

# Managing Mine Closure Risks in Developing Communities — A Case Study, Kelian Equatorial Mining, Indonesia

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## ABSTRACT

The Kelian gold mine which was developed in East Kalimantan Indonesia in 1990 - 1992 is scheduled to complete mining and processing operations in 2004. This will have a major impact on the neighbouring communities who have benefited from the jobs, economic activity and infrastructure development which has been generated by the mine. Currently, there are no formal regulations or standards specifying the procedures for relinquishment of mining leases in Indonesia. Furthermore, a move towards regional autonomy, providing greater authority and responsibility to local (regional) areas, has recently been implemented in Indonesia and limited capacity exists in the new regional governments. Consequently, in October 2000, Kelian Equatorial Mining (KEM) initiated a partnership with the local community and government to explore sustainable post-closure options for the mine site and community development programs.

The Kelian mine closure strategy seeks full involvement of all stakeholders through the Kelian Mine Closure Steering Committee (MCSC) in the development of sustainable solutions which will enable communities to secure long-term benefits and minimise post-closure risks from the KEM operations. This organisation, jointly chaired by the Head (Bupati) of the regional West Kutai government and the KEM President Director, with representatives from the local communities, governments and NGOs, has developed a Charter, a website and evaluation criteria to ensure accountability and transparency. There are four technical working groups, consisting of representatives from the mine, local community leaders, NGOs, Universities, Local, Provincial and Central Government Departments, which report to the Steering Committee. These working groups have researched, developed and recommended sustainable options to the Steering Committee. The MCSC has met quarterly to examine options in accordance with the criteria set out in the Charter and has endorsed sustainable solutions which have support from Government, Community and the mine.

This paper describes the closure risks, sustainable outcomes derived through the Kelian mine closure steering committee process and outlines the methodologies used to develop and endorse sustainable solutions in a society with limited capacity undergoing enormous change and uncertainty.

## INTRODUCTION

Kelian Equatorial Mining (KEM) is a large gold mine in East Kalimantan, Indonesia. The mine is 90 per cent owned by Rio Tinto and has a ten per cent Indonesian shareholder. It is located just south of the equator (see Figure 1), adjacent to the Kelian River. The site is surrounded by tropical rainforest and has an average annual rainfall of 4000 mm. There is usually a distinctive dry season in the middle of the year, but El Nino/La Nina weather patterns influence seasonal variations and can result in severe drought and flood conditions.

Production of gold commenced in 1992, after a two year construction period. Following exhaustion of the ore reserves, pit operations were completed in March 2003. Low-grade ore stockpiles will continue to be processed until mid-2004. The mine was an open cut operation, mining an average of 45 Mt of material and producing approximately 14 t of gold annually. The mining was undertaken by conventional means using trucks and excavators; the gold recovery process uses SAG and Ball Mills followed by gravity separation and carbon in leach cyanidation. Major mine infrastructure (2002) are shown in Figure 2.

A local population of approximately 80 000 in 114 villages surrounds the Kelian site and can be broadly divided into the largely Christian *Dayaks* who are indigenous to the area and those mainly Moslem groups whose origins lie outside the province such as the *Javanese*, *Bugis* and *Banjarese*. There is also a small proportion of *Kutai* who are Moslem and indigenous to the province. The employees at the mine are largely drawn from the local area with up to 60 per cent drawn from the local Region of West Kutai (refer to Figure 3) and 80 per cent originating from the local Province of East Kalimantan.

The communities impacted by the mine operations are ethnically diverse and have widely different histories of settlement. The dominant ethnic group, known and referred to as 'the *Dayaks*', although the term '*Dayak*' is simply the generic term for 'up-stream' persons (Kunanayagam, 1995). The *Dayaks* are the indigenous people to the area. They are made up of a number of distinct ethno-linguistic groups and sub-groups, each with their own systems of traditional law, customary forms of worship, beliefs and ritual practices (Hopes, 1997). A number of these communities have expressed a desire to enter the KEM area after mining to search for gold and harvest timber (Green, 2000).

The key risks for mine closure are long-term management of permanent engineered structures (dam walls, spillways, wetlands, roads, waste dumps) and acid rock drainage (ARD); achievement of environmental closure standards; orderly retrenchment of employees and contractors; and relinquishment of the site with associated permanent structures and community development infrastructure and programs to new owners. The likelihood of completing these tasks is dependent on the ability to successfully implementing negotiated agreements with the government, community and employees within a framework of political and social change. The consequences of a difficult closure range from increased closure costs and handover delays to ongoing environmental impacts, corporate reputation damage and social unrest if desired outcomes can not be achieved.

