A CRITICAL ANALYSIS OF THE MINE CLOSURE PROCESS AS FOLLOWED BY THE DE BEERS OAKS DIAMOND MINE, LIMPOPO PROVINCE, SOUTH AFRICA

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A minor-dissertation submitted in partial fulfillment of the requirements for the degree Master of Arts in Environmental Management in the Faculty of Humanities at the University of Johannesburg.  

December 2011
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ABSTRACT

The Minerals Act No. 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) No. 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 certificates have 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 have been adequately and sustainably dealt with. In this research, a case study and interview approach were used 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. The objectives of the research were to stipulate the legal requirements for mine closure certification in South Africa, identify the problems associated with institutional authorisation of closure certificates and to critically analyse the mine closure procedures that were followed in the closure plan for the Oaks Diamond Mine. Findings 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. 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 such as the Mine Residue Disposal Complex and waste rock dump was rehabilitated effectively. Some risks however are still present, such as the possible pit wall failure. These issues need to be rectified in order for the Department of Mineral Resources to issue a closure certificate. Most of the processes and many of the lessons learnt could be used as a benchmark for other mines wishing to achieve closure.
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<td>AQA</td>
<td>Air Quality Act</td>
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<td>AAplc</td>
<td>Anglo American plc</td>
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<td>DMR</td>
<td>Department of Mineral Resources</td>
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<td>DWEA</td>
<td>Department of Water and Environmental Affairs</td>
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<tr>
<td>DWA</td>
<td>Department of Water Affairs</td>
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<td>DWAF</td>
<td>Department of Water Affairs and Forestry</td>
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<td>EMP</td>
<td>Environmental Management Plan</td>
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<td>ERM</td>
<td>Environmental Resource Management (Pty) Ltd</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>I&amp;APs</td>
<td>Interested and Affected Parties</td>
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<td>ICMM</td>
<td>International Council of Mining and Metals</td>
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<td>LEDET</td>
<td>Limpopo Department of Economic Development, Environment and Tourism</td>
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<tr>
<td>masl</td>
<td>Meters above sea level</td>
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<tr>
<td>MRDC</td>
<td>Mine Residue Disposal Complex</td>
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<td>MPRDA</td>
<td>Mineral and Petroleum Resource Development Act</td>
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<td>NEMA</td>
<td>National Environmental Management Act</td>
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<td>NGO</td>
<td>Non-Governmental Organisation</td>
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<td>National Water Act</td>
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<td>RoD</td>
<td>Record of Decision</td>
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<td>SIA</td>
<td>Social Impact Assessment</td>
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<td>SDI</td>
<td>Social Development Initiative</td>
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<td>SLP</td>
<td>Social and Labour Plan</td>
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<td>Tailings Storage Facility</td>
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CHAPTER 1 INTRODUCTION

Globally the mining industry has a questionable environmental reputation due to the fact that historical mining operations have created severe negative impacts on the natural and social environments. Many mining operations have destroyed or altered whole ecosystems that may take decades or even millennia to fully recover (Cooke, 1999). This reputation is reinforced by abandoned mining operations and an absence of responsible mine closure (Garcia, 2008). Presently stricter global mine closure legislation is attempting to ensure that mining areas are restored to an optimum post-mining land use, such as agriculture (Limpitlaw, 2004).

In South Africa, mining contributes significantly to the generation of economic growth and employment. 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 (Statistics SA, 2011). However, beyond its significant economic benefits, mining has also impacted negatively on the environment, producing land surface subsidence, air and water pollution, and disruption in drainage systems (Cao, 2007). Thus it has created a significant negative social and environmental legacy in South Africa (Swart, 2003). Land affected by mining is approximately 180 000 ha which is a large surface area of South Africa as a result much of the national environment (natural and social) has been affected directly or indirectly by mining (Arendse & Wilkinson, 2002).

Trade-offs between environmental protection and developmental growth have been occurring for many years in South Africa and government consensus on development priorities has complicated these trade-offs. Development priorities in South Africa are currently focused 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: 8), and on job creation. As a result, it has been asserted that mining will continue regardless of the fact that environmental losses may outweigh economic benefits (Limpitlaw, 2004).

However, there has been an increased awareness that mine closure regulations need to be established, thus an increasing number of countries, including South Africa, have developed legislation and policies (Mineral and Petroleum Resource Development Act 28 of 2002) related to this. Internationally there is no agency that regulates mine closure, however certain financial institutions (World Bank) have adopted guidelines on closure to ensure fiscal safe banking. These guidelines are known as the Equator Principles, which require that the company conducts a social and environmental impact assessment, and hence identifies potential liabilities to the mining company (Garcia, 2008). Furthermore, the International Council on Mining & Metals (ICMM) has
established a toolkit which provides a step by step manual to achieve integrated mine closure. This toolkit is used as a planning aid that assists mining companies in the early development of a project and continues throughout the life cycle of the project (ICMM, 2008).

Before the 1970s, in South African legislation (Mines and Works Act 27 of 1956) the exploitation of minerals was more important than the conservation of the environment, which was, if at all, indirectly relevant (Wells et al., 2009). In 1977 the Mines and Works Act 27 of 1965 was amended to allow for regulations pertaining directly to the conservation of the environment during and post mining operations. This essentially was the first time the environment and rehabilitation thereof was incorporated into mining legislation (Wells et al., 2009).

The Minerals Act 50 of 1991 set a precedent in South Africa for mining and environmental legislation because it required a mining project proponent to consider all factors pertaining to mining to be addressed in the mine plan, covering the full cycle of exploration, mining and specifically rehabilitation. Even though there were drastic alterations made to mining and environmental legislation, they did not effectively and stringently address mine closure and the management thereof (Wells et al., 2009). Therefore, prior to the promulgation of the Mineral and Petroleum Resource Development Act (MPRDA) No. 28 of 2002 (DME, 2002), many mining companies in South Africa “...used irresponsible mining methods with no regard towards environmental rehabilitation; by leaving an area unrehabilitated prior to the them being liquidated or leaving the country” (Swart, 2003: 489).

Present South African legislation ensures that important requirements are met in the project decision-making process and forces mining companies to acquire closure certificates. Through the promulgation of the MPRDA in 2002 (DME, 2002), all mines have to acquire a mine closure certificate in order to effectively close all mining activities. With the aid of other crucial pieces of legislation, such as the National Environmental Management Act (NEMA) 107 of 1998 (DEAT, 1998) and National Water Act (NWA) 36 of 1998 (DWAF, 1998), closure certification can be obtained. While this process may be valuable for the protection of the environment and communities, it is difficult to achieve and requires substantial financial and logistical input from the mining company. Despite the establishment of these Acts, the government has not allocated sufficient resources to fund the legislative demands and enforcement requirements for mine closure. As a result, no mine in South Africa has as yet received a full mine closure certificate. The Oaks Diamond Mine (the identified study site) is in the process of applying for such a closure certificate and, should it be successful, will be the first fully closed mine since this legislation was put in place.
1.1 Research Justification

The research will contribute to an understanding of the best practice in acquiring a mine closure certificate in the South African context, specifically in the diamond mining industry. Very little research on best practice procedures for mine closure has been conducted in South Africa while the majority has been conducted in the international mine closure arena (Fourie & Tibbett, 2006; Fourie et al., 2007; Fourie et al., 2008; Fourie & Tibbett, 2009; Fourie et al., 2010). While some research has been conducted in the South African context by Limpitlaw (2004), Swart (2003), and Cooke and Limpitlaw (2003), the focus has been on mine closure and sustainable development.

This research, in its investigation of best practice in acquiring a mine closure certificate, will serve to present new and relevant information on these principles of successful mine closure. This in turn would allow for the future assessment of policy and may even serve as an aid in the establishment of a South African mine closure handbook.

This research will use a case study 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 because it has stringently followed all relevant legislation and openly communicated with relevant departments in all levels of government. The entire mine closure procedure will be critically analysed to determine the areas where the mine excelled and the areas that could have been approved upon. One such area is the pit that may be a concern for the Department of Mineral Resources (DMR) when issuing a closure certificate.

1.2 Research Problem

Rehabilitation practices during closure have greatly improved over the past five years. However no mine in South Africa has been able to acquire a closure certificate required by the Department of Mineral Resources. This research will identify the best possible mine closure practices through the examination 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) as a possible model for acquiring mine closure certification.

1.3 Research Objectives

- Critically analyse the mine closure procedures that were followed in the development of closure for the Oaks Diamond Mine;
- Identify the best possible mine closure practices thereof
- Evaluate the legal requirements for mine closure certification in South Africa
- Ascertain the problems associated with institutional authorisation of a closure certificate
1.4 Chapter Outlines

This research is divided into six chapters which review relevant literature, examine the environmental and social characteristics of the province and site, discuss the methods used to conduct this research, and analyse the procedures employed by De Beers. Chapter 1 introduces the research topic, research problem and objectives in order to guide the focus of the research. Chapter 2 examines all relevant literature pertaining to mine closure, South African legislation and best practice to determine research previously conducted. Chapter 3 presents the location of the Oaks Mine and discusses the bio-physical and socio-economic characteristics thereof. The Oaks Mine has a large environmental extent with a limited socio-economic context. Chapter 4 explains and discusses the methodology used for this research including a review of the case study approach in mine closure. Chapter 5 critically analyses and discusses the South African legislation, institutional issues in relation to the Oaks Mine closure procedures. This analysis will present the positive and negative procedures and discusses the issues that may prevent the Oaks Mine from obtaining a closure certificate. Chapter 6 concludes the findings established from the research in order to summarise the legislation employed by De Beers and the mine closure procedure developed for the Oaks Mine.

1.5 Conclusion

In conclusion the research will create an understanding of best practice needed to acquire a mine closure certificate in South Africa with a specific focus in the diamond mining industry of the country. The research will thus determine the best mine closure practices by examining all applicable legislation utilised in the closure of the Oaks Mine and present the institutional difficulties and obstacles to obtaining a closure certificate as well as critically analysing the closure procedures employed by De Beers. This research will therefore serve as a model for acquiring a mine closure certificate.
CHAPTER 2  LITERATURE REVIEW OF MINE CLOSURE, LEGISLATION AND BEST PRACTICE

2.1 Introduction

“Closure may not always occur as planned. The life span of an exploration project is dependent on the discoveries made, or not, and it is quite common of the life of a mine to be extended by the re-evaluation of existing reserves, changes in the commodity markets, new ore discoveries, etc. This type of change can be accommodated by revising the closure plan and reviewing and revising the financial surety. Alternatively, the life of an exploration or mining project may be curtailed unexpectedly because of falling metal prices, technical difficulties, or financial problems of the company. In these instances, if the company is not in a position financially to carry out the planned rehabilitation, it is essential that the regulatory authority has the funds available to commission the work themselves” (World Bank Group, 2008: 43).

It is very important to plan effectively for closure from the beginning of the exploration phase of the life cycle of the mine. This chapter will examine the numerous different aspects of mine closure and assess what procedures need to be considered when dealing with mine closure. The challenges faced by mining companies, communities and government are discussed. Finally, the best practice options for mine closure in South Africa are examined, as there is no existing generic guideline or handbook that can be used to establish an effective mine closure system in South Africa.

2.2 Mine Closure

According to the Australian and New Zealand Minerals and Energy Council (ANZMEC, 2000), mine closure seeks to avert or minimise negative residual environmental impacts associated with mining operations and to create a self-sustaining natural ecosystem or land use alternative, based on an agreed set of objectives. In essence, mine closure refers to the restoration of the land, both surface and subsurface, to an optimum state and quality. This is achieved through rehabilitation which is the primary focus in mine closure procedures and, according to ANZMEC (2000: v), is “...designed to restore the physical, chemical and biological quality or potential of air, land and water regimes disturbed by mining to a state acceptable to the regulators and to post-mining land users.” The core idea of rehabilitation is to identify the mined land potential and to choose technologies to transform this potential into a sustained capability (Morrey, 1999). Therefore once closure has begun, the mine owner(s) are legally and socially obligated to restore the land to a safe, stable and self-sustaining condition as agreed upon by all relevant authorities and stakeholders (Bentel, 2009).
This approach to mine closure has evolved over six decades following the evolution of key paradigms and developments in mine closure practices (Clark & Clark, 2005). The history of mine closure is characterised by an evolution in thinking towards a sustainable approach to mine closure. In the 1950s, there was a lack of concern in most countries regarding thorough mine closure. This, however, changed in the 1960s when comprehensive mine closure practices were established. In the 1970s and 1980s, there was an increasing concern over environmental issues that were related to mine closure such as acid mine drainage and mine rehabilitation. In the 1990s, sustainability and sustainable development became the dominant paradigm used in the protection of the environment and as a result, comprehensive mine closure procedure focused on sustainable economic, environmental and social development. This approach to mine closure has continued and strengthened in present day society (Clark & Clark, 2005).

