Mine Closure 2011 — A.B. Fourie, M. Tibbett and A. Beersing (eds)
© 2011 Australian Centre for Geomechanics, Perth, ISBN 978-0-9870937-1-4
doi:10.36487/ACG_rep/1152_108_Botham

Best practice in acquiring a mine closure certificate – a critical analysis of the De Beers Oaks Diamond Mine, South Africa

N.D. Botham *Department of Geography, Environmental Management and Energy Studies, University of Johannesburg, South Africa*

C.J. Kelso *Department of Geography, Environmental Management and Energy Studies, University of Johannesburg, South Africa*

H.J. Annegarn *Department of Geography, Environmental Management and Energy Studies, University of Johannesburg, South Africa*

Abstract

The Minerals Act 50 of 1991 set a precedent in South Africa for mining and environmental legislation as it considered all factors pertaining to mining, specifically with respect to mine rehabilitation and closure. The Minerals Act No. 50 of 1991 was replaced by the Mineral and Petroleum Resource Development Act (MPRDA) No. 28 of 2002, which included far more stringent conditions related to mine closure. In addition, as of 2010, mining became a listed activity and the environmental provisions of the National Environmental Management Act (NEMA) 107 of 1998 now also apply to mine closure certification resulting in mines having to comply with stipulations of this act too before qualifying for closure. No mine closure certificate has ever been issued under either the Minerals Act of 1991 or the Mineral and Petroleum Resource Development Act of 2002. The authorities are reluctant to accept responsibility for granting closure, without being persuaded beyond doubt that all risks (environmental, social, health and safety) have been adequately and sustainably dealt with. In this paper, the authors use a case study and interview approach to critically examine the mine closure procedure of the De Beers Oaks Diamond Mine, Limpopo, as it is anticipated that this mine will be the first in South Africa to acquire a full mine closure certificate, as it has stringently followed all relevant legislation and policy directives, and openly communicated with relevant departments at all levels of government. The objectives of the paper are to stipulate the legal requirements for mine closure certification in South Africa and to critically analyse the mine closure procedures that were followed in the closure plan for the Oaks Diamond Mine. Specific challenges and actions taken to implement the closure plan are highlighted. Results indicate that the most effective way of acquiring a mine closure certificate is to integrate legislation with procedures throughout the life cycle of a mine.

1 Introduction

In South Africa, mining contributes significantly to the economy, generates economic growth and employment opportunities. For example, in 2010 mining and quarrying contributed 5.5% of the South African GDP, which is far greater than the 2.2% contribution of agriculture, forestry and fishing, but less than the 15.3% contributed by manufacturing (StatsSA, 2011). However, beyond its significant economic benefits, mining has also impacted negatively on the environment, producing impacts such as land surface subsidence, air and water pollution, and disruption in drainage systems (Cao, 2007). Thus it has created a significant negative economic, social and environmental legacy in South Africa (Swart, 2003). Development priorities in South Africa are currently focussed on addressing the inequalities created under apartheid policies, which have led to an emphasis on "*black economic empowerment, bridging the historical wealth divide and providing access to land*" (Limpitlaw, 2004). Limpitlaw (2004) predicts that mining in South Africa will continue regardless of the fact that associated environmental losses may outweigh economic benefits because of its economic importance.

More recent South African mining legislation has shifted the responsibility and the cost of mitigating all negative environmental impacts of the mining process onto mining companies. This has been done through the establishment of stringent mine closure regulations, as part of the Mineral and Petroleum Resource Development Act 28 (MPRDA) in 2002. All mines now have to acquire a mine closure certificate in order to effectively close a mine. Mines should also comply with sections of the National Environmental Management Act (NEMA) 107 of 1998 and the National Water Act 36 (NWA) of 1998, in order for the closure certificate to be obtained. However, no mine in South Africa has yet been able to acquire a closure certificate as required by the Department of Mineral Resources, or its predecessor the Department of Minerals and Energy. This paper seeks to highlight the best possible mine closure practices through the review of all applicable legislation and a critical examination of the closure procedure of the Oaks Diamond Mine (Oaks Mine) owned by De Beers Consolidated Mines Ltd (henceforth known as De Beers), anticipated to be the first mine to obtain a closure certificate, as a possible model for acquiring mine closure certification.

2 Location and description of the Oaks Mine

The Oaks Mine is located in the Lephalale District Municipality, Limpopo Province, South Africa. Swartwater, the nearest town, is located 20 km north of the Oaks Mine, and Mokopane is approximately 175 km to the southeast. The property is made up of three farms and covers an area of 5,323 ha. The mine and its operations only utilised 63 ha (1.2%) of the property. The property has a flat topography with a slope gradient of approximately 1:100. The mine is located in the A50J Quaternary catchment area. The climate of the region where Oaks Mine is located has a mean annual precipitation of 380 mm and a mean annual runoff of only 4 mm, thus depicting an arid climate. There are no major perennial rivers on the property and the drainage is towards the Limpopo River from southeast to northwest. The drainage lines originate from the calcrete ridges east of the property which have an altitude that ranges from 950 to 1,100 m above sea level (masl). The mean altitude at the mine is 900 masl (ERM, 2008).