This paper discusses the closure works and programs agreed through a consultative process (the Kelian Mine Closure Steering Committee) involving key KEM, Rio Tinto, community and government representatives. The agreed measures are currently being implemented to mitigate undesirable environmental and social risks associated with a challenging mine closure within the framework of a community undergoing significant political and social changes.

## ENVIRONMENTAL RISK MITIGATION MEASURES

### Permanent structures

The single open pit will have final surface area of approximately 95 ha and have a final water depth of 160 m. The Pit will be used to store about 10 Mt of tailings and 5 Mm<sup>3</sup> of potentially acid producing waste rock and will be actively filled with water over a two to three year period. Peak flows from the Kelian River will be diverted into the Pit via an over-flow channel. Overflows from the Pit will exit through a submerged spillway into a 20 ha wetland, adjacent to the Kelian River. The Kelian Wetland has been designed to reduce metal levels [especially manganese (Mn)] to meet agreed water quality standards for closure prior to discharge into the Kelian River (see Figure 4).

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FIG 1 - Indonesian locality map of mine site.

A waste rock dam (Nakan Waste Dump Dam) has been constructed at a cost of \$US 20 million, to selectively place potentially acid producing waste. This facility has a design capacity of 185 Mt of waste rock that is being progressively submerged to minimise acidification and release of metal discharges. A water cover of at least 1.0 m will be retained after closure to prevent future acidification reactions. A 25 ha wetland is also being constructed with the Nakan Dam to remove residual metal levels prior to discharge from the Dam.

Slurry discharges from the Process Plant are pumped via a 5 km pipeline to a tailings dam (Namuk Tailings Dam) which will have a final surface area of 455 ha. The tailings dam has sufficient capacity to enable dilution and natural decay by solar radiation of cyanide (CN) prior to decant discharge. The tailings dam decant overflow volume is controlled via a siphon and current levels of CN are well within compliance ( $CN_{total} < 0.05$  mg/L). The closure option chosen for the Namuk Tailings Dam (NTD) is a water cover of at least 1.0 m depth combined with an upgrading of the NTD wall and the construction of an emergency spillway.

The Upper and Lower Polishing Ponds receive all drainage from the mine site including the Process Plant, waste dumps and NTD. The ponds act as a settling and mixing basin and also allow some natural oxidation and precipitation of metals. These areas will be integrated into the Kelian Wetland system at closure to assist with uptake of any residual metals in the runoff waters. The original Nakan River Channel (a tributary of the Kelian River) will be reinstated during construction of the wetlands.

A comprehensive risk assessment (social, environmental and engineering aspects) was undertaken by Klohn Crippen and Hatfindo (2002) for all permanent structures which will remain after closure. This risk assessment was integral to the selection of the preferred closure option and the development of post-closure management plans.

## Water quality

Modelling of post closure hydrology, hydrodynamics, geochemistry and water quality emanating from the pit, Nakan Waste Dump Dam (NWDD) and NTD was undertaken based on agreed closure plans (Bechtel *et al.*, 2003). These models provided a predictive tool for investigating the impact of closure options against water quality compliance requirements. Results indicated that the key compliance parameter, manganese (Mn) will have concentrations of 1.7 mg/L and 8.4 mg/L in discharge water from the NWDD and Pit areas respectively, when they have reached equilibrium after closure.

The proposed wet covers of 1.0 m on the tailings and waste rock dams were determined of sufficient depth to maintain a saturated cover during the driest possible recorded period (EGI, 2001). The hydrodynamic modelling of the Pit (Bechtel *et al.*, 2003) indicated that a periodic stratification of temperatures would occur and this thermocline would impact on salinity and dissolved oxygen concentrations in the surface layers during mixing events. These results formed the basis of plans to divert the pit discharge waters through wetlands prior to discharge into the Kelian River.

Research on the biological uptake of Mn, was undertaken using local bacterial-algal complexes cultured both in laboratories and on-site. Results indicated that 90 per cent of Mn can be removed from low flows using a system of floating bacterial-algal mats. Additional research investigated the potential of local aquatic plants, combined with the bacterial-algal complexes, to remove Mn. The results of this research were also used in the design of the wetland systems, which will receive water from Pit and NWDD overflows after mine closure.