In order to fully understand mine closure, the mine closure process needs to be understood. Lambeck (2009) states that mine closure needs to be incorporated into the whole life cycle of a mine in order to minimise the environmental and social impacts of the mine while still promoting economic development and growth. Therefore, various mining stages of development are incorporated in the mine closure process. These stages are as follows: exploration; concept and design; feasibility; construction; operation; closure; and decommissioning phases (Koontz, 2009).

During the exploration and feasibility phases (known as the conception phase) of a mining project, it is uncertain what kind of closure implications will be created and established. The level of certainty in these phases is dependent on whether the site is a greenfield or brownfield site (Koontz, 2009). A greenfield site is one that has not been altered by mining activities whereas a brownfield site is one that has been altered by mining activities, usually historic in nature. The closure implications are clarified by doing a due diligence which will evaluate the potential value of the site. This is based on existing information such as development potential, environmental sensitivity, and previous activities present on the site (Koontz, 2009).

How a mine ceases operations is vastly different from how it began, therefore it is important that all closure criteria set in the feasibility phase are flexible, allowing for adaptive measures to be taken during the project life cycle. The closure criteria and objectives set in this feasibility phase need to be accepted by government during the pre-development approval phase. Therefore getting government involved as early as possible in the closure process of the mine will allow for effective communication between government and the proponent (Koontz, 2009).

Even though the closure process should start from the conception phase and be continuous through to the operation phase, the main activities of closure normally take place during the closure or decommissioning phase (Otto, 2009). The objectives and criteria set in the conception and
operation phases are used in the decommissioning phase to determine what care and maintenance needs to take place (Bentel, 2009; Otto, 2009). This care and maintenance period is used to demonstrate that all closure objectives are being and will be maintained for an extensive (5-10 years) time period (Bentel, 2009). The authorities will then inspect the site and agree that all objectives have been met and that the natural and social environments have been maintained and even in some instances enhanced. Once this has occurred the proponent may relinquish the land to the next land owner or competent person who will accept any remaining liabilities (Bentel, 2009).

2.3 South African Legislation

The majority of mining countries, including South Africa, have developed comprehensive and detailed policies and legislation that provide, within national mining law, for effective mine closure (Clark & Clark, 2005). Most mining companies rely on government to develop clear and transparent frameworks for environmental management, mine closure, monitoring and enforcement (Cao, 2007). “Without a good legal framework for mine closure, mining companies do not know their obligations and potential future liabilities, and mining communities do not know their rights or responsibilities” (World Bank, 2002: 10). This section sets out the regulations, the legislation and the organisational requirements, policies, standards, and guidelines, that provide the legal frameworks under which closure planning, execution and relinquishment will be carried out. It should be noted that while this section discusses the legislation required for closure, details of relevant sections of the Acts and associated regulations made in the Acts are highlighted and presented in Chapter 5.

2.3.1 Historical Mining Legislation

Early Apartheid mining legislation was exploitive in nature and had no regard for environmental conservation. The main concern of this legislation was the loss incurred by landowners from mining. As a result environmental concerns did not feature in the legislation, which were only indirectly relevant. Environmental concerns were included in legislation for the first time in 1977. The Mines and Works Act 27 of 1956 was amended in order to allow the Minister of Mineral and Energy Affairs to create environmental conservation regulations for mining areas and works. The amendment to this Act created one of the most fundamental stipulations (the restoration of mining land) for environmental conservation in the mining industry of South Africa. There were, however, areas of the legislation that needed to be improved, specifically the lack of legislation pertaining to environmental management.

After 1990, revised mining legislation became highly focused on environmental management and the conservation of the environment during mining activities (Wells et al., 2009). The Minerals Act 50 of 1991 was one such Act that promoted environmental management. This Act was
developed by the De Klerk administration which sought to reform the exploitive mining legislation of the apartheid government (Leon & Wentzel, 2010). The Act commenced on 1 January 1992 with numerous new objectives which ensured: optimal mineral exploitation; labour health and safety; and orderly use and rehabilitation of the mining area during and post mining. Even though there were major advancements in mining legislation due to this Act, areas of the Act needed to be improved such as the development and implementation of environmental management plans (Wells et al., 2009).

It was therefore necessary that the new democratic South African Government replace the old mining legislation with legislation that included extensive environmental conservation regulations. Hence the Department of Minerals and Energy promulgated the MPRDA (Wells et al., 2009). This Act commenced on the 1 May 2004 and had adopted all environmental concerns and conservation principles. This Act obligated mineral rights holders to firstly convert their old mining rights to new order mining rights. Secondly it obligated mineral rights holders to develop and implement an environmental management plan, and finally to effectively consult with landowners and interested and affected parties. The MPRDA is a legislative framework that has allowed mining and the environment to sustainably coincide (Wells et al., 2009).

2.3.2 Current Legislation

In this section all applicable legislation pertaining to mine closure is examined. The Constitution; Mineral and Petroleum Resources Development Act (NMPDRA); National Environmental Management Act (NEMA); and National Water Act (NWA) formed the basis of this examination as these acts stipulate the regulations needed to close a mine in South Africa.

The current (and comprehensive) South African legislative framework for mine closure begins with the Constitution promulgated in 1996 which states in Section 24(a) that every person has the right to an environment that is not harmful to their health or wellbeing (Constitution, 1996). Section 24(b) states that everyone has the right to have the environment protected (Constitution, 2006). The Constitution promotes responsible mining by: giving the people a right to a safe and healthy environment; requiring government to develop the appropriate legislation to protect the environment; promoting accountability; and promoting co-operative governance (Cooke & Limpitlaw, 2003).

In response to the Constitution’s request for appropriate legislation, the national government developed the MPRDA, promulgated in 2002. This Act is the main regulator for mining in South Africa and it prescribes the requirements for: prospecting; construction and operation of mining activities; mine closure and the acquiring of a mine closure certificate (DME, 2002; van Eeden et al., 2009; van Tonder et al., 2009). This Act is important as it utilises a holistic cradle-to-grave
approach from prospecting to closure activities which promotes economic growth while considering social and environmental concerns (van Tonder et al., 2009). It is also important because it requires that mining companies have addressed all residual environmental impacts and that the post-closure land use conforms to the sustainable development principles before the mining site can be considered for closure (Haagner et al., 2008).

The MPRDA (DME, 2002) states that the mining company is responsible for the environmental liabilities and financial implications of the mine post-closure until such time as a closure certificate has been issued by the Department of Mineral Resources (DMR). Once a closure certificate has been issued, the environmental liabilities are transferred to either the new landowner or a competent person within the DMR (van Tonder et al., 2009). Furthermore Dixon (2003) states that no certificate may be issued unless the Chief Inspector or the Department of Water Affairs and Forestry (DWAF) has provided proof in writing that provisions such as pollution prevention and health and safety have been addressed. Serious implications arise from this because if the Chief Inspector declines to issue a favourable report, it is not possible to obtain a closure certificate and the mining company can be held responsible indefinitely for all environmental and financial liabilities that may incur. At present, the South African authorities are reluctant to accept the environmental and social responsibilities of a closed mine. These delays are preventing the issuing of closure certificates to mines, which results in environmental liabilities remaining on the sites long after closure (Cooke & Limpitlaw, 2003; Fourie & Brent, 2006).

The most important section of the MPRDA, deals specifically with mine closure, is Section 43 (Swart, 2003). This section provides a legal framework for the issuing of a closure certificate and the transfer of environmental liabilities (Swart, 2003). Section 43 also makes reference to closure planning (Cooke & Limpitlaw, 2003; Dixon, 2003). Supporting regulations in this section prescribe:

- Mine closure principles;
- Mine closure application;
- Application to transfer environmental liabilities;
- Details on the qualifications of the competent person receiving environmental liabilities;
- Environmental Risk Report content (what needs to be included in the report); and
- Closure plan content.

Bosman & Kotze (2005) state that the MPRDA is the only Act in South Africa that specifically shows the end point of remediation, and also includes sustainable land use practices in the statutory framework. The MPRDA also prescribes the mine closure principles, which are as follows (Sutton et al., 2008):
• Closure must start at the beginning of the operation phase and continue until the start of the closure phase;
• The quantification and management of environmental risks must be achieved;
• The Mine Health and Safety regulations must be complied with;
• The identification and quantification of residual environmental impacts must be achieved;
• The land must be rehabilitated to its natural state or to the pre-determined state agreed upon by the government which incorporates the concept of sustainable development; and
• Mining operations must be closed effectively and be cost effective.

The MPRDA has also set out objectives that need to be achieved during closure. These objectives are presented as follows:

• “Immediate harm to human health and safety must be eliminated;

• Groundwater must be fit for current and future domestic and other uses consistent with agreed current and future land use;

• Surface water must be fit for current and future basic human needs and aquatic ecosystems requirements;

• Risk of harm to non-aquatic organisms (vegetation) must be eliminated; and

• Soil (property) must be fit for use consistent with current and future land use”

(van Eeden et al., 2009: 62).

The DMR is trying to appropriately address community development issues in the MPRDA (Mban, 2008). The Act makes provision for a social plan which aims “…to consider the development of the mining operation in the context of generally recognised standards of sustainable development by integrating social, economic and environmental factors in planning the mining operations throughout the life of the mine” (DME, 2002: 2). The objectives of the plan are as follows:

• Integrate and manage all social, economic and environmental impacts generated by all phases of mining;

• Avoid a loss in jobs and mitigate the social and economic impacts on individuals if the mine closes suddenly or at the closure of mines; and

• Avoid the development of unsustainable settlements

(after Cooke & Limpitlaw, 2003).

Even though the MPRDA is the primary Act for regulating mine closure in South Africa, other Acts need to be considered when dealing with mine closure procedure. The most important acts are NEMA promulgated in 1998 and NWA promulgated in 1998. NEMA firstly provides a framework and principles for sustainable development, integrated environmental management, and imposes a Duty of Care and remediation of environmental degradation on any person who causes,
has caused or may cause such degradation (DEAT, 1998). Secondly, NEMA requires that mine closure and the associated costs involved be considered in the design phase of the project’s development and be included in the Environmental Management Plan (EMP) that governs the way in which the mining company will protect and preserve the environment throughout the life-cycle of the mine (DEAT, 1998; Grant-Stuart, 2008). However, an EMP cannot be utilised by mines that were already in existence prior to the development of this legislation and as a result they have to do post-closure planning and monitoring (Grant-Stuart, 2008).

The National Water Act serves to protect natural water resources in South Africa (DWAF, 1998). Due to the fact that mining is one of the leaders in water consumption and water pollution in South Africa, the NWA ensures that mines manage water use and the quality thereof by providing a hierarchy in which the mine must follow (for example) pollution prevention, water re-use or reclamation, water treatment, and discharge (Swart, 2003).

Cooke & Limpitlaw (2003) state that it remains to be seen whether the formation of these acts will actually result in best mining practices and thus the issuing of a mine closure certificate. The combination of this detailed legislation, with a strong environmental emphasis has the potential to improve the long term impacts of mining in South Africa, however many issues on institutional and implementation levels currently mean that this is not the case.

### 2.4 Mine Closure Procedures

Presently, mine closure procedures have to meet the standards developed by government and regulatory authorities (Wolkersdorfer, 2008). Even though there is an extensive South African legislative framework pertaining to mine closure procedure, there is no generally accepted set of generic procedure guidelines which can be followed in a mine closure situation. Therefore, international literature will be examined to shed light on mine closure procedures adopted globally.

Mine closure procedures are a set of activities that should commence during the project design phase which will alter the site layout design of the mine to better suit closure (Finucane, 2008). These continue throughout the mine life cycle which concludes with long-term site stability and the establishment of a self-regulating and sustaining ecosystem (Heikkinen et al., 2008). These activities or procedures are extensive (Tongway, 2008) and can include:

- Setting social and environmental objectives;
- Identification of ecological essentials;
- Appropriate technology selection and implementing;
- Immediate ecological monitoring; and
- Reviewing of monitoring information.
The procedures that are all discussed in the sections below include: planning, setting of closure objectives; stakeholder involvement and community upliftment; risk management; operations; cost estimates and financial provision; rehabilitation; decommissioning and post-closure monitoring; post-closure land use; and relinquishment. According to Peck & Sinding (2009) mine planning, operations, and closure have significantly improved recently to ensure that closure is environmentally and socially acceptable.