The Oaks Mine started operations in 1998 and ceased all mining activities in 2008. The mine utilised an open cast method to extract the Kimberlite ore from the pit (Mban, 2008). This ore was transported to the processing plant. A crushing, washing and screening process was then used to extract the diamonds from the ore. The waste rock, coarse residue deposit, and fine residue deposit was then transported to the Waste Rock Dump and Mine Residue Disposal Complex (MRDC).

Inevitably this ore reserve became depleted and as a result closure was initiated. In 2008 when operations ceased, a total of approximately 2,400,000 tons of Kimberlite ore had been extracted and treated. All restorable and non-restorable land had to be either reclaimed or rehabilitated in order to achieve effective closure. Restorable land such as the process plant, mine infrastructure, and general infrastructure had to be reclaimed whereas non-restorable land such as the pit, waste rock dump, and MRDC had to be rehabilitated as far as possible (DME, 2002; ERM, 2008).

3 Methods to acquire closure

In order to acquire closure all South African legislation relating to the closure process needs to be examined and implemented. This legislation includes the MPRDA, NEMA, and the NWA. In addition, various mine closure toolkits have been developed to aid in the processes of closure. One example is the International Council on Mining and Metals (ICMM) toolkit, which is intended to be used as a guide by mining companies to plan for effective closure. De Beers, however, did not utilise this toolkit as it is a planning tool which enables mining companies to develop the different plans (conceptual, operational, and decommissioning plans) required for closure and does not provide direct instructions on the methods, processes, and technologies needed for a specific mining process. Therefore, the Oaks Mine used the Anglo American plc (AAplc) toolbox (2007) which is more attuned to South African legislation and provides a ‘step by step’ procedure for acquiring closure. It stringently evaluates, assesses, and determines the methods, processes and technologies required by the mine to reach optimal closure.

3.1 Legal requirements

Legislation was stringently followed by De Beers during the closure process of the Oaks Mine. All applicable legislation was examined and adhered to. For example: Section 43 of the MPRDA; Section 24 and 28 of NEMA; and Section 33 of the Air Quality Act 39 (AQA) of 2004. A legal review was drawn up in 2008 to provide stakeholders and government with proof that legislation was consulted and adhered to during the closure of the Oaks Mine (Lala, 2008). With regards to the legislation consulted by De Beers, it should be noted that this legislation should be utilised in the closure of other mines in South Africa; however, in other cases additional legislation may also apply depending on the specific nature of the mine and its processing activities. Future changes and additions in the applicable laws will also need to be taken into account.

3.2 Mineral and Petroleum Resources Development Act 28 of 2002

The MPRDA differentiates between an old mining right issued in terms of the Mineral Act 50 of 1991 and a mining right granted in terms of the MPRDA. The act stipulated the procedures that must be followed and the requirements that must be met by the holder of the mining right. Because the Oaks Mine was started in 1998, it commenced operations under an old mining right, therefore the procedures and requirements for closure had to be altered in order to apply for a closure certificate in terms of Section 43 of the MPRDA.

In terms of Section 43(1), responsibility for any environmental liability, pollution, ecological degradation and the management thereof remains with the mining rights holder until a closure certificate has been issued. As the holder of the mining right, De Beers is responsible for the management of impacts associated with closure until a closure certificate is awarded. Under Section 43(3) of the MPRDA, "*the holder of a mining right must apply for a closure certificate upon: (b) the termination of mining operations; and (d) the completion of the prescribed closure plan*" (DME, 2002). This application must be submitted once the closure plan has been drafted, not upon being fully implemented. Submission to the Regional Manager must take place within 180 days of termination and must include the prescribed environmental risk report. This report must include (among other things) a detailed screening level environmental risk assessment and second level assessment. A risk report was compiled for the Oaks Mine and included in the final closure plan which was submitted to the DMR. Section 43(5) states that "*the Chief Inspector (appointed by the Minister), and the Department of Water Affairs and Forestry must have confirmed, in writing, that provisions pertaining to Health and Safety and management of potential pollution to water have been addressed before a closure certificate will be issued*" (DME, 2002). This confirmation by the Department of Water Affairs is still pending as is the closure certificate.

