump house and forebay as well as the Lime Treatment Plant. This contract was awarded to North America Construction (1993) Ltd., of Morriston, Ontario.

Project 2 included the preparation of rock, granular, and clay pits as well as the construction of the new NUT dam and reinforcing the north dam. This contract was awarded to M.J. Labelle Co. Ltd., of Cochrane, Ontario.

The combined bids for the Phase “A” projects were more than \$9.8 million. This amount was more than 65% higher than the original cost projections even after the projected cost was adjusted to include the additional costs for the

reinforcement of the North-South dam and the construction of a high-density sludge plant during Phase “A”, rather than waiting to convert it during a later Phase of rehabilitation. These additional costs caused MNDM to put a cap on Phase “A” and “B” expenditures. It became the project manager’s and the Ministry staff’s responsibility to ensure that any extra cost was offset by savings found elsewhere during the construction work.

The Phase “A” work started in October 2001, with the intention of it being completed by March 31<sup>st</sup>, 2002. Project 2 had difficulty developing the granular and clay pits due to warmer than usual winter weather, so the Project 2 completion date was extended until the summer of 2002.

Once the construction of the dam started, it was realized that the information provided during the tender was not adequate and that approximately \$400,000 was required for the extra material in the NUT dam due to lower than expected original ground. Since there was no cost overrun allowed, it was decided to forego the topsoil and seeding of the NUT and the North-South dam to offset the extra costs. Project 2 was completed by July 18, 2003 with no cost overruns.

Project 1 had its own difficulties. Problems were encountered, both during the Phase “A” construction and later during the Lime Plant operation, with the selection of pumps for Project 1. Changes also had to be made to the sludge outfall piping resulting in costs for this component escalating to about three times that originally bid. To cover these additional costs, some of the tailings north of the SUT interception ditch were left in place, to be removed during the Phase “B” work. Project 1 was completed on March 30, 2002 with no cost overruns.

### **Phase “B” Rehabilitation**

The Phase “B” work was tendered as two contracts during September 2002, and in October two firms were selected to conduct the work.

A local Timmins firm, Leo Alarie and Sons Ltd., was the successful bidder for the Phase “B” construction work. The Project Management

contract was awarded to D.F. Elliott Consulting Engineers of New Liskeard. However, due to the price cap that had been placed on the combined Phase “A” and “B” work, the two firms’ bids for the Phase “B” work exceeded the total amount of money available for the project by \$142,991.26. As a result, before the project even started both of the firms and the Ministry were looking for ways that the cost of the Phase “B” work could be pared down. It had been expected that the only possible way to do this would be to limit the actual amount of tailings to be re-located by leaving the thinner areas around the perimeter of the SUT in the expectation that their acid generating potential would have already been exhausted.

The Phase “B” work started slowly. Alarie had indicated that they would need good frost conditions to be able to move their equipment onto the tailings. Unfortunately, both heavy snow and milder than usual temperatures in the early part of the winter contributed to very poor frost conditions. As a result, excavation and transport of the first loads of tailings did not occur until the second week of January, and much of the early work was sporadic. To further complicate matters, although the contracts called for a project completion by March 31<sup>st</sup>, 2003, Alarie had indicated in their schedule that they intended to complete the project by the end of February so that they would be able to remove their equipment from the site before the spring “reduced load” requirements were to take effect.

Fortunately for the project, Northern Ontario was hit with a period of deep freeze starting in mid-January and lasting right through February. In order to relocate all of the estimated 330,000 m<sup>3</sup> of tailings in the SUT to the NUT impoundment area, Alarie’s original plans had called for the relocation of 6,000 m<sup>3</sup> of tailings daily. However, due to the delays experienced, Alarie began to operate two 12-hour shifts, seven days a week, and brought substantially more equipment onto the site. This resulted in them being able to relocate 9,000 m<sup>3</sup> of tailings per day and complete the project by early March.

In the end Alarie relocated a total of about 340,000 m<sup>3</sup> of tailings to the NUT impoundment area, with the only tails left in place being around

hydro-electric poles in the SUT and those that were over the pipeline from the pumphouse to the Lime Plant. All other SUT tailings were relocated to the NUT impoundment area.

The savings that were expected to be obtained from a reduction in the tailings removed were actually realized by Alarie managing to reduce the clearing and grubbing required to conduct the tailings relocation, and by canceling the seeding of the SUT area. The reduction of the seeding had been considered as a possible cost cutting measure since before the project had begun – one that was discussed with the local residents of Kamiskotia Lake. However, Alarie indicated that, due to the severe frost conditions in the ground by the latter part of February, the seed could not be harrowed into the peat soil as deeply as needed to ensure the seeds survival.

It was determined that if the seed could not be sufficiently harrowed in, it would probably be killed by the Agricultural (Ag) Lime's alkalinity. So the seed was cancelled, and the total cost reductions resulted in enough savings that the final combined costs of Phases "A" and "B" were \$4,111.88 less than the expenditure cap placed on these phases of the project.