2.4.1 Planning

During the exploration phase, the main concern of the mining company is the feasibility of mining and not of closing. It is well known that exploration does not always lead to the establishment of a mine and thus closure planning is not seen as necessary during this phase. However it is very important not just because it will enable closure but also because it provides baseline information on the area and engages the community as early as possible in closure. Transparent and effective community engagement should also begin at the exploration phase to ensure that effective closure will eventually be possible (Finucane, 2008). As a result planning is one of the most vital activities as this process will ensure 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 & Sinding, 2009). The lack of a closure plan will result in severe environmental and economic consequences (ANZMEC, 2000). Thus this plan will be used throughout the design and construction phases to ensure that closure objectives are incorporated into the design and construction of the mine (Tongway, 2008; Koontz, 2009). “Therefore closure planning...is a key driver of any company’s ability to provide for the closure of any mining operation” (Bentel, 2009: 43).

Closure planning has broad aims that need to be considered when starting the planning process (ANZMEC, 2000). These aims are to:

- Protect the natural and social environments;
- Reduce negative environmental impacts once the mining operations have ceased;
- Establish pre-determined post-closure land use conditions; and
- Reduce the need for long-term monitoring and maintenance.

These broad aims allow for the development of effective principles for planning. The World Bank (2002), in its document entitled “It’s not over when it’s over: Mine closure around the world”, has developed these principles for mine closure planning. They are identified as:

- Clarification on times and costs;
- Details regarding final rehabilitation process;
- Conducting a risk assessment to aid prioritisation;
• Conduct a cost-benefit analysis;
• Development of a detailed closure management plan; and
• Establish a proposal for post closure monitoring.

These principles act as guidelines for the process, however it must be noted that these are generic in nature and should be adapted to specific mining sites. These principles, if achieved correctly, can positively affect the design of the mine to better handle the proposed environmental and social impacts (World Bank, 2002).

Once the aims and principles have been met in the planning phase, the closure plan becomes integrated into the whole life cycle of the mine and is adapted and transformed where necessary to include new regulations and technologies (ANZMEC, 2000). This is referred to as continuous closure planning which extends throughout the life of the mine (Fleury & Copley, 2008; ICMM, 2008). Continuous closure planning involves the consideration of all aspects of closure and allows for changes to be made to the plan if and when needed. It is important to include in the plan a statement that suggests change is going to occur. This will ensure that all stakeholders and government are aware of the possibility of change to the closure plan (Finucane, 2008). Continuous planning should also consider the future land use options but must allow for the extraction activities to be carried out. However these activities must be in balance with the natural and social environmental limits of the site (Neri & Sánchez, 2010).

There are three types of closure plans that need to be established and implemented at different stages of the life of mine. The first type is a conceptual plan which normally is developed in the conceptual phase of the development. This plan is used within the first five years of the life of the mine. The second type is a detailed closure plan which involves ongoing development and implementation. This increases understanding and details the specific goals and objectives of the plan. The detailed closure plan is used in the operational phase of the mine which will be in effect until operations cease, between five and thirty years. The final closure plan type is the decommissioning and post-closure plan. This plan details the transition to closure and the care and maintenance needed for effective closure. This plan is used for approximately two years until closure is complete (Fleury & Copley, 2008; ICMM, 2008).

A successful closure plan will develop positive outcomes (ICMM, 2008, as cited in Fleury & Copley, 2008). These positive outcomes include:
• Transparent consultation with stakeholders and Interested and Affected Parties (I&APs);
• Local community participation during closure planning and implementation;
• Stakeholder approval and support of all closure decisions;
• Easy management of closure planning;
• Accurate closure cost estimates will be established;
• Regulatory non-compliance will be minimised;
• Identification of potential impacts will be done in a timely manner;
• Available funding for closure;
• Reduction in the presence of potential liabilities; and
• Recognition of lasting opportunities will be adequately planned for.

2.4.2 Closure Objectives

Closure objectives are the targets and goals that are set out in the planning phase of development. A target is a statement that depicts all that needs to be achieved in closure whereas goals are specific and include details of how to achieve closure (ICMM, 2008). Broad closure objectives are set in the planning phase to ensure that any constraints can be identified and rectified as soon as possible. These objectives also identify the costs and liabilities predicted during the construction, operation and decommissioning phases of project’s development. Through the development of these broad closure objectives, the mining company can identify the relevant closure activities that can be incorporated into the engineering design phase (Koontz, 2009).

Closure objectives are used to determine and evaluate the final outcomes of closure. These objectives are also used to provide guidelines for negotiations between the mining company and regulatory authority concerning performance indicators and issues. Closure objectives are mostly determined by standards set by regulators and government in legislation but sometimes objectives can be set by site specific situations or local community concerns (Heikkinen et al., 2008). By using a combination of the aforementioned means of setting objectives, effective and appropriate objectives can be developed (Heikkinen et al., 2008). An appropriate objective is ensuring that the environment is restored to an adequate state to allow for the development of a diverse and functional ecosystem (Heikkinen et al., 2008). Once these objectives have been established, they are regularly monitored against performance indicators to ensure that the mine closure process is effective over the long-term. A mine is only completely closed when all the closure objectives have been satisfactorily met (Heikkinen et al., 2008).

2.4.3 Stakeholder Involvement and Community Upliftment

Social and Stakeholder involvement in mine closure has become a very important area of focus for many authors. The reason for this is that government and mining companies have not made social issues and concerns a priority when dealing with closure in the past. The World Bank (2002) states that mining companies over the past decade have learnt that the combination of community consultation and early planning is the best way to ensure efficiency and better management of
closure and the associated procedures. It is also a community’s right to participate in early planning as they will live with the effects of mining long after the mine has closed (Garcia, 2008).

Stakeholder involvement in mining projects normally is the consultation with mainly two groups, namely the local community and local government. In addition, civil groups, Non-Governmental Organisations (NGOs) and environmental groups may form part of the consultation process (Pollett, 2009). Consultation with these dynamic groups requires intuitive, open-minded information acquisition and bottom-up decision-making (Cragg et al., 1995). Therefore Bentel (2009) states that it is very important to take into account the different concerns, needs and aspirations presented by the stakeholders in the early stages of consultation. All these need to be resolved and tensions need to be relieved (Tongway, 2008). This aids mining companies to develop effective closure objectives and define the landform, land use and closure completion criteria needed to limit the impacts associated with the scope, timing and costs of closure (Bentel, 2009).

Consultation with all stakeholders should begin during the planning phase and extend to the closure and decommissioning phases (ANZMEC, 2000). Early stakeholder involvement develops trust relationships between the proponent and stakeholders. Ongoing interactions between these two groups will strengthen trust relations as well as develop mutual respect and understanding in the decision-making process (Pollett, 2009). The involvement of stakeholders does not just require the commitment of the proponent to engage but requires that the local community and government take an active role in this involvement (Pollett, 2009). Thus establishing a trilateral communication which is the key to ensure the sustainability of a community after a mine has closed (ANZMEC, 2000; Pollett, 2009).

This trilateral communication and consultation achieves outcomes that are beneficial to both the community and company involved (ICMM, 2008 as cited in Fleury & Copley, 2008). The outcomes that must be achieved include:

- Early consultation with all stakeholders;
- Incorporating stakeholder concerns and goals into planning for closure;
- Community and stakeholder engagement to achieve set goals and objectives; and
- Multidisciplinary expertise and multi-stakeholder engagement to limit potential risks presented.

Many mining companies can contribute to the development of the local community by providing schools, clinics, roads and housing (Cooke & Limpitlaw, 2003). Communities within or surrounding a mining area can, therefore, become heavily dependent on the mining company to provide these services. This dependency will have negative long term effects should community
development increase at the start of operations but cease towards the end. It is thus very important that “…mining companies actively…manage unrealistic raised expectations, avoid or limit dependencies, foster capacity building at the community and local government levels, and implement an action plan to shift responsibilities and accountability for sustainable development initiatives before mine closure” (Pollett, 2009: 419).

It is also important that mining projects become integrated with local short and long-term economic development plans. By becoming involved in local economic development plans, mining companies can ensure that post-closure land uses are compatible with the surrounding development initiatives (Limpitlaw, 2004). This will also limit the extent to which the community will be negatively affected by the lack of industrial support previously experienced prior to the closure of the mining project. Therefore extensive planning and development needs to occur prior to mine closure to ensure that there are other sustainable economic enterprises that can replace or take over the responsibilities of the mining company (ANZMEC, 2000; Pollett, 2009). Working with the community in the form of a community committee to establish these development plans or programmes will ensure that there are effective economic enterprises in place once the mine ceases operations (ANZMEC, 2000).

When stakeholders do not have the resources or ability to make decisions effectively, a third party (loyal to the stakeholders) will become involved (Cragg et al., 1995). As a result, NGOs play a vital role in ensuring that the correct decisions are made, and that community development programmes continue once the mining company has moved out of the area. NGOs achieve this by planning extensively with the community, government and mining company. The engagement of NGOs ensures that the community is not marginalised in any way and that the benefits will be directly received by the community and not the local government even though they do receive some of the benefits (World Bank, 2002; Pollett, 2009).

During mine closure, positive outcomes for stakeholders should be achieved. This requires extensive planning and evaluating of different options concerning the local community and all stakeholders (Heikkinen et al., 2008). There are three ways in which this can be achieved; the first is the mitigation of environmental and social impacts. Mitigation should ensure that the natural and social environment is restored to a suitable level so that the local community will be able to survive and even thrive after mine closure (Cragg et al., 1995). The second is the internalisation of costs. This means that the mining company should internalise any community costs associated with impact developments for example the pollution of a water resource in the surrounding area (Cragg et al., 1995). Finally, the mining company should give support to the local community and the employees by developing schools, roads and hospitals, and providing salaries that are fair and a safe environment to work in (Cragg et al., 1995). However most stakeholders do not receive these
outcomes, and therefore challenges develop for the local community. These will be discussed in Section 2.5.3.

2.4.4 Risk Management

Risk management is a method used to predict specific risks and the consequences thereof such as the future risks to the environment as well as the risks incurred by the company (Candia & Oblasser, 2008; Garcia, 2008). The risks (safety, environmental and social) that can arise from a badly conducted mine closure will result in major liabilities which must be borne by the company concerned (Limpitlaw, 2004). For example, the long-term risks of extensively managing the tailing storage facility, waste rock dumps, and surface drainage such as spillways (Finucane, 2008). Risk management is, therefore, one of the most important procedures because when all the risks have been established and mitigated the outcome should be a healthy, safe environment and community with no unexpected expenses incurred after closure (Laurence, 2006; Heikkinen et al., 2008; Bentel, 2009).

In order to achieve successful closure risk management, a risk management plan needs to be developed and implemented to minimise all potential impacts before they occur or as soon as they are observed (Garcia, 2008; Heikkinen et al., 2008; Bentel, 2009). This involves the development of a risk management plan during the planning phase which will determine the sources of emissions, the emission pathways and the associated impacts thereof (Heikkinen et al., 2008). This is known as the first level of risk management. According to Candia & Oblasser (2008) the risk management plan process included three stages which are as follows:

- Identification of risks;
- Quantitative evaluation of these risks; and
- Decision-making on the mitigation measures and controls for the possible associated risks.

Bentel (2009) states that these identified closure risks are then categorised into four areas of the mining process. For example:

- Operational risks that impact closure;
- Closure design and planning risk;
- Closure execution project risks;
- Closure management risks; and
- Post-closure risks.

These are monitored throughout the life cycle of the mine and reassessments are made when needed (Heikkinen et al., 2008). This process is known as the second level of risk management (Candia & Oblasser, 2008).
Risk Management is used to minimise the negative and maximise the positive impacts of closure (Fleury & Copley, 2008; ICMM, 2008). Risk management must minimise all the risks even if they are not covered by legislation and regulations, or even if the site environmental standards will become far more stringent (Swart et al., 1998). All these risks will therefore be timely quantified and managed so that closure is obtained (Swart et al., 1998). At all phases of development, risk assessment and management also aids in the choice of best technologies to be utilised to protect the environment, social and technical properties of the mine (Heikkinen et al., 2008).

Risk assessment and management must be completed when the final closure plan is developed and implemented. The final closure plan must indicate the possible residual risks post-closure that may have significant negative effects on the natural and social environments (Heikkinen et al., 2008). Successful risk management will enable the mine to be more adaptive to changing legislation and will also give stakeholders and I&APs peace of mind that no unknown environmental and social impacts will occur after mining has ceased. With proper management (including risk management), a safe, stable and sustainable environment can be established, resulting in the awarding of a closure certificate. (Swart et al., 1998).

2.4.5 Operations

Continuous rehabilitation should start in the operation phase. Therefore closure does not only start at the end of the operation phase but is continuous until the end of operations. During operations, concurrent rehabilitation takes place which provides information critical to the establishment of a detailed closure plan (ICMM, 2008). Ideally this detailed closure plan must include employee training programmes. This will enable a mine employee to have multiple skills and thus they should be able to find another job easily and effectively. This training should be ongoing and must become a part of the mining operational phase. This programme should also provide benefits and pay packages that will allow employees to save and invest the money made by working in the mining environment (Pollett, 2009).