Prior to the issuing of a closure certificate, the holder of a mining right must give effect to the general objectives of the integrated environmental management requirements set out in Chapter 5 of NEMA; "*must consider, investigate, assess and communicate the environmental impacts as stated in Section 24(7) of NEMA; must manage all environmental impacts in accordance with the Environmental Management Plan (EMP); must as far as possible rehabilitate the environment to its natural or predetermined state or land use which conforms to the principles of sustainable development; and is responsible for any environmental damage, pollution or ecological degradation that exists and which may occur inside and outside the boundaries of the area*" (DME, 2002). De Beers has complied with all of these requirements by developing and implementing an EMP throughout the life of the mine.

3.3 National Water Act 36 of 1998

Regarding water management two regulations were predominantly utilised by De Beers. The first was Water Regulation 4(c) which prohibits a person in control of a mine from placing or disposing of any residue or substance which causes or is likely to cause pollution of a water resource; in the working of any underground or opencast mine excavation, prospecting diggings, pit or any other excavations. The second was Water Regulation 9 which provides that "*…any person in control of a mine must: (a) upon permanent cessation of operations, ensure that all pollution control measures have been designed, modified, constructed and maintained to comply with regulations; (b) ensure that the affected or altered in-stream and riparian habitat of any water resource is remedied to comply with regulations; and (c) the minister may request copies of any surface or underground plans as required in terms of the Mineral Act, 1991 on permanent cessation of the mine*" (DWAF, 1998).

These regulations were utilised by De Beers because "*the land owners or persons controlling, occupying or using land on which any activity or process was performed or undertaken which causes, has caused or is likely to cause pollution of a water resource must take all reasonable steps to prevent any such pollution from occurring, continuing or recurring*" (DWAF, 2008). Therefore De Beers needed to ensure that unpolluted water was not contaminated by polluted water, and was obligated to not dispose of any residue or substance that was/is likely to cause pollution of a water resource (Lala, 2008). This was achieved through the effective design of a pit to capture all polluted groundwater (discussed further in Section 4.1).

3.3.1 National Environmental Management Act 107 OF 1998

The MPRDA requires the use of NEMA to fully satisfy all closure requirements. Sections 24 and 28 are the most important elements of NEMA which were utilised by De Beers. Section 24(4) determines "*…the procedures for investigation, assessing and communicating the potential impact of activities. The procedure requires an investigation of: (a) the environment significantly affected by the proposed activity and alternatives thereof; (b) the possible impacts on the environment and assessment of the significance thereof; (c) mitigation measures; and (d) public consultation and information presented to stakeholders*" (DEAT, 1998). De Beers achieved these requirements by developing and implementing an EMP. However in terms of Section 28 of NEMA, a duty of care is imposed on all persons to remediate environmental damage (DEAT, 1998). Therefore De Beers was obligated not just to comply with requirements of the EMP as stipulated in NEMA and the MPRDA, but were responsible for the care and maintenance of environmental damages that occurred prior to and post mining operations. This was achieved through regular monitoring and the development of effective risk assessment strategies (discussed further in Section 4).

3.3.2 National Environmental Management Act: Air Quality Act, 2004

Air quality at the Oaks Mine was not significantly affected because closure operations were minor in comparison to other mines, thus generating minimal amounts of dust. However, legislative requirements still needed to be complied with. Therefore Section 33 of the AQA was examined in order to achieve full closure. This section states that if a mine is likely to cease operations within a period of five years, the owner of that mine must "*…notify the Minister in writing of: (a) the cessation of mining activities; and (b) the plans that are in place or in contemplation for the rehabilitation of the area and the prevention of pollution of the atmosphere by dust after those operations have stopped*" (DEAT, 2004). Therefore De Beers submitted notification to the Minister of Environmental Affairs and Tourism of the cessation of operations. This notice informed the Minister of the plans in place for the rehabilitation of the area and the prevention of pollution of the atmosphere by dust generation.

3.3.3 Anglo American plc toolbox

Anglo American plc developed a toolbox for mine closure in 2007 that is copyright protected, but as a shareholder, this could be utilised by De Beers (Botha and Coombes, 2007). The aim of the toolbox is to expand the focus from rehabilitation and physical closure to planning for sustainability beyond mine closure. The intent of the toolbox is to design and plan for closure in the pre-mining phase and to integrate the closure planning process to be part of the operational activities and procedures, that will then facilitate successful closure at the end of the life of mine. The AAplc toolbox suited the needs of De Beers because it effectively addressed the stringent challenges of closure posed by the South African legislation and regulations outlined above. The toolbox quantifies the different closure aspects in a logical and standardised way in order to ensure adequate financial provisions are available for closure. It also provides a framework for decision-making and implementation of closure criteria (Mban, 2008).