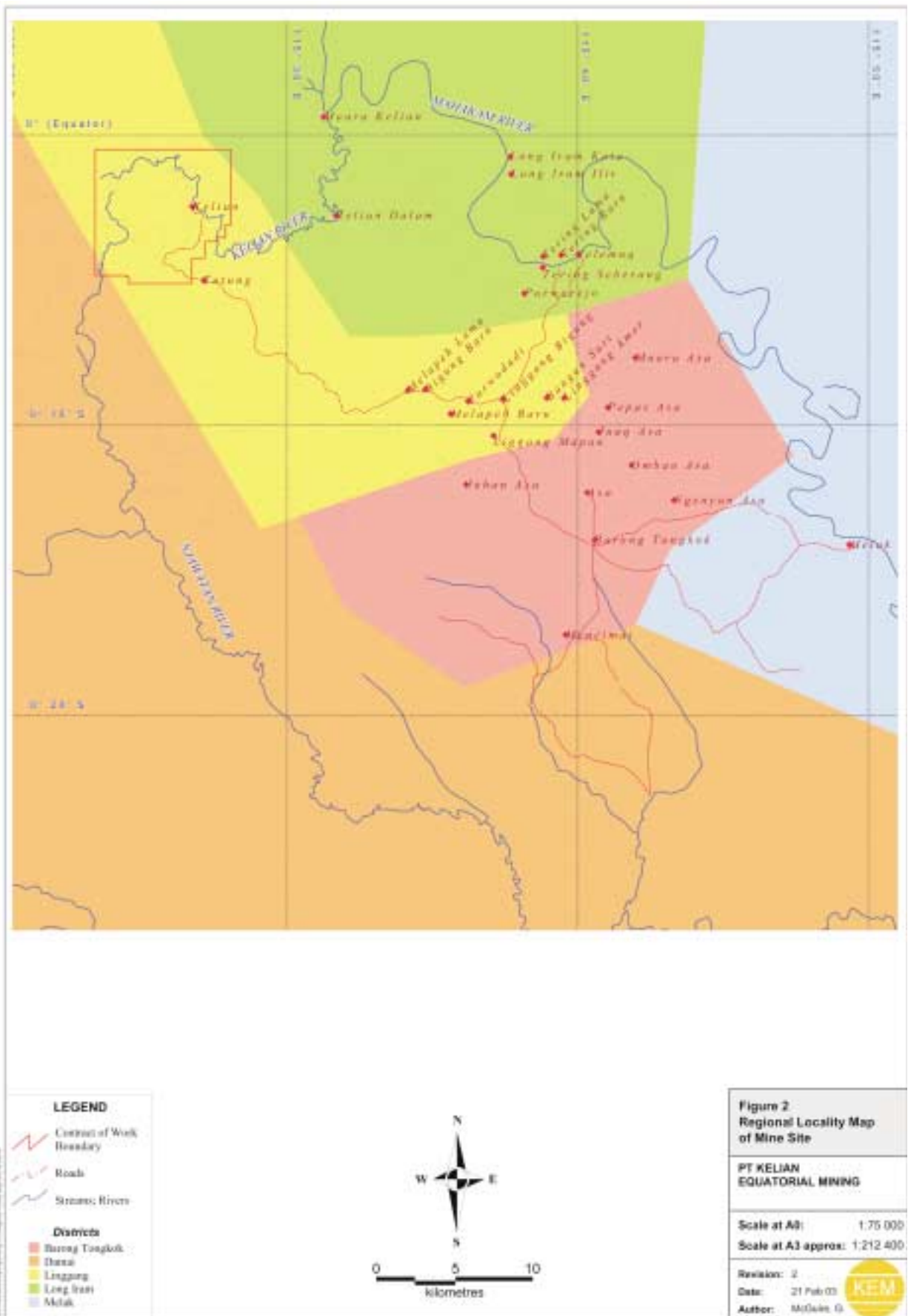


FIG 2 - Regional locality map of mine site.