The detailed closure plan must also include adapted conceptual targets and goals. The goals should be highly detailed with interim goals to make for a smooth transition from conceptual to detailed closure activities (ICMM, 2008 as cited in Fleury & Copley, 2008). Once this has been achieved the detailed closure plan should specify:

- The goals targeted;
- The interim goals targeted;
- The indicators used to determine whether the goals and targets are being met; and
- The ways in which the indicators will be obtained.
2.4.6 Cost Estimates and Financial Provisions

Controlling closure costs are very important for achieving closure and should be applied to all phases of the mine (Garcia, 2008). Controlling costs are made possible by estimating all closure associated cost. "Cost estimates factor in all closure activities and consider the potential range of influences on the closure execution works, as well as the post-closure costs associated with care and maintenance" (Bentel, 2009: 49). Whereas financial provision is the setting aside of moneys to ensure that closure can be achieved. Financial provision is a key element in effective mine closure and ensures that there are sufficient financial resources available to close the mine (Clark & Clark, 2005).

Closure Cost Estimates

Cost estimates are used by five primary areas of mining (Bentel, 2009) and include:

- Operational budget which is used to develop closure plans, manage risks, conduct on-going management activities, and manage the closure process;
- Execution closure costs which include the design costs, reviewing, approval, management costs and closure execution contingency costs;
- Post-closure costs which include all costs involved with planning, care and maintenance;
- Life of mine costs specifically focussed on closure which includes all costs involved with planning, progressive rehabilitation, closure execution, and care and maintenance; and
- Liabilities such as rehabilitation and closure environmental and social liabilities which include the costs to rehabilitate and the annual report on rehabilitation and closure.

These costs need to be estimated as early as possible to ensure that the project is viable and ensure that all predicted and unpredicted closure costs are accounted for (ANZMEC, 2000; Finucane, 2008). The closure costs should be reviewed annually so that changes to these costs can be made because inflation and the work requirements are dynamic and thus changing constantly (ANZMEC, 2000). The changes made to cost estimates should be based on the latest data available and current legal requirements (World Bank, 2002).

Garcia (2008) states that it is vital that all cost estimates are accurate in the planning phase because if they are not then the mining project will not make a profit once closure has been achieved. Closure cost estimates can also be reduced by progressively rehabilitating the site during the operation phase which means that the operational costs will include rehabilitation costs (United Nations Environmental Programme, 2005).
Financial Provision

Financial provision (financial surety) is ensuring that there are sufficient funds available for mine closure and rehabilitation (World Bank Group, 2008). These funds need to be available from the beginning of the project development to ensure that all closure costs can be covered and that all monitoring and maintenance costs are also covered (World Bank Group, 2008). If the closure and rehabilitation costs are taken into consideration early in project development then there should be a decrease in expenditure in the long-term thus making the rates of restoration similar to those of exploration (World Bank Group, 2008). It is important to note that social costs need to be considered when predicting possible financial implications and final closure costs (World Bank Group, 2008).

In order to create effective financial surety, instruments are utilised. Numerous financial instruments have been developed to provide assurance to the local government and community that the mining company is able to meet all obligations and commitments even if the operation has to cease suddenly (World Bank, 2002). Choosing the most appropriate instrument is critical to financial surety. The choice of instrument is dependent on the financial strengths of the mining company, the amount of required surety, and the time frame for which the funds are needed (World Bank Group, 2008).

Of all the financial instruments available, three will be examined because they are the most commonly used. The first financial surety instrument is a letter of credit which is also known as a bank guarantee. This letter is an unconditional agreement between the bank and proponent in order to provide funds from a third party on demand. The third party in this case is the government. The letter of credit indicates the terms and conditions between the government and proponent and specifically indicates the rehabilitation programme and agreed costs (World Bank Group, 2008; Otto, 2009).

The second financial surety instrument is a surety bond which is also known as an insurance bond or performance bond. A surety bond is a conditioned agreement between the insurance company and proponent to give money to the third party which in this case is the government authorities. The bond is similar to the letter of credit in that it also provides terms and conditions between the government and proponent, and stipulates the rehabilitation programmes and associated cost involved (World Bank Group, 2008; Otto, 2009). The final surety instrument is the trust fund (most commonly used in South Africa) which is also known as a mining reclamation trust, a qualifying environmental trust or a cash trust fund. The trust fund is an agreement between a trust company and proponent for the sole purpose of funding the rehabilitation of a site. The trust fund is not a standalone agreement like the surety bond or letter of credit, so there must be a signed agreement between the government and proponent administered by the trust company which
stipulates the proponent’s responsibilities to the trust. The trust fund provides security that the costs for rehabilitation are covered (World Bank Group, 2008; Otto, 2009).

2.4.7 Rehabilitation

Rehabilitation in this section refers to all kinds of rehabilitation from general to specific such as the rehabilitation of the Tailings Storage Facility (TSF). Presently, rehabilitation requires the removal of all unwanted mining infrastructure and equipment; the stabilisation of waste dumps and TSFs; the detoxification of hazardous materials, and the re-vegetation of all land on or surrounding the site (World Bank, 2002; Wolkersdorfer, 2008). All equipment and infrastructure that can be sold should be. TSFs and waste dumps should be stabilised and made safe and secure (World Bank, 2002). Some of the infrastructure present on the site may be beneficial to the local community, government or subsequent owner of the land. Such infrastructure should be transferred to the competent authorities, community or new owner to ensure that its upkeep takes place (World Bank, 2002).

Previously it was believed that rehabilitation was best achieved after mining operations had ceased because it was considered safer and it reduced the possible environmental impacts. However, recently progressive rehabilitation has replaced this way of thinking (Heikkinen et al., 2008). Progressive rehabilitation is the process that ensures that all closure criteria are identified early in the project, and that appropriate steps are taken throughout the project lifecycle to minimise residual impacts. It requires that performance requirements have been implemented prior to and throughout the decommissioning phase (Bentel, 2009). The most suitable vegetation types and the correct ways of achieving the closure objectives need to be established preferably in the operational phase of the project (World Bank, 2002; Koontz, 2009). It may take many years (5-10 years) to determine whether the chosen strategies have been effective in “recreating” the ecosystem function and landform stability needed for adequate land restoration. Therefore continuous monitoring of the progressive rehabilitation process is essential and could result in a decrease in final closure costs (World Bank, 2002; Koontz, 2009).

The use of progressive rehabilitation will result in the removal and stabilisation of potential hazards, and contribute to the establishment of a diverse and functioning ecosystem (Heikkinen et al., 2008; Lottermoser & Ashley, 2008). The following goals need to be addressed:

- The elimination of safety and health hazards;
- Restoration of impacted land and water resources;
- The elimination of off-site environmental impacts; and
- Ensuring that post-closure land use is self-sustaining with respect to socio-economic and environmental benefits. (Cao, 2007)
Open Pit Rehabilitation

Open pit mining is used when the ore body is close to the surface and when the ore body is a vertical pipe-type deposit. The ore body is blasted and transported to the processing plant. In the pit, the ore body and waste rock are removed in a series of benches. Waste Rock is transported to the dump. The waste rock that needs to be separated from the ore body is transported to the processing plant, separated and then transported and dumped on a waste rock dump. Open pit mining results in the disruption of the surface environment which can negatively affect the soil, surface water, groundwater, fauna, flora and land uses (Wells et al., 2009). Such is the case in Western Australia with the Kalgoorlie Super Pit. This gold mine pit is one of the ten largest pits in the world and is 3.5 km long, 1.5 km wide and 360 m deep. The Kalgoorlie Super Pit has numerous environmental issues such as air pollution, water shortages, and noise and vibration issues (Fabricius, 2009).

As backfilling is hardly ever economically viable, conventional practice is to leave a pit open and put in place public safety measures, which generally involves restricting access. This method limits public access to the pit by constructing a berm around the pit and enclosing it with a fence around the pit perimeter, with clear warning signs displayed. The fence would need to be constructed in such a way that the public could not easily gain access to the site. Thus the fence should be a chain-link type, approximately 3 m high (Queensland Government, 1995). The fence position is determined by the ground stability that is taking into account its potential for collapse (Heikkinen et al., 2008).

The land surrounding the pit area should be rehabilitated. Engineers must consider the erosion potential of the soils as well as the surface water runoff volumes so as to prevent erosion of the edge of the pit and runoff entering the pit. Stabilising the pit edges and rock faces is very important when restoring the land surrounding the pit (Heikkinen et al., 2008). The final slopes of the pit should be left in a state where the risk of slope failure is minimised. This generally requires cut back of the highwall from a vertical unstable angle to a stable slope angle (Queensland Government, 1995). The public safety method has been used worldwide as it is the easiest method to employ and is relatively inexpensive. For example the “Big Hole” in Kimberly, South Africa and Mirny Diamond Mine in Serbia, Russia. The “Big Hole” in Kimberly developed as a result of diamond mining and is 463 m wide and approximately 240 m deep. The Mirny Diamond Mine in Serbia is the second largest open pit in the world with a surface diameter of 1.2 km and a depth of 525 m. The pit is so large that it generates a downdraft and thus a no-fly zone has been established over the pit. Both these mines, upon closure, determined and developed a safety zone and then established a chain-link fence surrounding the pit to prevent public access (Fabricius, 2009). This was especially important for the “Big Hole” as it is now a world renowned tourist site.
There are other rehabilitation options, including backfilling, water storage and waste disposal. Backfilling is the processes of filling the pit with tailings and waste rock (Breitenbach, 2008). Backfilling is the environmentally preferred method of rehabilitation as it reduces the access of atmospheric oxygen into the underlying geology and reduces surface water runoff into the pit; furthermore it provides a medium for the establishment of suitable vegetation cover (Ayres et al., 2005). Backfilling of a pit would also decrease the above surface volume of tailings, and as a result would lower the reclamation costs at closure (Breitenbach, 2008). However, the steep pit walls and groundwater conditions limit the use of this method (Breitenbach, 2008). This method also is not usually economically viable and as a result alternative methods are utilised (Queensland Government, 1995). Recently there have been a few mine pits that have used the backfill method of rehabilitation. Examples of the various pit rehabilitation methods are reviewed below.

According to Breitenbach (2005), the first pit backfilled with tailings was the El Valle gold mine pit located in Austurias, Northern Spain. The pit was depleted of ore in 2003. “In 2004 the bottom portion of the 152 to 518 m deep mine pit was backfilled to above the existing groundwater conditions with a low permeability clayey waste rock...tailings disposal within the impoundment commenced in 2005 with conventional slurry tailings disposal” (Breitenbach, 2008: 2).

The water storage option is used when the location and water chemistry of the pit are suitable for water storage. Either the pit is used as an internal drainage system or is a storage system for water generated from the tailings and underground workings. When this option is selected, proper engineering design is needed to ensure that the pit and surrounding areas are geotechnically stable. Generally the result of this option is the establishment of a pit lake, which if chemically stable, can be used for recreational purposes (Queensland Government, 1995). A pit lake was created in the Sleeper Gold Mine, Nevada in the United States of America. A detailed water balance study was conducted prior to the rehabilitation of the pit. From this study it was determined that a pit lake would be a suitable form of rehabilitation. The study indicated that the pit lake would act as a permanent hydraulic sink with the local groundwater flowing into the pit (Boak & Beale, 2008).

The disposal of waste into the pit is another option. In this case, the pit would have to be located near a source of waste and there must be a need for a refuse disposal facility. This option would need to be approved by the local government and other regulating authorities. In order for this rehabilitation method to be approved, an investigation into the groundwater regime would need to be conducted. This investigation would include determining the possibility of groundwater contamination by leachate from the disposal material. An investigation into the quantity of waste generated by the local population would also need to be conducted. The rate and density of total waste generated would need to be determined in order to determine the amount of refuse being disposed of in the pit (Queensland Government, 1995). This option was implemented in Bristol,
Virginia in 1998. Municipal solid waste was deposited into the abandoned open pit mine quarry excavation. This pit has a near vertical wall of approximately 100 m high. Loose rock debris on the pit walls were covered in safety wire mesh screens to prevent the rock from falling. The pit was then lined with a HDPE geomembrane liner to ensure that the waste would not negatively affect the underlying groundwater. The pit became a landfill which was used by the municipality to dispose of waste (Breitenbach, 2008).