However, Ag Lime was still spread over the peat/soil surface after the removal of the tailings to provide increased buffering capacity in the pore water in the ground, and the area should be able to revegetate naturally.

### **Future Phases of Rehabilitation**

As funds become available, further phases of rehabilitation at the Kam Kotia Mine site will be conducted. Plans are already under way to begin Phase "C" during the winter of 2003/04, contingent on funding.

Phase "C" removal of the unimpounded NUT tailings within the northeast of the site will also have to be conducted as a winter project. However, it is projected that the volume of the NUT tailings to be relocated will be 2.5 times greater than the volume of the SUT tails that were moved during Phase "B", so it is possible that

Phase "C" may have to be conducted over a two-year period.

### **References**

SENES Consultants Limited, Lakefield Research Limited, ESG International, Denison Environmental Services; August 2000; "Final Report Kam Kotia Mine Property Rehabilitation Study – Phase 1".

**Figures**



**Figure 1:** An aerial view of the Kam Kotia Mine site prior to rehabilitation commencing.



**Figure 2:** A view of the NUT area, and the northeast seep with a pH of 2 to 3, prior to rehabilitation.

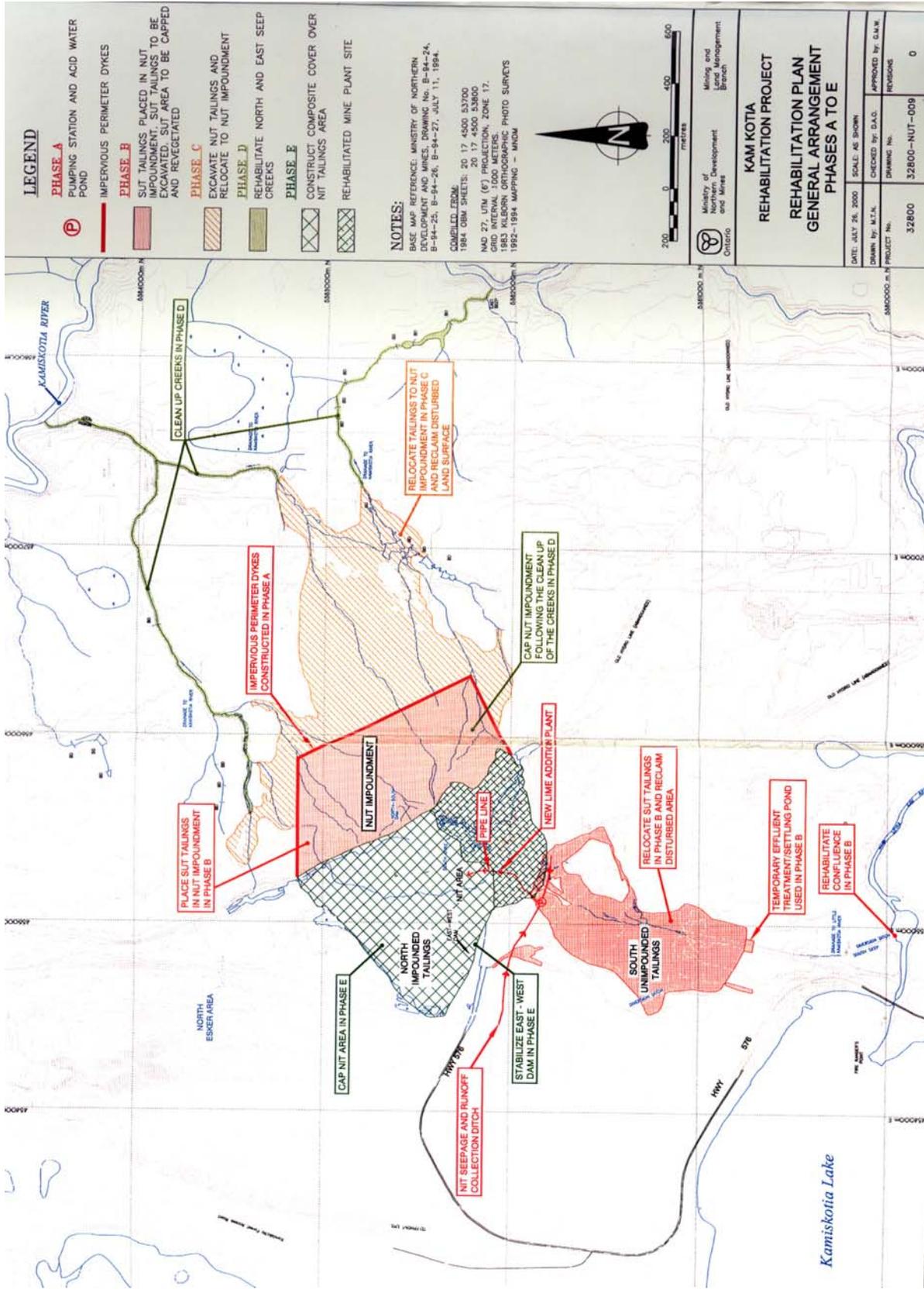


Figure 3: A map of Kam Kotia showing the five phases of rehabilitation (SENES, 2000)