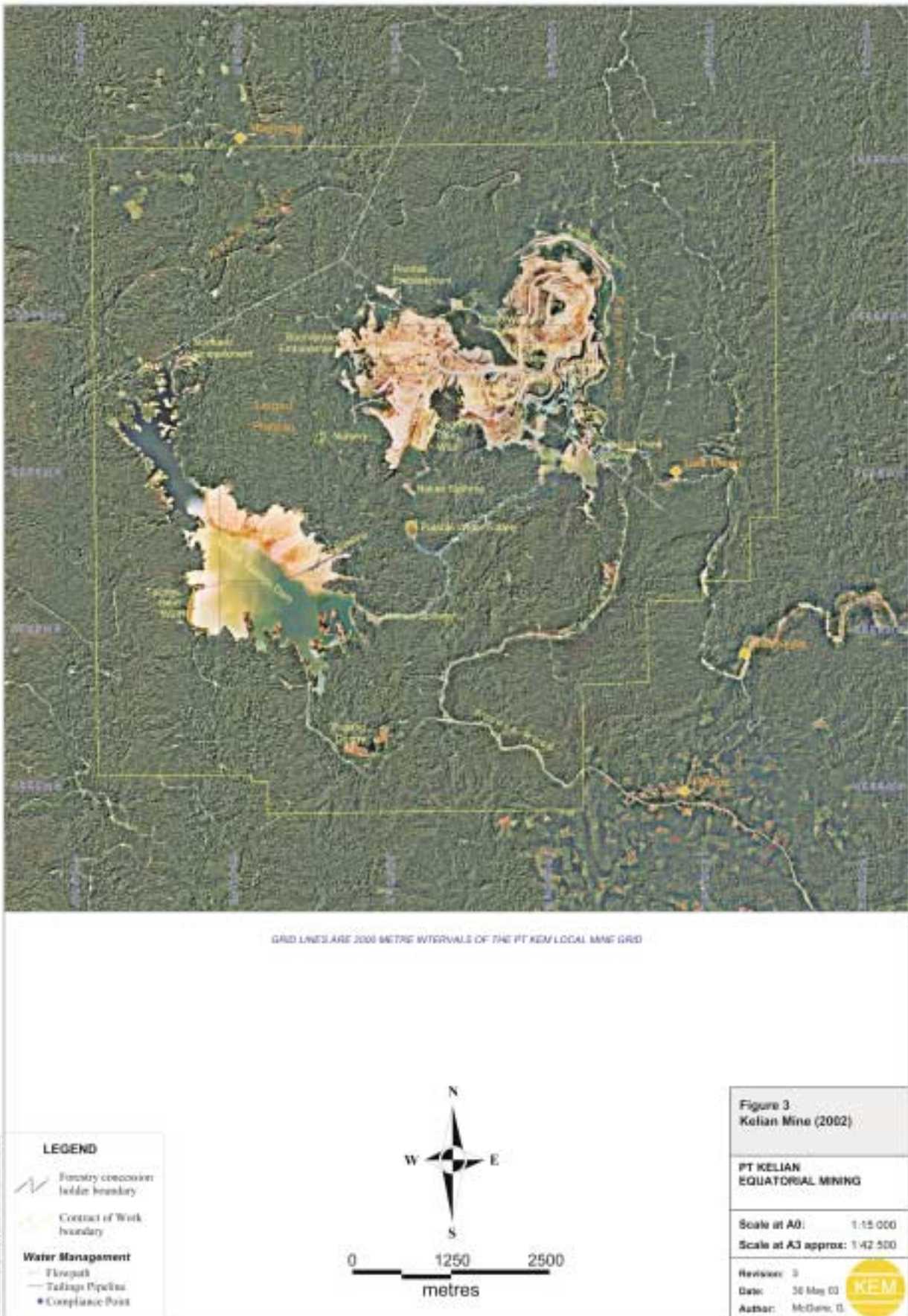


FIG 3 - Kelian Mine (2002).