**Tailings Storage Facility Rehabilitation**

The TSF must not become a source of pollution – it should impose no risks to the environment, human health or public safely, therefore effective rehabilitation of the TSF must occur before closure is granted. Rehabilitation must restore the land to optimal conditions by landscaping and re-vegetation. Prior to this, an investigation of whether tailings material can be used in mining operations needs to take place. If the tailings can be utilised in road construction, earthworks and backfilling then the surface area of the TSF will be reduced and as a result will have a smaller impact extent (Heikkinen et al., 2008).

TSF rehabilitation requires a tailings management plan which stipulates the ways in which the tailings and TSF will be managed. Planning must involve landform evaluation experts and biologists to ensure that landform will not be subject to erosion and will facilitate rapid development of vegetation cover (Tongway, 2008). The following actions can be used to aid TSF rehabilitation:

- “Mineralogical, chemical and geotechnical characterisation of tailings properties;
- Water management and possible treatment strategies;
- Re-vegetation of the tailings impoundment;
- Environmental impact assessment;
- Site monitoring after closure;
- Liability and security;
- Proposed closure techniques and procedures; and
- Post-closure land use options.”

(Heikkinen et al., 2008: 93)

TSF landscaping has been historically dominated by engineering ideas and designs such that they minimise costs and inconveniences. This led to the development of TSFs with uniform slopes which conform to neat lines and grades (Sawatsky et al., 2008). However the resulting rehabilitated landform does not suit the ecosystem in which it resides so presently mining companies have been seeking the advice of other experts in TSF landscaping (Tongway, 2008).
These experts have been valuable to TSF landscaping as they try to make the TSF behave like a hill with ridges and valleys (Sawatsky et al., 2008).

The main goal of landscaping is to develop sustainable physical features that complement the natural landforms of the site and surroundings, without drastically changing the way in which the TSF is constructed and managed (Haagner et al., 2008; Sawatsky et al., 2008). The target of landscaping is to minimise the degradation of the landform and minimise the maintenance thereof (Sawatsky et al., 2008). This new technique to TSF landscaping has taken into consideration hydrological action and geomorphic processes, whereas previously these were not considered (Sawatsky et al., 2008). However there are constraints with using this technique, the main constraint being additional costs. Because the technique is relatively new, the costs involved are very high. These costs can be reduced if this technique is used in the construction phase of mining because reconstruction will not need to be considered. Great savings in costs can also occur when landform configuration enhances the equipment and methods used to build the TSF (Sawatsky et al., 2008).

Re-vegetation of the TSF is very important especially in areas with high winds that generate dust. Re-vegetation and landscaping are normally started in the operational phase, which results in the site ecosystem being restored faster than when rehabilitation begins in the closure phase (Heikkinen et al., 2008). After rehabilitation the TSF can be used for numerous purposes but care must be taken that the TSF is not structurally disrupted because this may lead to new environmental problems or the failure of the TSF (Heikkinen et al., 2008).

2.4.8 Decommissioning and Post-Closure Monitoring

Monitoring should be started as soon as possible, normally after rehabilitation has been completed so that the rehabilitation progress can be assessed (Tongway, 2008). In order to monitor the post-closure environment, a decommissioning and post-closure plan needs to be drawn up (ICMM, 2008). This is normally done in the closure phase. This plan defines aspects that need to be monitored, such as groundwater, soil and air, and then evaluates whether this corresponds with the original closure plan objectives and criteria (Candia & Oblasser, 2008; Bentel, 2009). If so, then all closure elements are being achieved and the plan has been implemented effectively. The post-closure plan aligns closely with the conceptual and detailed closure plans which indicate, firstly, that all goals and targets have been met and secondly that monitoring has been considered in the early phases of the mining operation. This is the key to a successful closure and monitoring system (ICMM, 2008; Bentel, 2009).

Once a decommissioning plan has been established and developed, government should sign a contract with the mining company that should stipulate the arrangements for decommissioning.
This contract should emphasis giving adequate closure notice; development of a trust fund for decommissioning; and establishment of a security deposit for rehabilitation (Laurence, 2006).

2.4.9 Post-Closure Land Use

Post-closure land use refers to the land use after mining operations have ceased. Planning for this is very important because the local community should benefit from the post-closure land use. Therefore the mining company has the responsibility to make sure that land use planning occurs between the proponent, community and local government (Pollett, 2009; Neri & Sánchez, 2010). The most common method to achieve this is participatory land use planning, which ensures that the design of the mine and associated infrastructure can be utilised in a post-mining setting and will benefit socio-economic requirements (Pollett, 2009).

Participatory land use planning ensures that community sustainability is achieved in the post closure phase. In order for a community to participate effectively all soil and land use information needs to be represented in maps and diagrams to illustrate the way in which the land is to be restored. These maps will also be utilised by the mining company to design the mine infrastructure and plant in accordance with what was discussed in the participatory land use planning meetings (Pollett, 2009).

The mining infrastructure can remain on the site and be used for other purposes such as roads that can be used by the public to access other area. These roads are usually upgraded or modified to meet the needs of the local community or the new owners of the land (Heikkinen et al., 2008). The land post-closure can be used for various forms of recreation (game parks or ecotourism venues) (Heikkinen et al., 2008). Once post-closure land use has been finalised, a contract between all parties should be drawn up stipulating which areas will be used on site and which are excluded. This contract should include an agreement on the responsibility and accountability of possible residual environmental impact mitigation (Heikkinen et al., 2008).
2.4.10 Relinquishment

Relinquishment begins with the mining company meeting all the requirements set out by the government. The government will then accept that all requirements have been met and as a result will release the property to the new land owner (ANZMEC, 2000). In theory this is achievable, however often the state or government is not willing to release mining companies from future liabilities because the government does not wish to accept liability for any additional costs that may occur. This is the case in South Africa, leading to reluctance on the part of the Department of Mineral Resources (or its predecessor, the Department of Minerals and Energy) to grant mine closure certificates.

Prior to the relinquishment of ownership and title deeds, an environmental due diligence must be completed. This due diligence will inform the new owner of the environmental and social liabilities still present on the site. The owner is then aware of all the issues with the site prior to its purchase. A contract should also be drawn up prior to relinquishment. This contract should stipulate the responsibilities of the old and new owners of the property such as the liability or exemption of certain activities that still need to be completed (Heikkinen et al., 2008).

Relinquishment does not just mean that the mining company has met all legal requirements and now is released of their responsibilities but rather the mining company, community and government have fulfilled all the commitments agreed upon. The mining company will have provided services to employees and the local community that will now have to be taken over by the government or the local community itself. The mining company, prior to relinquishment, must ensure that the services will continue once the mine has been closed, thereby ensuring that satisfactory transfer of responsibility has been achieved and that the services will continue with little maintenance or care required (World Bank, 2002).

In order for effective relinquishment, the community must ensure that there is no dependency on the mining company and, if there is, the community and government must work proactively to ensure that the community is self-sufficient (World Bank, 2002). Prior to relinquishment, the local government must proactively develop economic planning processes for the local community, so that the community survives the transition from one economic activity to another. The government must also ensure that some of the financial transfers from the mining company are used in social and infrastructure development programmes for the local community to use in the long-term (World Bank, 2002).
2.5 Challenges

There are numerous challenges which mining companies, local communities and regional and local government have to face. This section presents these challenges in order to shed light on the areas that need to be rectified. In general most mining companies only comply with the minimum requirements set out by legislation and government regulations, and do not seek to improve the environmental and social quality of an area. The most common reason for this is that the impacts transcend the different government agencies thus resulting in extensive consultation with numerous levels of government (van Tonder et al., 2009). However this is not the only challenge facing mining companies, government or institutions and local communities. These other challenges are discussed below.

2.5.1 Institutional and Government Requirements

Governments see mine closure as a complex combination of environmental, social, economic and development issues. The government must thus ensure firstly that a mining company has prepared adequately to mitigate adverse impacts that might occur over the life of mine, and secondly that it has carried out its closure plan to the satisfaction of all stakeholders and levels of government (Clark & Clark, 2005). Government have realised they have the most responsibility, in comparison to mining companies, in ensuring effective mine closure in the broad context of sustainable development. In many countries (developed and developing) strict environmental legislation exists. Even though regulations are in place, problems still arise in ensuring that mine closure is completed in an acceptable manner (Peck & Sinding, 2009). Sometimes these problems may arise within the government, where the personnel lack the skills and information to correctly communicate and enforce the legislative framework, thus not fulfilling their roles and responsibilities (Pollett, 2009).

Some governments are well functioning and positioned with numerous staff members to solve broad social welfare issues that develop as a result of mining practices such as squatting and unwanted urban development; however many governments are not well equipped to deal with social welfare issues that may arise (Clark & Clark, 2005; Peck & Sinding, 2009). Effective mine closure is further affected by the lack of adequate enforcement and monitoring as well as a lack of financial and technical resources at the national, regional and local levels of government (Clark & Clark, 2005). This lack of financial and technical resources has resulted in limited enforcement and monitoring by the regulatory authorities and government (Cao, 2007). In Namibia, Botswana and Zambia, for example, legislative mine closure requirements are not being achieved as government are ineffectively monitoring and enforcing these requirements. This ineffectiveness is due to a lack of technical and financial resources present at national and local government (Clark & Clark, 2005).
Institutions and governments are also unable to maintain the infrastructure, such as schools and health care systems, developed by mining companies to help social services. This inability results in these systems collapsing and thus the community is worse off than when mining operations first ceased. For example, in South Africa, remote communities benefit from development projects initiated by mining companies however, when government takes over the management of these projects, they fail due to a lack of resources. The communities are then left without the necessary goods and services needed and as a result end up poorer than before mining commenced (Limpitlaw & Hoadley, 2006).

2.5.2 Mining Challenges

In most developing countries, mine closure is poorly planned for by mining companies. This results in long-term negative economic impacts for the local community. The direct impacts include loss of employment and income which was used to uplift the local community. There are however also indirect impacts that can be attributed to poor planning. These include a loss of businesses in the community and a decrease in the sales of goods and services. Poor planning does not just affect the local community but the surrounding environment as well. The environment will be more susceptible to air and water pollution. For example, extensive water pollution has occurred in the Blesbokspruit due to the cessation of pumping at the Grootvleli Mine in the East Rand of Johannesburg, South Africa. If the mining company had properly planned for closure, the water quality impacts would not have been as severe (van Tonder et al., 2008).

The process of closing a mine is very costly as the mining company has to meet all the goals, targets and objectives developed in the planning and conceptual phases. These costs are normally incurred only once the mining operations cease. At this phase of mining, funds have decreased and there are often insufficient funds to correctly complete closure (Peck & Sinding, 2009). Together with this challenge, is the inability of a mining company to internalise the external costs involved in mine closure. The most common solution to this is the promulgation and enforcement of strict national regulations. However the costs incurred at the end of life of the mine and the internalisation of external costs may leave the mine bankrupt and therefore the solutions provided by strict regulations are by themselves an inadequate remedy (Peck & Sinding, 2009).

2.5.3 Community Challenges

Mining companies and government often know little about the community in which a project resides. Sometimes governments are unable to provide even the most rudimentary information, such as population numbers of the community. Often the community is marginalised by being left out of the most important decisions made in the mine development. This results in a lack of community empowerment (Limpitlaw & Hoadley, 2006). Economic benefits developed from the
mining do not reach the local community but rather flow to shareholders, government and supply-chain partners. In Limpopo Province, a mining company established catering and laundry businesses in a settlement. These businesses were tendered and awarded to the chairman of the community development committee. The profits of these businesses were supposed to filter down into the local community however these profits only benefited the chairman and his committee. If economic benefits do reach the local community, these benefits overwhelm the community’s management capacity, which may result in social division and welfare issues (Hoadley et al., 2003).

In developing countries, specifically in rural areas, the community structures that are supposed to be in place are often lacking, therefore local communities will turn to the mining company to assist in these areas of concern (Andrews-Speed et al., 2005). When a mining company takes on the roles and responsibilities of government, the local community becomes dependent on the mining company, which develops a dependency relationship between the two entities and a lack of community ownership (Hoadley et al., 2003; Pollett, 2009). This leads to difficulties in achieving effective implementation of mine closure strategies (Pollett, 2009).

If a mining company does not involve the community in the mine closure process, numerous negative outcomes may occur, which include:

- “Unnecessary expenditure of management and employees time;”
- Mining as a future land use in an area that may be threatened;
- Social ills, including crime and alcoholism, may escalate, an increasing problem in developing countries;
- Local businesses could dramatically collapse;
- Real estate values could plunge;
- Breakup or elimination of communities could occur (although this may be inevitable);
- Inappropriate or non-existent rehabilitation could create long-term problems for the community; and
- A negative corporate and industry image is likely to result due to a media thriving on stories such as these.” (Laurence, 2006: 296)

This often leads to the community being poorer after closure than they were when the mine first started. In the Copperbelt Province of Zambia, the communities are very poor, even more so than communities in South Africa. The copper mines in this region were nationalized and communities became dependent on the Zambian Consolidated Copper Mines who established community housing, infrastructure and services. Once these copper mines were nationalised, the community goods and services ceased. The community/mine dependency established was dissolved, leaving community members unable to maintain the housing facilities and general infrastructure, thus
making them poorer than they were prior to the commencement of mining (Limpitlaw & Hoadley, 2006).