The AAplc toolbox is a risk-based approach that incorporates three tool sets (Figure 1), which ensure that the physical, bio-physical and socio-economic aspects of closure are integrated into the final closure procedure (Botha and Coombes, 2007). Tool 1 uses strategic planning to develop closure targets and goals as determined by the existing social, environmental and economic baselines. According to Botha and Coombes (2007) this strategic planning is used as a sustainable development planning guideline to:

- Understand the current environment.
- Determine the future post-closure outcome.
- Determine the economic and land use alternatives.
- Effectively consult and engage with stakeholders.
- Ensure there is provision for institutional support.

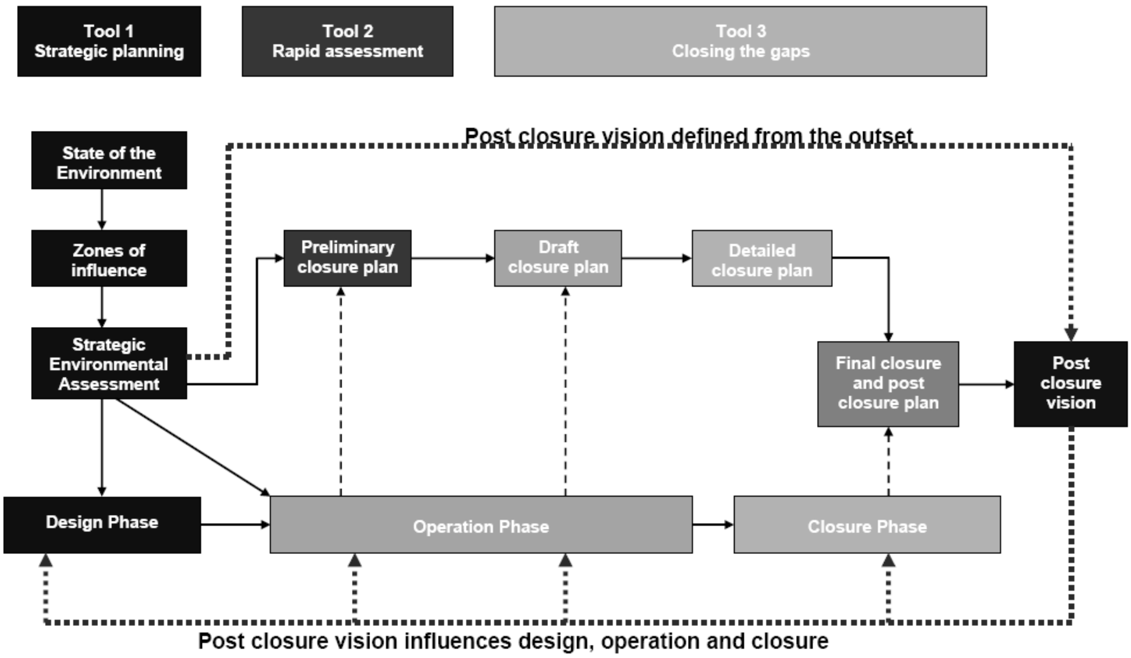

Figure 1 Tools to aid closure (Botha and Coombes, 2007)

Tool 2 rapidly assesses the existing mine closure plan in order to determine gaps in knowledge, and identifies the level of detail still needed to be included in the closure plan, comparative to the current time constraints. An assessment was carried out in order to ensure that all objectives were being met and that effective closure was taking place. This rapid assessment assesses: physical closure criteria; bio-physical and rehabilitation criteria; stakeholder engagement and social closure criteria; closure cost estimates; programme and cash flow criteria; and the integrated closure plan. Tool 3 determines the best ways to fill in the gaps in a closure plan by selecting the best approaches, technologies and resources (Mban, 2008).

4 Key closure procedures for the Oaks Mine

4.1 Planning for closure

Planning is one of the most vital activities as this process ensures that effective implementation of the closure procedures occurs. The way in which closure planning is prepared can have major positive effects on the duration and magnitude of impacts over the life of mine (Peck and Sinding, 2009). From a physical and bio-physical closure perspective, the Oaks Mine was planned with closure in mind for example the MRDC was progressively rehabilitated, and the pit was designed in such a way that any contaminated groundwater would drain and collect in it. The pit has impermeable rock walls thus ensuring that any contaminated groundwater does not access the whole groundwater system.

Despite planning for closure, the conceptual planning process was inadequately initiated and followed. The final closure plan had to be accelerated in order to close within the given time constraints. Thus, as a result, the final closure plan was only started after closure procedures had already begun. Furthermore, stakeholder engagement issues arose as a result of the consultation process following the commencement of closure procedures. Rushing the planning process caused some problems which could have been avoided such as stakeholder disillusionment and loss in terms of consultation outcomes.