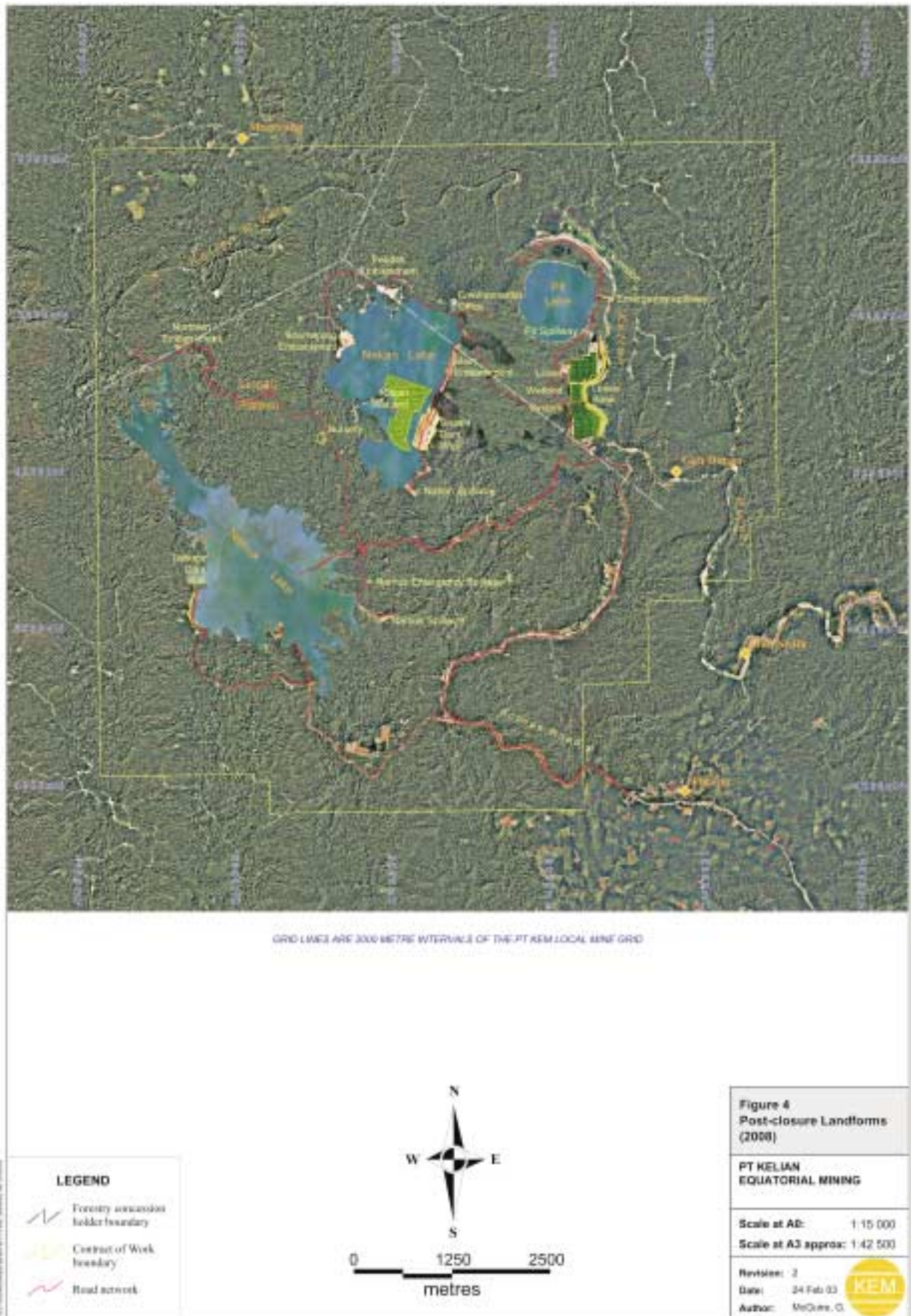


FIG 4 - Post-closure landforms (2008).

## Rehabilitation

Areas disturbed by waste dumps, stockpiles and diversions are being progressively reshaped to stable landforms and revegetated with native rainforest species. The method of revegetation used is the Framework Species Method (Goosem and Tucker, 1995) which involves simultaneous plantings of dominant native species from the various structural layers of the adjacent rainforest. This method results in rapid revegetation of exposed areas with the addition of fruit-bearing trees and shrubs that encourage wildlife from the adjoining forest and continually improve species diversity through the resultant seed dispersal.

Rehabilitation using engineered dry covers on potentially acid producing, waste rock dumps has been in progress since 1998. This rehabilitation involves three types of material, placed in 1.0 m thick layers. The first layer is an impermeable layer of saturated and compacted muddy breccia which seals the dump and prevents oxygen from entering the sulfidic waste rock. The second layer is a blocky andesite which acts as a root break and the final layer consists of growing media suitable for revegetation. Initial results from the application of dry covers indicated an immediate reduction in Mn discharge levels; and temperature monitoring within the dump indicated that the dump temperatures have stabilised at approximately 30°C. Additional monitoring of oxygen levels within the dumps will continue to determine if acidification reactions are still occurring below the engineered layers.

The criteria of completion or success for the rehabilitation program was agreed in consultation with government and community representatives. This criteria determines the types and numbers of species to be planted; and requires an active maintenance period of five years before relinquishment. The method of *landscape function analysis* developed by the CSIRO, Australia was also trialled as a potentially appropriate method for determining completion criteria. However, another year of field monitoring is required to determine if the technique will be practical for post-closure monitoring.

## Alternative land uses

The local (regional) government played a significant role in determining final land use because under current licensing agreements the mine site area reverts to the Department of Forestry and the access road reverts to the Department of Public Works post-closure. However, due to the significant interest from the community in other resources within the mine area, the post-closure uses had to be balanced against the need to protect the dams and rehabilitated areas from disruptive activities, which would damage the long-term safety and stability of the engineered site structures.

Some facilities such as the Process Plant, workshops and warehouse have no local beneficial use after mining and once processing ceases they will be demolished. The power station and major fixed plant components which have commercial value will be sold. However, it was agreed during the stakeholder discussions that the buildings from the camp will be dismantled and donated to the local government for use by the community as educational and cultural facilities. The land under these buildings will be mined and alluvial gold removed before the wetlands are constructed. The removal of alluvial gold is intended to reduce the risk of local artisanal (alluvial) miners accessing the site in search of gold and damaging the wetlands which are required to control post-closure water quality.

The forest within the lease area was classified as *Limited Production Forest* prior to the commencement of mining. This permitted selective logging of hardwood timbers (Meranti) from the primary rainforest. In order to protect the permanent engineered structures and rehabilitated waste dumps post-closure, it was agreed to change the classification of the area to *Protection Forest* after mining ceases. A range of activities

will still be permitted within the *Protection Forest* providing they do not damage the forest or surrounding water catchments. A Community Advisory Group has been established to discuss possible sustainable and low impact land uses such as fruit growing, rattan harvesting, fish farming, ecotourism and research opportunities within the ex-mining area of 6670 ha. This advisory group is also designing a community forest ranger program to enable active protection of the area after closure.