2.6 Best Practice Options

The only certainty in mining is mine closure, and the closed mine site will be a legacy for future generations (Jones, 2008). Consequently, regardless of what causes closure, mine closure must be achieved quickly and cheaply while doing so in an environmentally sound manner (Wolkersdorfer, 2008). It is for this reason that South African mine closure best practices need to be established and attained, but first best practice needs to be understood and implemented correctly. Cawood (2001: 51) states that:

“First, the process of introducing environmental best practice must be ushered in by environmental education in the mining industry, government officials and local communities, who need to play a more participatory role. Second, government officials need to adopt a rigid approach in ensuring environmental compliance. Third, mining should not be allowed to continue when revenues cannot cover environmental compliance costs.”

It should be noted that the different procedures presented in Section 2.4 are based on international best practice. Over the years experts in South Africa have suggested ways of improving mine closure practices and procedures. However, there is no single strategy that can be implemented nationwide. Therefore this section deals specifically with South African best practice and what mining companies are supposed to be doing during the life cycle of the mine to accommodate for effective closure.

Bentel (2009) states that the start of the mine closure process is when the mine or mining company decides to finally stop all mining activities and operations. However, this is not the case as mining companies have increasingly become aware of the importance of including mine closure procedures in the life cycle of the mine. As a result concurrent mining operations and closure must be achieved in order to place closure costs with operational costing rather than relying on closure provisions (Garcia, 2008).

The main aim of mine closure is to eliminate future environmental (both bio-physical and social) impacts and financial risks, and where possible restore presently impacted environments (Hoadley et al., 2002). Therefore in planning mine closure, sustainability practices are incorporated and all elements of the environment are considered. This results in a holistic approach to planning. Limpitlaw (2004) states that in order to achieve a holistic closure plan, the following elements need to be included:

- Economic viability assessment needs to be achieved to determine the viability of the proposed development. This must include funding for monitoring and maintenance;
• The inclusion of the mine closure plan into the regional economic development plans;
• The plan’s relevance to the skills profile of the area and community buy-in;
• Development of post-closure land use alternatives that can be reviewed in the operation phase of mining; and
• A culture of dependency must be avoided.

Planning also needs to consider the rehabilitation of the site and surrounding areas (Limpitlaw & Smithen, 2003). This planning needs to take place prior to the start of the construction phase of mining. Data should be provided during the exploration phase to determine the aspects of rehabilitation that need to be planned for. This data should include the chemical, geo-technical, physical and hydrological properties of the ore. The data should form part of the Environmental Management Plan (EMP) which will ensure progressive or concurrent rehabilitation is taking place throughout the life cycle of the mine (Fourie & Brent, 2006).

Risk management must be completed after a closure plan has been developed. The reason for this is that risk management evaluates the surrounding environmental and community safety against the environmental criteria of mining activities (Fourie & Brent, 2006). This technique determines the mining activities that have significant environmental impacts. It also prioritises these activities to limit potential future risks (Fourie & Brent, 2006). Potential future risks and impacts can also be reduced by onsite rehabilitation closure procedures. These procedures focus on long-term care and maintenance of closed facilities that may otherwise cause severe impacts (Garcia, 2008). On site rehabilitation closure procedures include:

• TSFs and waste rock dumps must be physically and chemically stable;
• Water quality maintenance must occur during the rehabilitation of the site;
• Mine infrastructure must be safely disposed of;
• A sustainable ecosystem must be developed; and
• Local community expectations must be met.

Therefore, according to Cooke & Limpitlaw (2003), mine closure procedures in South Africa should include the following:

• Land and ecological restoration;
• Physical and chemical dump stability;
• Ensuring no future pollution;
• Post-mining alternative uses for infrastructure;
• Current and future impact minimisation specifically to water resources;
• Job creation;
• Equitable participation through development projects; and
- Skills and literacy training.

As a result a mining company should follow these closure procedures with the aim to optimally distribute financial resources with no long-term obligations. In order to ensure that there are financial resources available, financial surety instruments must be utilised (Fourie & Brent, 2006). The most common financial surety instrument used in South Africa is the Trust Fund. Financial surety is assessed by the regulatory authorities of South Africa using the Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by the Mine (World Bank Group, 2008). This guideline serves to provide guidance on determining the financial surety needed for the different aspects of closure such as surface rehabilitation; air, water, and soil pollution prevention; decommissioning and final closure; and post-closure management (Grant-Stuart, 2008). The only aspect of closure that is not covered by the guidelines and the government is ongoing rehabilitation (World Bank Group, 2008). Financial surety is only released once the Minister has issued a closure certificate. However a portion of the surety may be retained by government to cover latent environment impacts (World Bank Group, 2008).

Currently in South Africa, Social Impact Assessments (SIAs) are not legislated and as a result mining companies do not need to conduct this type of assessment. However, despite the gap in the legislation, best practice in mine closure dictates that procedures should not only include land restoration and financial provision, but should include stakeholder consultation and community upliftment. In terms of consultation, a trilateral consultation between the government authorities, proponent and communities need to take place during all phases of a project, but especially in the planning phase, in order to close a mine successfully, as the affected community will live with the mine and associated impacts long after closure (Limpitlaw, 2004; Garcia, 2008). Such consultations should help in ensuring that local communities are better off after mine closure than when it started (Hoadley & Limpitlaw, 2008). This will include communities that may have developed around a mine to support the mine operation with labour and services.

Community consultation also gives a mining company an understanding of the environmental setting in which the mine is situated, and the expectations of the local community and government. This understanding will result in the management of expectation and avoid tensions between the proponent, community and government. During the consultation process, full disclosure and awareness need to be created because this will limit community exploitations and enhance participation in identifying post-closure land use alternatives and options. Early consultation is the key to ensuring that the community participates in critical decisions made during the project’s development which in turn will manage sustainability risks and avoid cost legacies on closure (Hoadley & Limpitlaw, 2008).
Community upliftment through this trilateral consultation is guaranteed because it identifies the community development needs and includes the community in the decision-making process. With the intention of maximising the contributions made to community upliftment, the following needs to occur (Hoadley et al., 2003):

- Effective participation of communities in the decision-making process;
- Development of transparent, collaborative and respectful relationship between communities, government and the mining companies;
- The equitable and sustainable sharing of benefits with and within a community; and
- Development of ways in which to improve the capacity of local government to deliver services developed by the mining company.

Consequently “…successful closure depends on setting, continually reviewing and validating and finally meeting closure goals that align with company and stakeholder requirements” (ICMM, 2008: 12). For successful closure of a mine in the South African context (Cooke & Limptlaw, 2003), the following principles must be achieved:

- Full, transparent consultation with interested and affected parties (I&APs);
- Integrating closure planning and implementation into the life-cycle of the mine;
- Create a sustainable community and environment upon closure through contributions made;
- Establishing alternative economic activities before closure to minimise dependency on mining; and
- Internalisation of closure costs during mining operations.

The principles are dependent on: early closure planning; continuous monitoring throughout the life cycle; and alternative economic livelihoods identification. The achievement of these principles will result in the easy auditing of the closure process by the authorities. This auditing will ensure that the closure process is formalised and that resources are available for rehabilitation and post-closure management. Once the authorities have approved this audit, a mine closure certificate will be issued (Fourie & Brent, 2006).

2.7 Conclusion

There are numerous international mine closure procedures which have been implemented and these will be determined by the individual nature of a mine. These procedures originate from the need to achieve effective closure. In South Africa, these international mine closure procedures have been adopted by a few literary sources but they apply them in a context specific way. This chapter has highlighted the mine closure procedures utilised internationally and specifically within South Africa. The challenges faced when closing a mine and the South African legislative requirements to acquire a mine closure certificate were also presented. This chapter has created an
understanding of the South African mine closure situation and provided insight into current developments in best practice requirements to acquire a mine closure certificate.
CHAPTER 3 LOCATION, BIO-PHYSICAL AND SOCIO-ECONOMIC DESCRIPTION OF THE OAKS DIAMOND MINE

3.1 Introduction

Bio-physical and socio-economic environments vary from site to site. The unique aspects of these environments need to be included in the mine closure plan in order to provide the mining company, stakeholders and government with a clear understanding of the present site environment. The environment also will change during the life of the mine. Therefore it is important to present accurate baseline information on the current bio-physical and socio-economic environments. The purpose of this chapter is to create an understanding of the regional (Limpopo Province) and site specific bio-physical and socio-economic environments. This chapter also reviews the current state of these environments and presents credible environmental and social information concerning the Oaks Mine site.

3.2 Location

The Oaks Mine was located in the Lephalale District Municipality, Limpopo Province, South Africa. In 2010 the municipality boundaries were readjusted. The mine is now located in the Blouberg District Municipality (du Plessis, 2011). Limpopo Province is the northernmost of the nine provinces in South Africa. It has an area of 123,910 km² which is 10.2% of South Africa’s surface area (Limpopo DFED, 2003).

Swartwater, the nearest town, is located approximately 20 km north of the Oaks Mine, and the nearest commercial centre, Mokopane, is approximately 175 km to the southeast. The Southern African locality of the Oaks Mine is depicted in Figure 3.1 and the provincial locality is depicted in Figure 3.2. The property is made up of three farms, namely the Oaks 153 MR, Oatlands 151 MR, and Jakhalsfontein 199 MR; and covers a total area of 5,323 ha. The mine and its operations only utilised 63 ha (1.2%) of the property (ERM, 2008).
3.3 History of the Oaks Mine

The Oaks Mine started operations in 1998 and ceased all mining activities in July 2008. The mine utilised an open cast method to extract the Kimberlite ore from the pit (Mban, 2008). Truck and shovel operations were used to excavate the Kimberlite which was then 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 were then transported to the waste rock dump and Mine Residue Disposal Complex (MRDC). In 2008, when operations ceased, a total of approximately 2 400 000 tons of Kimberlite ore had been extracted and treated. However gradually the ore reserves became depleted and closure was initiated (ERM, 2008).
Figure 3.2: Provincial locality of the Oaks Mine (after ERM, 2008)

3.4 Bio-physical Extent

The bio-physical (natural) environment includes “…the nature of the living space (sea or land, soil or water), the chemical constituents and physical properties of the living space, the climate, and the assortment of other organisms present” (Mayhew, 2009: 1). In this section the bio-physical extent is defined as the point or degree to which the natural environment extends within the Limpopo Province and the Oaks Mine site. This section illustrates the climate, topography, geology and soils, land capability and land use, surface and groundwater, and flora and fauna within the province and the site.
3.4.1 Climate and Air Quality

Limpopo Province is located in a summer rainfall region. The western portion of the province is a semi-arid to arid region whereas the eastern portion is a sub-tropical region (Limpopo DFED, 2003). Droughts mostly occur in the western and far northern portions of the province. “The mean annual temperature of the Limpopo Province ranges from 16° in the south to 22° in the north, with an average of 20° for the whole province. The average maximum monthly temperature is 30° in the month of January, while the average minimum monthly temperature is 4° in the month of July” (DWAF, 2004: 15). Winter temperatures throughout the province are mostly mild with limited frost occurrences (Limpopo DFED, 2003).

The provincial rainfall is low and diverse ranging from 200 mm a⁻¹ in the north to greater than 1,200 mm a⁻¹ in the Soutpansberg Mountains. General trends indicate that the rainfall decreases from south to north (DWAF, 2004). Rainfall in the semi-arid to arid regions of the province ranges from 300 to 500 mm a⁻¹, with most of the rainfall occurring in January. In the Central Bushveld region, rainfall is greater than in the Northern Arid Bushveld with rainfall ranging from 500 to 750 mm a⁻¹ (De Villiers, 2011). East of the Central Bushveld is the Lowveld Bushveld region which has an average rainfall of 600 mm a⁻¹ but the humidity in the region is high. Further east is the Lowveld Mountain Bushveld which has higher rainfall averages due to the mountainous terrain. The rainfall is orographic in nature with a peak rainfall of 2,000 mm which occurs in January (De Villiers, 2011).

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. Most of the rainfall occurs between November and March. This region has drastic monthly and annual variations in rainfall. This variation is depicted in Table 3.1 (ERM, 2008). It should be noted that there is limited climatic data available due to the remote nature of the site and nearest town. There is no long-term meteorological data for the site and its surroundings. Table 3.1 includes available climatic data.