4.2 Physical and bio-physical closure

According to ERM (2008), the main objective of De Beers was to complete the closure and rehabilitation of the Oaks Mine within a year of mine closure. This time frame was not realistic as a minimum of two growing seasons were necessary for effective rehabilitation, and should rather have been anticipated at the outset of closure planning. Even though the timeline was extended to the beginning of 2011, all the forms and applications were submitted to the DME in 2009 so that the closure approval process and issuing of a closure certificate could commence. De Beers's main objective in terms of closure was to strive toward achieving closure that would be wholly acceptable and serve as a benchmark for other De Beers mines (ERM, 2008). Therefore, the Oaks Mine served as a reference site which provided a credible site for rehabilitation and provided extensive information on the way in which the rehabilitation progressed and was achieved (Tongway, 2008).

The objectives developed by De Beers for physical and bio-physical closure were divided into two sections. Firstly, the reclamation objectives for restorable land which include the provisos that: the land must be left in a safe condition; the land must be chemically and physically stable; waste will be managed responsibly and in line with legislation; all infrastructure not required for post-closure land use will be removed; a sustainable growth medium and indigenous vegetation layer must be established; and the land must be restored to a state that is suitable for wild life. Secondly, the rehabilitation objectives for non-restorable land which include the provisos that: the land must be left in a safe condition; the land must be chemically and physically stable; waste will be managed responsibly and in line with legislation; and a suitable growth medium and indigenous vegetation layer must be established (ERM, 2008).

4.2.1 Restorable land

The chemicals (ferrosilicon and flocculent) used in the crushing, washing and screening process are inert and thus will not negatively affect the environment if released. Ferrosilicon was recovered and recycled during operation; the lost fraction was contained within the MRDC, thus ensuring that the chemical was never released into the environment. The flocculent used is fully bio-degradable and degrades naturally in the fine tailings deposited on the MRDC. The mine infrastructure included workshop and office buildings. The workshop was used for the maintenance and washing of earth moving equipment. The oils and grease used were stored in drums and then removed by a contractor to be recycled. Washbay hydrocarbons were trapped in Drizit units and removed in similar fashion. This method ensured that the local soil did not become contaminated with oil and grease thus indicating that the protection of the environment is an important concern of De Beers (ERM, 2008).

General infrastructure on the mine site included sewage handling infrastructure, waste disposal facilities, roads, water infrastructure, and borrow pits. A series of pipelines were used to transport sewage to the sewage handling facilities which comprised of 43 septic tanks and French drains. The sewage was contained in these facilities for less than 90 days and then transported to a permitted waste site in Polokwane. Industrial waste generated was recovered for reuse and recycling. "*All salvageable waste generated by the mining and recovery operations was inspected by the Engineering Department, after which all useable material was taken back into service, and all scrap metal which could not be reused was sold by tender to scrap merchants*" (ERM, 2008). This shows that De Beers is committed to the 'reduce, reuse and recycle' (three R's) policy. Three gravel roads are used to access the mining area. The roads were maintained using watering and bio-degradable coating mechanisms. These roads have been retained to act as fire breaks as well as for access to the property and mine site by monitoring personnel. Water was pumped from boreholes via water supply pipelines and then stored in two storage dams and used for domestic and industrial use. There are two borrow pits on-site. The first was a pre-existing borrow pit dug by the Department of Roads to construct the gravel road leading to Swartwater and the second was dug by De Beers and used by the mine. It should be noted that all infrastructure to be used by the new land owner will remain on-site. This infrastructure includes the roads, water pipelines and the potable water tank, sewage facilities, and the borrow pit developed by the Department of Roads.

However, the areas and infrastructure not being used by the new land owner (plant, mining and general infrastructure) were rehabilitated in such a way that minimal or no subsidence and erosion will occur. For instance, all the building rubble was removed from the area prior to ripping and seeding of the area. Prior to the capping and revegetation of a part of the waste rock dump, broken concrete was deposited in the dump, after all metal reinforcing had been removed. This reinforcing was removed from site and transported to scrap dealers. All hazardous waste, including soils contaminated by hydrocarbons, was contained and disposed of at a licensed waste site in Rosslyn, Pretoria (ERM, 2008).

The plant equipment and infrastructure was auctioned off and removed from the area. The concrete in the plant area was a concern as the blasting and transporting of it would not be cost-effective. As a result, ERM

(2008) proposed that the concrete be covered with approximately 1 m of waste rock and 300 mm of topsoil, and then ameliorated and seeded. This proposal was used as it does not affect land availability as the plant area was less than 0.05% of the total 5,300 ha. The concrete is also inert and does not pose a threat to the environment. Once this was achieved the area was rehabilitated to match the surrounding topographical profile so that it is presently indistinguishable from the surrounding terrain.