## Post-closure monitoring and maintenance

There is a commitment to ongoing post-closure monitoring of the permanent structures, the Kelian River, discharge streams and lake water until post-closure standards have been obtained. Negotiations with external stakeholders determined the performance indicators and targets for the post-closure engineering and environmental standards. The time taken to achieve these standards will determine the length of time that monitoring will be required. At this stage, it is predicted that the environmental closure standards will be achieved by 2007/2008 and then an additional five years of reduced monitoring will be conducted prior to relinquishment. Some permanent structures (eg dam walls and spillways; wetlands) will require monitoring and maintenance in perpetuity to retain agreed standards.

A Forest Management Board consisting initially of representatives from KEM, the community and the government will oversee the post-closure monitoring. However, disturbance of the permanent structures by human interference would severely impact on the environmental and engineering controls planned for closure. The Forest Management Board will be working closely with the Community Advisory Group and Community Forest Rangers to mitigate the risk associated with post-closure disturbance. KEM will establish an endowment fund in 2005 to cover the annual monitoring, maintenance and protection activities of the Forest Management Board in perpetuity.

## SOCIAL MITIGATION MEASURES

### Social landscape

A primary difficulty facing the community and KEM at closure is the shifting political and economic landscape in Indonesia (Green, 2000). KEM entered the region at a time in Indonesia's political history when community expectations were quite different from those currently in place. Regional autonomy, newly implemented in 2001, has also presented a number of challenges. The Kelian project was developed under a Contract of Works (CoW) agreement between KEM and the Indonesian Government signed in February 1985.

In the social landscape in which KEM now operates, workers and the community prefer to manage their grievances directly with KEM. This is both an expression of the lack of confidence in 'state structures' and a genuine desire to develop a direct social and economic relationship with an institution living amongst them. KEM's challenge for closure is to partner the community in this new, less predictable political and economic landscape where changes at the national level are also evident locally. For instance, formal village institutions that in the past served as instruments of government control have lost much of their authority as traditional (customary) and non-government organisations (NGOs) take their place.

This changing political scene throughout Indonesia has altered the relationship of communities surrounding the Kelian project towards KEM. State autocracy has been replaced with a far more parochial system that has required KEM to deal directly with the community, as NGOs pursue democratic reform and other agendas in Indonesia.

KEM has not been able to rely on the judiciary or any other aspect of the government to resolve day to day, or accumulated or emerging problems between themselves and the community. This is evidenced in the number of other foreign companies that have been forced to defer investment or suspend operations in Indonesia in recent years. Instead, KEM has chosen to negotiate directly with the key community and government representatives to define workable processes agreed by all parties.

The new democratic era is a hopeful sign for Indonesia but has presented certain difficulties for KEM in matters surrounding project closure. Viewing it from the inside, KEM operates against a backdrop of inertia in national law reform, these are events largely outside its control. Political, social and economic tensions are also external factors which impact on KEM. Viewing it from the outside, KEM appears to operate within a much larger corporate structure that needs to be flexible and responsive to keep pace with these changes.

### **The base line studies (2000)**

Community and workforce consultations at KEM have been conducted in the closing stages of the mine life to address the likely impacts of closure on a large and complicated community. That community includes local mine workers and the village communities from which workers were drawn. In particular, the studies sought to identify the concerns and aspirations well before the effects of closure become apparent. The detailed Base Line studies were designed and implemented in order to reveal the circumstances of these groups. One study was dedicated to the work force and the other to surrounding villages.

#### *The purpose of base line studies; responsibility and vision*

In accordance with the KEM 'Preliminary Closure Statement for Consultation (Marshman *et al*, 1998), the social criteria for mine closure was to ensure that after closure the surrounding community has positively and permanently benefited from the Kelian mining project. While identifying those communities most impacted by closure, the studies also identified community aspirations as they apply to the mining area after closure. Because KEM is bound to restore that environment for government agreed use, early cooperation between KEM and other stakeholders was required to address longer term legal, environmental and community objectives.

#### *Community inclusion and participation*

On average, 1800 local men and women were employed or contracted annually by the mine and 114 villages were considered to have been influenced by the project in some way. Most workers were from traditional *Dayak* villages while others were from mixed villages whose population came from elsewhere in Kalimantan or from Java, Sulawesi and other parts of the Indonesian archipelago.

The results of the baseline studies have allowed KEM to prioritise community development efforts in the design of programs and other interventions that address closure needs. These initiatives are intended to smooth the transition for workers from the industrial setting of the mine to private projects such as farming or business. For the community, these programs will assist in mitigating the problems of mine wealth dependency.