<table>
<thead>
<tr>
<th>Station</th>
<th>Location (Latitude &amp; Longitude)</th>
<th>Elevation of Rain Gauges (masl)</th>
<th>Time Period</th>
<th>Mean Annual Rainfall (mm a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elanshoek</td>
<td>22°43’S; 28°33’E</td>
<td>820</td>
<td>1992-1996</td>
<td>452</td>
</tr>
<tr>
<td>Tolwe</td>
<td>22°59’S; 28°34’E</td>
<td>840</td>
<td>1969-1996</td>
<td>409</td>
</tr>
<tr>
<td>Towle</td>
<td>22°59’S; 28°34’E</td>
<td>840</td>
<td>1997-2008</td>
<td>355</td>
</tr>
<tr>
<td>Oaks Farm</td>
<td>22°57’S; 28°18’E</td>
<td>892</td>
<td>1999</td>
<td>340</td>
</tr>
<tr>
<td>Zoetfontein Farm</td>
<td>22°47’S; 28°18’E</td>
<td>940</td>
<td>2007-2008</td>
<td>711</td>
</tr>
<tr>
<td>Oaks Farm</td>
<td>22°57’S; 28°18’E</td>
<td>892</td>
<td>2000</td>
<td>859</td>
</tr>
<tr>
<td>Oaks Farm</td>
<td>22°57’S; 28°18’E</td>
<td>892</td>
<td>2001</td>
<td>585</td>
</tr>
</tbody>
</table>
High evaporation rates do occur in this region due to the lack of available moisture. Average potential evaporation rates range from 100 mm in July to 268 mm in January (ERM, 2008). These will affect the surface water runoff in the area, adding to the low runoff of 4 mm.

Regionally the air quality indicators are below the threshold of concern. However this may change as more coal power stations are being established in the Province. This will thus increase the amount of coal extracted in the Province. Increased extraction will result in significant impacts on human health and the environment (Limpopo DFED, 2003).

3.4.2 Topography

The topography of Limpopo Province is diverse with numerous important environmental features. The topography is characterised by the Limpopo Plains, located in the northern portions of the province, and the Bushveld Basin. Surrounding this basin is the Central Highland which on the east is bordered by the Great Escarpment and Eastern Plateau Slopes (Limpopo DFED, 2003). Within the province there are significant scenic areas which include: the Waterberg Complex with its tablelands and escarpments; the Soutpansberg and Blouberg mountain ranges; and in the north the extensive plains of the Limpopo River (Limpopo DFED, 2003). The topography of Limpopo province is depicted in Figure 3.3.
Figure 3.3: Limpopo Province drainage and relief (supplied by Acudraft)
The general topography of the Oaks Mine property is depicted in Figure 3.4. The property has a flat topography with a slope gradient of approximately 1:100 which has been illustrated in Figure 3.5. The calcrete ridges (called Vlieërante) east of the property have an altitude that ranges from 950 to 1 100 masl. The mean altitude at the actual mine site is 900 masl (ERM, 2008).

The topography of the Oaks Mine has been altered by the development of a waste rock dump and Mine Residue Disposal Complex (MRDC). However the combined size of 46 ha is only 1.1% of the total 500 ha of the property. Due to the small area of these sites, the property has been insignificantly altered from a topographical consideration.

Figure 3.4: Topography of the Oaks Mine (Sivertsen, 2011)
3.4.3 Geology and Soils

In the Limpopo Province there are numerous lithologies. The Limpopo Mobile Belt and Soutpansberg Group occur in the north. The Soutpansberg and Blouberg mountains form part of this group. The Waterberg sandstone and Bushveld complex are located in the southern portions of the province. The northern slopes of the Bushveld complex are made up of Nebo Granite and the Lebowa Granite Suite which are important for mining. The central portion of Limpopo Province is made up of Houtrivier and Mashashane gneisses with intrusions of Mashashane and Matlala granites (DWAF, 2004).
On the other hand the geology of the Oaks Mine is not as complex as the regional geology and is depicted in Figure 3.6. The Kimberlite ore body, found on site, is an intrusion into the Quartzofelspathic and Amphibolite gneisses of the Limpopo Mobile Belt. On the southern side of the Kimberlite ore body is a low ridge of calcere-capped Amphibolites and Metaquartzites. The Kimberlite ore body is weathered to a depth of 40 m with a calcere surface. Surrounding the ore body is black-white Plagioclaseamphibole gneiss which has a strong metamorphic fabric (Cymbian, 2007).

The soils of Limpopo Province are complex and are summarised as follows. In the north there are deep sandy soils whereas in the central regions there are moderate to deep sandy loam soils. In the south there is a mixture of sandy loam and clayey soils. Clayey loam soils dominate the Soutpansberg area. The deep soils distributed sparsely across Limpopo Province are usable for agriculture however the limited regional rainfall and runoff has restricted the development of agriculture (DWAF, 2004).

Figure 3.6: Geology of the Oaks Mine and surrounding Areas (ERM, 2008)
The soils found at the Oaks Mine are not high in clay with a topsoil clay content of between 10% and 20%. This content increases slightly in the subsoils. The soil is mostly red and unstructured with calcrete (Cymbian, 2007). The calcrete extends to depths between 400 and 600 mm. This results in the soil having a low agricultural potential and is further exacerbated by the sandy texture of the soil and the unsuitable climate of the region (Cymbian, 2007).

The soils found at the actual mine site are of the Hutton Form which means that they are highly suitable for reclamation (Cymbian, 2007). Soil disturbance during construction and operation phases was approximately $2 \times 10^6$ m$^3$ which in retrospect is not a very large area however the soil had to be stripped and topsoiled correctly (Cymbian, 2007). This process is discussed in greater detail in Section 5.4.3.

### 3.4.4 Land Capability and Land Use

The climate of Limpopo Province does not allow for dryland agriculture and there is limited surface runoff for irrigation. The dominant land use in the province is stock farming, mostly cattle farming. The dominant land uses are depicted in Figure 3.7. There has however been an increase in the development of game farms in the region. Many of the game farms are used for hunting purposes. Hunting in the province is conducted on provincial and private game farms (Limpopo Tourism and Parks, 2011). Hunting has become a very popular activity and this province provides 63% of the revenue generated by hunting in South Africa (Polokwane Business Directory, 2004). Most of the area is still covered by natural vegetation (DWAF, 2004). The land use in the Limpopo WMA is summarised in Table 3.2. It should be noted that “other” land uses in table are mostly natural veld used for stock or game farming.

<table>
<thead>
<tr>
<th>Area</th>
<th>Irrigation</th>
<th>Dryland Crops</th>
<th>Afforestation</th>
<th>Nature Reserves</th>
<th>Urban</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matlabas</td>
<td>28</td>
<td>37</td>
<td>0</td>
<td>387</td>
<td>0</td>
<td>5 562</td>
<td>6 014</td>
</tr>
<tr>
<td>Mokolo</td>
<td>100</td>
<td>733</td>
<td>0</td>
<td>131</td>
<td>0</td>
<td>7 431</td>
<td>8 395</td>
</tr>
<tr>
<td>Lephalala</td>
<td>77</td>
<td>372</td>
<td>0</td>
<td>199</td>
<td>14</td>
<td>6 063</td>
<td>6 725</td>
</tr>
<tr>
<td>Mogalakwena</td>
<td>103</td>
<td>2 885</td>
<td>0</td>
<td>931</td>
<td>20</td>
<td>15 375</td>
<td>19 314</td>
</tr>
<tr>
<td>Sand</td>
<td>76</td>
<td>1 330</td>
<td>12</td>
<td>562</td>
<td>32</td>
<td>13 757</td>
<td>15 769</td>
</tr>
<tr>
<td>Nzhelele</td>
<td>21</td>
<td>221</td>
<td>26</td>
<td>86</td>
<td>0</td>
<td>2 713</td>
<td>3 067</td>
</tr>
<tr>
<td>Nwanedi</td>
<td>25</td>
<td>83</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 028</td>
<td>1 136</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>430</strong></td>
<td><strong>5 661</strong></td>
<td><strong>38</strong></td>
<td><strong>2 296</strong></td>
<td><strong>66</strong></td>
<td><strong>51 929</strong></td>
<td><strong>60 420</strong></td>
</tr>
</tbody>
</table>

Table 3.2: Land use in Limpopo WMA (km$^2$) (DWAF, 2004)
Figure 3.7: Limpopo Province land use (Supplied by Acudraft)
The farms surrounding the Oaks Mine property are utilised for cattle and game farming with game farming being the more dominant land use. It is expanding as it currently generates higher revenue for the farmer than commercial cattle farming (du Plessis, 2011). The Oaks Mine property, in its entirety, is classified as grazing land. The pre-mining land use was commercial beef production with a stocking rate of 1 livestock unit per 15 ha. On the western portion of the farm however there was evidence that dryland cropping had been conducted in the past. There is a low agricultural potential as there is only one area on the property where agricultural has been previously practiced. The general land uses of the Oaks Mine are depicted in Figure 3.8. During closure De Beers converted the official land use classification from commercial livestock farm to a conservation area and game farm.

Figure 3.8: Land uses at the Oaks Mine (Supplied by Acudraft)
3.4.5 Surface and Ground Water

Limpopo Province is a water stressed province because it has limited surface and ground water resources. Many people in the province do not have access to water supplies. Groundwater is the main provincial source of water supply (Limpopo DFED, 2003; DWAF, 2004). South Africa is divided into 19 Water Management Areas (WMAs). The Limpopo WMA is the northern-most water management area in South Africa and falls within the Limpopo River Basin. This WMA borders Botswana and Zimbabwe with the Limpopo River forming the border (DWAF, 2004). The Limpopo WMA covers a surface area of 60 420 km² (Midgely et al. 1994). Seven major rivers form part of this WMA and include: the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele, and Nwanedi. These rivers, which are depicted in Figure 3.3, drain predominantly from the north and east; and eventually drain into the Limpopo and Olifants Rivers (DWAF, 2004). These rivers and their annual runoff are summarised in Table 3.3.

<table>
<thead>
<tr>
<th>Area</th>
<th>Natural Runoff (x 10^6 m³ a⁻¹)</th>
<th>Natural Runoff (mm a⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matlabas</td>
<td>49</td>
<td>8</td>
</tr>
<tr>
<td>Mokolo</td>
<td>312</td>
<td>37</td>
</tr>
<tr>
<td>Lephalala</td>
<td>142</td>
<td>21</td>
</tr>
<tr>
<td>Mogalakwena</td>
<td>255</td>
<td>13</td>
</tr>
<tr>
<td>Sand</td>
<td>64</td>
<td>1</td>
</tr>
<tr>
<td>Nzhelele</td>
<td>89</td>
<td>29</td>
</tr>
<tr>
<td>Nwanedi</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>936</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

The runoff distribution (Table 3.3) is directly associated with the higher than average rainfall present in the mountainous areas of the Waterberg and Soutpansberg ranges. The Lephalala River and drainage area falls within the semi-arid to arid region of the province and contributes 15% (142 x 10^6 m³ a⁻¹) to the total runoff (936 x 10^6 m³) (DWAF, 2004).

In comparison to the other provinces in South Africa, there are limited areas in Limpopo Province to accommodate the development of dams. The Mokolo Dam, located on the Mokolo River, is the largest dam in the province. The total supply capacity of the dam is 146 x 10^6 m³ with a mean annual runoff of 240 x 10^6 m³ a⁻¹ (Midgely et al., 1994). Water from the Mokolo Dam is supplied to:

- Matimba power station (7.3 x 10^6 m³ a⁻¹);
- Grootegeluk coal mine (9.9 x 10^6 m³ a⁻¹);
- Lephalale town (1.0 x 10^6 m³ a⁻¹); and
• Downstream irrigation (10.4 x 10^6 m^3 a^{-1}). (DWAF, 2001).

Due to the limited surface runoff and dam generation, the province is heavily reliant on groundwater supply. The amount of groundwater available across the province varies greatly because of the hydrological characteristics of the underlying aquifers. Most of the rural areas and communities use groundwater for domestic and agricultural purposes. For example north of Polokwane and in Dendron, large groundwater abstractions for irrigation and domestic purposes are practiced. The total groundwater supply is estimated at 460 x 10^6 m^3 a^{-1} (DWAF, 2004). Groundwater supply in the major river regions of the Limpopo WMA are provided in Table 3.4.