4.2.2 Non-restorable land

The pit surface area is 10.6 ha, which is a much smaller surface area in comparison to other mines such as the Venetia Mine that has a pit area of 345 ha. The depth of the pit is 113 m with a slope of 50° and 10 m high benches. The large open pit will remain since back filling is not a viable option. One of the options considered (to reduce the moderate slope failure risk) when planning pit closure was to step back the upper benches to a lower angle. However this decision was not taken as it would have been a costly exercise and the steep drop into the pit would not have been avoided it would simply occur at a deeper level.

Pit closure has never taken place in South Africa and is indeed rare in the rest of the world. The reason for this is that for a vertical pipe deposit backfilling has to take place entirely at the end of the mining life cycle. Replacing years of mine waste rock is very costly and it would render the mining of pipe deposits financially unviable. Backfilling is viable for a shallow tabular type deposit mined in strips, where backfilling can take place during the life cycle of a mine. Despite this knowledge the DMR closure guidelines recommend that backfilling should be planned for and carried out however in practice this is not viable. Backfilling of the Oaks mine was impossible through the life of the mine and would have been a closure activity lasting years (10 years of mining waste taken back into the pit). As a result pit closure at the Oaks Mine may still be a concern for the DMR as there is a danger that people will gain access to and illegally mine the pit. If access is gained there is a high safety risk.

Since backfilling was not feasible, the following alternative safety procedures have been implemented. A safety zone was established and a 2.4 m high game fence has been erected to prevent access to the pit area. The purpose of the safety zone is to ensure that once the pit walls have failed naturally to get to the break-back zone, the pit will be stable. To ensure that no illegal mining occurred in the pit, blasting of the bottom benches and ramp was done to create a 3 to 5 m thick rock layer covering the Kimberlite ore. This is now already covered by around 15 m of water. The water level in the remaining pit is expected to rise to the level of the water table, namely 45 m below surface. Though storm water runoff into the pit would be minimal given the low precipitation rate, nevertheless a berm of 700 m long and 0.5 m high was constructed on the eastern side of the pit to prevent storm water runoff entering the pit. On completion of all these procedures, the area was rehabilitated by amelioration of the soil and covering the berm with vegetation.

The waste rock dump and MRDC were designed with closure and full rehabilitation in mind. Some of the waste rock was used in the construction of the MRDC's paddock walls reducing the amount of waste rock present on the dump. The waste rock dump is adjacent to the MRDC, thus lowering waste rock transportation costs. The MRDC is made up of a series of paddocks that store coarse and fine residue. The MRDC has an area of 48.9 ha with three fine residue paddocks and one coarse residue paddock. Originally the slopes of the MRDC were between 34 and 36° but during rehabilitation they were reduced to 18° to prevent soil erosion and strengthen slope stability. In addition, stormwater catchment berms were constructed on all slopes to slow/prevent run-off. This indicates that the MRDC was progressively rehabilitated, and that the slope stability and water flow was taken into consideration.

A topsoil layer has been established on the waste rock dump and MRDC to encourage plant growth and reduce the risk of soil erosion. The topsoil had to be ameliorated to ensure that it was chemically neutral and suitable for vegetation growth. Therefore, Gypsum, organic and inorganic (Nitrogen, Phosphorus, and Potassium) material were added to the soil. A sustainable vegetation cover was then established on these facilities to ensure that soil erosion did not occur under grazing conditions and that a minimum of a 40% grass cover was established on the slopes. To obtain a 40% grass cover, the seeds of perennial grass species such as Blue Buffalo Grass (*Cenchrus ciliaris*), Guinea Grass (*Panicum maximum*), Finger Grass (*Digitaria eriantha*), and Wool Grass (*Anthephora pubescens*) were mixed, coated, and incorporated into the surface soil. These species were utilised because they are indigenous to South Africa and are most commonly found in semi-arid areas such as the Limpopo Province. Once this was achieved, the species growth has been monitored bi-annually for three growing seasons by an external consultant (Prof. Faan van Wyk) and thus far the results have indicated a good re-establishment of vegetation cover, both annuals and perennials. In addition, woody species are establishing as well.

4.3 Stakeholder engagement and socio-economic closure

Because the Oaks Mine closed in 2008, De Beers did not have to convert its mining right to the new order mining right stipulated by the MPRDA, as a result a social and labour plan (SLP) was not developed (Mban, 2008). Without an SLP, De Beers could not effectively determine the social impacts created by closure. Thus the preliminary socio-economic assessment was utilised which provided qualitative and quantitative evidence to stakeholders and demonstrated the effects closure would have on the community and other stakeholders. These effects, however, were not fully assessed because a social impact assessment was not conducted. Nevertheless, a stakeholder engagement programme was undertaken under the initiative of De Beers that included consultation with all stakeholders, such as the labour-sending communities, surrounding property owners, government, and suppliers. The consultations discussed closure assumptions, alternative land uses and the community's post-closure viability. According to ERM (2008) the objectives of the stakeholder engagement programme were to:

- Confirm the final closure criteria and other related requirements. The outcomes were included in the mine closure solutions.
- Obtain general agreement on the final closure plan.
- Review and change the closure criteria, based on the stakeholder engagement outcomes, to reflect the socio-economic costs.