#### *Methodology and aims*

These baseline studies were developed as questionnaires. For the workers, this included questions about their economic circumstances, including incomes, investments and debts. It also inquired about future plans and in particular, those that would

replace the income and way of life of the mine worker. For villages, the focus was on perceived and 'real' social and economic changes over the past ten years with a view to recording dependencies and other factors that could be attributed to the mine project. This questionnaire includes data on the village economy, health, education, infrastructure and many other indicators of importance to people of the region.

For both workers and villagers, the studies recorded the level of acceptance of new forms of agriculture and business that might supplement or replace project related dependencies.

Workers were interviewed as groups or individually within the workplace and villagers were met in situ at pre-determined times. These worker interviews and village meetings took roughly six months. All were conducted on a relaxed and informal basis that encouraged interaction and openness. So, while the studies were conducted separately, the intention has been to integrate and harmonise the results for benefit of the community as a whole.

Looking at individual villages was important for two reasons. Firstly, it was necessary to determine, after several years of engagement with KEM, the prevailing social and economic conditions and the 'perceived' and 'real' changes that have taken place over the past ten years. Secondly, from the information of this study, it was important to understand the circumstances redundant workers, contractors and their employees will have to cope with after mine closure.

For villages, identifying 'perceived changes' provided a more accurate picture of community well-being than material or economic wealth. The survey results enabled the prediction of those communities that may 'sense' hardship and those unlikely. It was important to identify those villages that had been measurably impacted by the project. The study focused on:

- villages that have been the subject of a KEM social and environmental impact statement;
- villages that receive or expect to receive KEM community development programs;
- villages that have members engaged as employees in the KEM project;
- villages that have farmers and producers that supply the KEM project; and
- villages that have local maintenance and other contracts connected to KEM.

#### *Research results*

For many topics, such as health, education and income, villagers defined an agreeable village standard and then described changes to that standard over the past ten years. In this way, people were able to describe what aspects of life have improved or deteriorated. The data reveals a number of common characteristics about village life. Most for instance, described poor infrastructure, health and education, low incomes, serious rice shortages and difficulties with forest and other resource depletion. However, despite these poor indicators, many villages perceived that health, education and incomes had generally improved over the past ten years.

In many respects, the problems which were identified are typical of other parts of developing Indonesia and were not, in isolation, the primary focus of the studies. Of particular interest were these statements in conjunction with others that described forms of dependency, alienation, debt or inequality that can be linked to the KEM project. Using these criteria, only 30 per cent of the 140 villages surveyed suggested any vulnerability to closure. These were placed into the following categories;

1. villages that show poor agricultural indicators and have a high dependency on KEM related incomes to offset food shortages;

2. villages that are more dependent on non agricultural business and commerce and are dependent on KEM related incomes to support these businesses;
3. alluvial mining villages on the Kelian River that were alienated by the project and could potentially reoccupy the mining area post closure;
4. villages where it is perceived that promises about the delivery of community development project have not been kept; and
5. villages where it is perceived that compensation and other KEM debts arising out of the project remain outstanding.

### **Mitigation measures**

In keeping with the closure criteria for the social objectives of closure, the primary considerations are sustaining harmony and ensuring the transfer of real benefits to this region. The studies identified broader issues that present obstacles for achieving those outcomes. Against those obstacles, practical mitigation measures were identified that could favourably modify the predictions.

#### *Problems of project dependency*

Mine closure could bring certain economic hardship to wage earners, contractors and other businesses and interests that depend on KEM. Many businesses will inevitably close and many wages earners will return to villages where they are no longer able to support others during periods of food shortage. Any threats of uncontrollable hardships or a perceived decline in wealth can place undue strains on relationships within and between villages.

#### *Solutions to the problems of project dependency*

Many traders and contractors that first came to the region because of opportunities presented by the KEM project will, after a period of hardship, leave as these opportunities disappear. Most local people, in some way dependent on the KEM project, stated that they intend to remain in the area after mine closure. The following program based solutions were designed to mitigate hardships for the most affected communities.

#### *Communications and training strategies*

With timely and accurate information, many communities indicated that they can plan and adjust to the hardships of closure. These business operators, suppliers, contractors and the communities that depend on KEM often live some distance from mainstream information available to KEM wage earners.

Clear and useful information about the anticipated effects of closure has been communicated regularly through Employee and Village Communications Programs. Mine visit and briefing sessions are provided regularly for community groups. In addition there are three communication offices located in villages and an employee information centre on the mine site established to receive people, answer concerns and provide information about closure as it becomes available.

KEM employees have also received a range of training programs aimed at developing skills post-closure. Up to 56 hours are allocated during work for studies such as economics, agriculture, small business management and motor mechanics.