Stakeholder engagement resulted in the establishment of objectives for social closure. These objectives included: the redeployment of all permanent staff; staff that could not be redeployed would be reskilled; support would be given to on-site service provider employees; and all potential support and ties to the host and labour-sending community would be noted, mitigated and managed. These objectives should, however, have been drawn up in the design and construction phases of the mine which would have given government and stakeholders ten years to consider the objectives and confirm them. Therefore, this would have ensured that all stakeholders were involved in the closure planning phase and thus would have allowed them to influence the final closure plan. As a result, there would not have been limited stakeholder engagement in terms of post-closure goals (Mban, 2008). In future mining contexts these requirements should be dealt with under a social and labour plan.

Stakeholder and government engagement had to run parallel with the upgrading of the conceptual closure plan to the final closure plan. Therefore resulting in some stakeholders feeling dissatisfied with the consultation outcomes. Even though the consultation programme was not as effective as anticipated, De Beers did establish numerous community development projects to improve the community's economic and social status. For example De Beers purchased farming equipment, provided marketing knowledge and techniques to enable the local community to effectively operate a restored processing plant, and renovated and provided equipment for two day care centres and three schools. Consultation with government was done effectively because government was engaged early and were invited on numerous site visits to ensure that they were fully aware of the mine closure approach utilised and thus able to determine their responses to the approach and criteria needed for closure (Mban, 2008).

4.3.1 Post-closure land use

The pre-mining land use was commercial beef production. De Beers considered this land use to be environmentally unsustainable for post-closure land use because of the risk of over-grazing which would damage the rehabilitated site and thus De Beers would be liable to rehabilitate the area once again. It was decided through various consultations with stakeholders that the most suitable post-closure land use would be conservation and game farming. The area will, therefore, be preserved and the rehabilitated environment not severely disturbed by commercial and human activities. This indicates that De Beers took great care to ensure that the environment would be preserved and that the newly established ecosystem would be sustained.

The final closure plan states that prior to the sale of the land, De Beers would manage and monitor the area in order to ensure that the vegetation was growing effectively and the biodiversity continued to strengthen. On this particular mine, the actual mining area is small in comparison to other mines, with most of the property undisturbed by mining activities and as a result is in pristine condition, thus resulting in a small monitoring area. Monitoring of the site includes identifying and eradicating alien invasive species; biannual surveying of the area until fully restored; and evaluating the populations of faunal species to ensure that these species do not exceed the sites carrying capacity. The good condition of the farmland surrounding the mine is largely due to the removal of cattle in the early days of the mine which were replaced with game on a controlled basis.

4.3.2 Closure costs

Controlling costs is very important for achieving closure and should be applied to all phases of life of the mine (Garcia, 2008). In the case of the Oaks Mine, some of the closure costs were absorbed into the operational costs as progressive rehabilitation methods were utilised. There were, however, outstanding rehabilitation costs realised once closure commenced and the final closure plan was drawn up. These costs were far greater than originally anticipated in the conceptual closure plan because rehabilitation interventions and social costs that had to be included in the final costing of closure. The additional closure costs were borne by the parent company (Mban, 2008). This could have been prevented if estimate closure costs developed in the conceptual phase were accurate. Therefore De Beers did not determine the actual costs involved in closure effectively and this led to outstanding rehabilitation costs which should and could have been prevented. De Beers was fortunate that it was able to internalise the additional costs. If the mine was run by a smaller company, these additional costs could not be absorbed into the company and thus as a result effective closure would not have been achieved. However, the costs borne by De Beers were partially neutralised from the sale of all metal to scrap merchants and will be further neutralised by the sale of the property. This indicates the importance in developing effective strategies for costing the closure process.

5 Conclusions

The most effective way of acquiring a mine closure certificate is to integrate legislation with procedures throughout the life cycle of a mine. In the case of the Oaks Mine, legislation was integrated with the AAplc toolbox establishing an effective way for acquiring closure. Even though planning was accelerated towards the end of the life of mine, all physical and biophysical objectives were met. All reclamation objectives were met and done in an effective manner, resulting in the area resembling that of its surroundings. Most of the rehabilitation objectives were also met but some risks were still present, for example the possible pit wall failure and alternatives to backfilling of the pit having to be sought. De Beers addressed these issues by developing a safety zone and constructing a game fence surrounding the pit.

In terms of the socio-economic closure parameters, De Beers did cater for all employees and ensured that they had employment after closure. De Beers also ensured that the community was socially and economically uplifted by providing the necessary tools to manage and operate farms and mines as well as renovating and rebuilding schools and day care centres in the area. Government was also consulted constantly, in order to establish a good relationship and to fulfil all legal closure requirements, thus strengthening the ability of the Oaks Mine to acquire a closure certificate. Even though some stakeholders were dissatisfied with the outcomes, De Beers did comply with legislation and achieved all social goals developed.

In conclusion, it is anticipated that the Oaks Mine will be the first mine in South Africa to acquire a full closure certificate. With the exception of one or two steps that needed to be adapted during the closure process, most of the processes and many of the lessons could be used as a benchmark for all other mines wishing to achieve closure. The main lesson learnt is that one should design, plan and operate a mine understanding the closure vision and final land use plan and not see closure planning as a event at the end of the life of mine that will be addressed in the final five year of operating life. Even though the Oaks Mine did experience some problems during the closure process, closure was still effective and resulted in a restored natural and social environment with minimal impacts. Thus achieving the company’s main objective and fulfilling the main legal closure requirements, which was to avert or minimise negative environmental impacts and to create a self-regulating natural ecosystem.

Acknowledgements

The authors thank De Beers and Anglo American for providing extensive information on the Oaks Mine, its closure procedures, and the AAplc toolbox. A special thanks to Chris Sivertsen, Ruldoph Botha, Chantelle Du Plessis, Mphoya Thobela, and Philadelphia Lala for being part of the interview process and providing all relevant information for the completion of this paper.

References

Botha, P.R. and Coombes, P. (2007) Anglo American Mine Closure Toolbox Version 1, Compiled for Anglo American plc, by Anglo Technical Division, Johannesburg.

Cao, X. (2007) Regulating mine land reclamation in developing countries: the case of China, Land Use Policy, Elsevier, Vol. 24, July 2007, pp. 472–483.

DEAT (1998) Department of Environmental Affairs and Tourism. National Environmental Management Act, Government Gazette, Vol. 401, No. 19519.

DEAT (2004) Department of Environmental Affairs and Tourism. National Environmental Management: Air Quality Act, Government Gazette, Vol. 476, No. 27381.

DME (2002) Department of Minerals and Energy. Minerals and Petroleum Resources Development Act, Government Gazette, Vol. 448, No. 23922.

DWAF (1998) Department of Water Affairs and Forestry. National Water Act, Government Gazette, Vol. 398, No. 19182.

ERM (2008) Environmental Resource Management. Final Closure Plan (July), The Oaks Mine, report prepared for De Beers Consolidated Mines, Johannesburg (confidential, cited with permission).

Garcia, D.H. (2008) Overview of international mine closure guidelines, in International Professional Geology Conference, 20–24 September, Flagstaff, USA, American Institute of Professional Geologist, Flagstaff, pp. 1–9.

Lala, M.P. (2008) Statutory obligations with regards to the closure of the Oaks Diamond Mine (January, 2008), created for De Beers Consolidated Mines, Johannesburg (confidential, cited with permission).

Limpitlaw, D. (2004) Mine closure as a framework for sustainable development, in Proceedings Sustainable Development Practices on Mine Sites – Tools and Techniques, 8–10 March, Johannesburg, South Africa, University of the Witwatersrand, Johannesburg, pp. 1–11.

Mban, M. (2008) Planning for mine closure at De Beers Consolidated Mines – an integrated approach, Proceedings Third International Seminar on Mine Closure (Mine Closure 2008), A.B. Fourie and M. Tibbett, I.M. Weiersbye, P. Dye (eds), 14–17 October 2008, Johannesburg, South Africa, Australian Centre for Geomechanics, Perth, pp. 21–26.

Peck, P. and Sinding, K. (2009) Financial assurance and mine closure: stakeholder expectations and effects on operating decisions, Resources Policy, Elsevier, Vol. 34, March 2009, pp. 227–233.

StatsSA (2011) Statistics South Africa. Statistical Release P0441, Gross Domestic Product, Fourth Quarter 2010, Pretoria, p. 10.

Swart, E. (2003) The South African legislative framework for mine closure, The Journal of the South African Institute of Mining and Metallurgy, Vol. 103, pp. 489–492.

Tongway, D.J. (2008) Facilitating mine closure with a continuous analysis and review system, Proceedings Third International Seminar on Mine Closure (Mine Closure 2008), A.B. Fourie and M. Tibbett, I.M. Weiersbye, P. Dye (eds), 14–17 October 2008, Johannesburg, South Africa, Australian Centre for Geomechanics, Perth, pp. 195–206.