#### **Food security projects**

From the studies, it was revealed that the deepest anxieties were about food security and it was clear that KEM derived incomes have overcome food shortages in many villages. All villages and

many mine workers expressed interest in agricultural programs to improve production. This anxiety about food security was requested over and above any other proposal to mitigate closure impacts through non-agricultural income schemes. Indeed, people often noted that in times of hardship food readily replaces money as the currency of choice.

To rectify this situation, 28 villages deemed 'critical' have commenced participation in agricultural programs to alleviate food shortages. A target of 5 ha/year (over three years) for each village was determined and initial harvest results are expected to produce 440 t of rice annually from 420 ha by 2006. KEM employees who expressed an interest in agricultural training are also eligible to receive assistance in the development of agricultural, aquaculture or animal husbandry enterprises.

In addition to the food security and employee training programs, KEM's Community Development Team has facilitated the establishment of 75 self-help groups in the 28 target villages. The program assists villagers in savings and loans, small business, commerce and micro-enterprise projects. The program provides villagers with technical, administrative and some financial assistance from inception to a point after three to four years when the projects prove self-reliant.

KEM transferred the management and operation of its community programs to the local Rio Tinto Foundation in 2002 and is working closely with the Foundation to ensure that these programs will be sustainable after mine closure.

#### **Sustainable alternatives for specific programs**

With respect to education, KEM has sponsored a free bus service for up to 500 children attending primary and secondary schools, and provided educational scholarships. To mitigate hardship among workers and villagers at the conclusion of these programs, it was determined that a boarding facility should be built to replace the bus service after mine closure. The boarding facility was completed by KEM in 2003 and will be run by a government and related community organisation.

A number of health programs (notably, tuberculosis control) have been undertaken through the locally located Rio Tinto Foundation. Some aspects of these programs have now been transferred to the local government. However support for these programs will continue with donor funding through a renamed and restructured Community Foundation. KEM and Rio Tinto have committed sufficient funding for the administrative costs of these programs to be met in perpetuity if well managed.

#### *Problems of community alienation*

Alluvial miners and farmers who customarily used the mine area moved from there during the construction phase of the KEM project. In surrounding villages, the mine area is considered resource rich with the potential to improve living standards and during the studies many community members expressed a determination to return after closure. KEM needs to restore and manage the mine area for a number of years after production ceases, therefore, unplanned community exploitation will conflict with the programs to satisfy agreed standards governing post-closure water quality and rehabilitation.

#### **Solutions in joint agreements**

The establishment of joint agreements through the Mine Closure Steering Committee (MCSC) between the community, government and KEM will enable all stakeholders to derive orderly benefit from the area. Post-closure these agreements will be implemented through a Management Plan developed by the Forest Management Board in consultation with the Community Advisory Group. Refer to MCSC website [www.kelianmineclosure.org](http://www.kelianmineclosure.org) for further information on the agreements.



### *Future village base line research*

A number of social and economic indicators arising out of the studies can be used in future surveys to measure changes in 'quality of life' and 'community well-being' as perceived by the village community. These general indicators can help indicate those villages that are adjusting more favourably to social change during and after closure. Some repeatable measurements include;

- perceived causes for changes to forest resources and the physical landscape;
- the number of months a village anticipates it will need to purchase rice;
- perceived improvements or deterioration in village health;
- illnesses that have increased and those that have declined;
- perceived improvements or deterioration in educational opportunities;
- perceived improvements or deterioration in wealth;

A review of the Village Baseline Study undertaken in 2002 concluded that most villages are now better prepared to meet the challenges of mine closure now than was the case two years ago, when the first Village Baseline Study (VBLS) was undertaken in 2000. Contributing to this overall picture are incremental improvements in sustainable agriculture such as rubber and rice production. Relations between KEM and the community have also improved to the point that both can discuss the process and detail of mine closure and plan and prepare for the changes together. This is ongoing through the Mine Closure Steering Committee (MCSC), the Community Advisory Group and the village communications strategy. KEM redundancy training programs and ongoing support of the food security initiative, small business, agriculture, health and other community support programs through the Community Foundation will substantially improve community capacity to deal with the a post-closure future.

### **CONCLUSION**

The Kelian mine closure project has involved resolution of many complex issues and challenges requiring active consultation and partnership with a wide range of stakeholders and interested parties to ensure risks and opportunities are identified and dealt with in a timely and appropriate manner. Clearly, the challenge

for the implementation of mine closure is to achieve environmental and social performance indicators which stakeholders agree are safe, non-polluting and socially responsible. Achievement of these objectives within Indonesia will indeed be extremely significant for the resources industry both in Indonesia and internationally.

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The figures in this paper are the work of Tony Williams of Esys Consulting, Cairns.

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