Table 3.4: Groundwater supply in Limpopo WMA (DWAF, 2004)

<table>
<thead>
<tr>
<th>Area</th>
<th>Groundwater Supply (x 10^6 m^3 a^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matlabas</td>
<td>4</td>
</tr>
<tr>
<td>Mokolo</td>
<td>11</td>
</tr>
<tr>
<td>Lephalala</td>
<td>12</td>
</tr>
<tr>
<td>Mogalakwena</td>
<td>55</td>
</tr>
<tr>
<td>Sand</td>
<td>165</td>
</tr>
<tr>
<td>Nzhelele</td>
<td>11</td>
</tr>
<tr>
<td>Nwanedi</td>
<td>2</td>
</tr>
<tr>
<td>Limpopo Main Stem</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>310</strong></td>
</tr>
</tbody>
</table>

Mining is one of the industrial activities in Limpopo Province that severely affects the volume of water abstracted. This results in a decrease in the provincial surface and ground water levels. Abstractions of water from water resources are expected to increase as new mines and power stations are constructed to exploit the Waterberg coal resources. In addition groundwater quality has been affected (such as groundwater pollution and abstraction) by mining activities in the province. The pollution of groundwater is a serious provincial issue because the pollution is diffused to numerous areas (DWAF, 2004). In 2006 a groundwater quality investigation was conducted in Limpopo Province. 26 boreholes were drilled across the province. The results indicated that groundwater quality was, in most cases, not suitable for domestic or agricultural use. The areas with poor quality groundwater are the Springbok Flats and the northern area of the Soutpansberg which have high concentrations of Fluoride, Nitrates and Solutes (Tredoux & Talma, 2006).
The Oaks Mine is located in the A50J Quaternary catchment area. 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 in the east. The drainage patterns are illustrated in Figure 3.5. The property is reliant on groundwater for water supply (Cymbian, 2007). A shear zone “aquifer” is used for water abstraction. This aquifer is classified as a minor aquifer with low vulnerability and susceptibility, and flows from southeast to northwest (ERM, 2008).

Post-closure water supplies will however be sufficient to sustain the end land use (Cymbian, 2007). The groundwater is at an average depth of 20 to 30 m below surface, and gradient is towards the pit. The groundwater is naturally of a low (domestic) quality and cannot be used for drinking purposes. However the water was of adequate quality to be used for diamond extraction (ERM, 2008). Due to the low quality groundwater, it will not be severely affected by Mine Residue Disposal Complex leaching thus limiting the large groundwater pollution plumes (Cymbian, 2007).

3.4.6 Flora and Fauna

The Limpopo Province is characterised predominately by the greater Savanna biome (commonly called the Bushveld) with small portions of the province residing in the grassland and forest biomes (Limpopo DFED, 2003). The Savanna biome is the largest biome in South Africa which occupies 46% of the country (ARC, 2003). The Savanna biome is characterised by a grassy ground cover and an upper layer of woody plants (Low & Rebelo, 1996). There are three zones of endemic vegetation found in the province and include the Drakensberg Escarpment, Sekhukhuneland and Soutpansberg. There are 15 veld types in the province which are depicted in Table 3.5.

Natural forests (Northern Mist Belt and Afromontane Forests) are present in the province but are limited to approximately 19 000 ha. This is one of the threatened vegetation types in the province. Other threatened types include the Turf thornveld and Pietersburg false grassveld (Low & Rebelo, 1996). There are approximately 170 threatened and rare plant species in the province many of which are used for traditional medicinal purposes (Limpopo DFED, 2003).

Limpopo Province is known for its numerous protected areas. There are 52 protected areas which covers an area of ~336 000 ha. Of these areas the most famous is the Kruger National Park which accounts for 5.6% of the total surface area of the province. The Kruger National Park is characterised by the Mopane Bushveld which is a dense cover of Mopane (Colophospermum mopane) and other tree species (Low & Rebelo, 1996). In addition there are 28 natural heritage sites and numerous private conservation areas. These areas contribute to the conversation and protection of the provincial environment (Limpopo DFED, 2003).
Table 3.5: Veld types of Limpopo Province (Acocks, 1974)

<table>
<thead>
<tr>
<th>Biome</th>
<th>Veld Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushveld</td>
<td>Mopani veld</td>
</tr>
<tr>
<td></td>
<td>Arid Sweet Bushveld</td>
</tr>
<tr>
<td></td>
<td>Lowveld Sour Bushveld</td>
</tr>
<tr>
<td></td>
<td>Sour Bushveld</td>
</tr>
<tr>
<td></td>
<td>Arid Lowveld</td>
</tr>
<tr>
<td></td>
<td>Sour Mixed Bushveld</td>
</tr>
<tr>
<td></td>
<td>Springbok Flats Turf Thornveld</td>
</tr>
<tr>
<td></td>
<td>Mixed Bushveld</td>
</tr>
<tr>
<td></td>
<td>Lowveld</td>
</tr>
<tr>
<td></td>
<td>Kalahari Thornveld and Shurb Bushveld</td>
</tr>
<tr>
<td></td>
<td>Sourish Mixed Bushveld</td>
</tr>
<tr>
<td></td>
<td>Other Turf Thornveld</td>
</tr>
<tr>
<td>Grassland</td>
<td>North-eastern mountain Sourveld</td>
</tr>
<tr>
<td></td>
<td>Pietersburg Plateau Grassveld</td>
</tr>
<tr>
<td></td>
<td>North-eastern Sandy Highveld</td>
</tr>
<tr>
<td>Forest</td>
<td>Afromontane Forest</td>
</tr>
</tbody>
</table>

The province has a wide variety of larger mammal species however some of their habitats are vulnerable and are restricted to small areas of the province. One of the threatened mammal species is the Gunning’s Golden Mole (Amblysomus gunningi) which is found on the Red Data List and is endemic to the province. The province is also home to numerous significant bird species and habitats such as the renowned Nylsvley floodplain ecosystem. There are 148 reptiles in the province which represents a diverse species population (Limpopo DFED, 2003).

Surrounding the mining area is a mixed dense woodland which has a cover of >75% (Cymbian, 2007). It is characterised by numerous tree species such as Acacia nigrescens, Lannea schweinfurthii, Sclerocarya birrea, Boscia albitrunca and Commiphora spp. The eastern calcrete ridges of the Oaks Mine site are dominated by a woodland savannah. This vegetation type is characterised by a variety of trees, shrubs and grasses (Cymbian, 2007). The dominant species include Acacia grandicornuta and Acacia mellifera. Vegetation species of significance are found on the property and include the Aloe littoralis and the Baobab tree (Adansonia digitata). These species are most commonly found on the eastern calcrete ridges (Cymbian, 2007).

The vegetation in the vicinity of the mining area has been disturbed. It is claimed by Cymbian (2007) that this disturbance has been minimal, as the mining area is very small in comparison to the whole property. The vegetation on the rest of the property is undisturbed and in “pristine” condition (Cymbian, 2007). The fauna found on the Oaks Mine is diverse and there are numerous large mammal species, mainly herbivores, including warthog (Phacochoerus aethiopicus), duiker...
(Sylvicapra grimmia), steenbok (Raphicerus campestris). There are a few smaller carnivore species present. The herpetological and invertebrate fauna on the property have not been identified (Cymbian, 2007).

3.5 Socio-Economic Context

The socio-economic environment is the “...interaction between the social and economic factors” (Stevenson, 2010: 1). The socio-economic contexts of the Limpopo Province and the Oaks Mine are discussed in this section. The provincial archaeological and heritage data is of great importance as it depicts the heritage diversity of Limpopo Province which contributes to the heritage of South Africa. It is for this reason that the archaeological and heritage data are discussed in the section below and not in the social section where it is commonly found.

3.5.1 Archaeology and Heritage

Heritage is an important resource for Limpopo Province because it bridges the gap between ancient and modern. This is strengthened by the numerous archaeological, cultural and historical heritage sites. The most well-known sites include: the Mapungubwe World Heritage Site; Thulamela Iron Age site (Kruger National Park); the Makapans Caves near Mokopane; the Garden of Modjadji the Rain Queen; and the San paintings of the Waterberg and Soutpansberg (Limpopo DFED, 2003).

An archaeological survey was conducted prior to the commencement of mining operations. It was noted in this survey that: a) there is some small traces of evidence of Middle Stone Age activity as there is limited scattering of stone tools; and b) Iron Age occupational sites are present on the southern and eastern sides of the open pit workings, however these sites are of little conservational value and if disturbed will need minimal mitigation (De Beers Consolidated Mines, 1998). Therefore there are no heritage sites of conservational and economic value within the mining property.

3.5.2 Social

The province has a mixed cultural population of approximately 5.27 million people, which is 12% of South Africa’s total population. 52.6% of the provincial population is younger than 20 years of age. This province is therefore characterised as a young province. Most of the people residing in the province live in a rural setting thus the province is predominantly rural in nature with the greatest portion (82%) of the population living in rural areas (Limpopo DFED, 2003; DWAF, 2004). The number of people living in rural and urban areas is depicted in Table 3.6.
Table 3.6: Population in Limpopo Province, 2001 (DWAF, 2001)

<table>
<thead>
<tr>
<th>Area</th>
<th>Rural</th>
<th>Urban</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matlabas</td>
<td>10 045</td>
<td>0</td>
<td>10 045</td>
</tr>
<tr>
<td>Mokolo</td>
<td>23 234</td>
<td>13 128</td>
<td>36 362</td>
</tr>
<tr>
<td>Lephalala</td>
<td>63 008</td>
<td>2 923</td>
<td>65 931</td>
</tr>
<tr>
<td>Mogalakwena</td>
<td>489 285</td>
<td>76 802</td>
<td>566 087</td>
</tr>
<tr>
<td>Sand</td>
<td>543 478</td>
<td>178 434</td>
<td>721 191</td>
</tr>
<tr>
<td>Nzhelele</td>
<td>155 324</td>
<td>2 118</td>
<td>5 368</td>
</tr>
<tr>
<td>Nwanedi</td>
<td>13 650</td>
<td>3 250</td>
<td>16 890</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1 298 024</strong></td>
<td><strong>276 655</strong></td>
<td><strong>1 574 679</strong></td>
</tr>
</tbody>
</table>

The people between the ages of 5 and 24 have a diverse range of literacy skills and education (depicted in Figure 3.9). 74% of these people attend school, 22% do not attend any form of educational institution and only 1% has a tertiary education (Limpopo DFED, 2003). Health problems seriously affected the population of Limpopo Province. The major health problems include: tuberculosis; HIV/AIDS; sexually transmitted diseases; upper respiratory tract infections; diarrhea; bilharzia; and malaria (Limpopo DFED, 2003).

![Levels of education of adults in Limpopo](image_url)

**Figure 3.9:** Levels of education of adults in Limpopo (Limpopo DFED, 2003)

In terms of settlements and urban areas, the apartheid policies have shaped and characterised these areas. The larger towns in this province were dominated by large white populations and high economic activities whereas smaller towns, settlements and homelands were populated with black, coloured and other races, and were determined by political forces and interventions. The patterns
which developed from these policies are more noticeable in Limpopo Province than the other provinces in South Africa (Limpopo DFED, 2003).

Limpopo Province has 6 district and 26 local municipalities. The capital city is Polokwane which is the centre of commerce and government for the province. This town services a wide surface area which extends into Zimbabwe and Botswana. Other towns service specific industries. For example Phalaborwa, Thabazimbi, Burgersfort and Lephalale are the main centres used to service the mining industry (Limpopo DFED, 2003).

There are an estimated 2,453 settlements with approximately 1,180,000 households in Limpopo Province. The majority of these settlements are in the former homelands of Gazankulu, Venda and Lebowa. From a demographic and economic stance, these settlements were not naturally developed and have yet to develop a sustainable economic base. Households in these settlements mostly rely on grants and migrational breadwinners (migration to urban areas, towns or farms) to provide the necessities to survive (Limpopo DFED, 2003).

The nearest town to the Oaks Mine is Swartwater – see Figure 3.2 above – located 8 km northwest of the mine. Swartwater is a very small town in comparison to the next nearest town, Mokopane, which is 175 km southeast of the mine. Swartwater has a total population of 450 people (Lephalale Municipality, 2009). The dwellings are widely scattered on smallholdings and farms – as a result the town centre occupies a small surface area (Lephalale Municipality, 2009). The town has limited services available, comprising of a spaza shop (general dealer), a post office and two churches. A small labour force was employed by the Oaks Mine. There were approximately 60 permanent staff and 100 contract personnel (Cymbian, 2007).

3.5.3 Economic

The economy of the Limpopo Province is small in comparison to the other provinces. It is mostly dependent on production and industrial activities, and has a large consumer population with limited income to spend. However the province has the highest potential in the country for economic development as it provides numerous sources for investment (Limpopo DFED, 2003). Different economic sectors contribute to the Gross Domestic Product (GDP) of the province and include:

- Government;
- Electricity;
- Trade;
- Agriculture;
- Financial Services; and
- Mining (DWAF, 2004).
The economy is supported by two major sectors: agriculture and mining. Mining is the largest contributor to economic growth, generating 24.2% of the provincial growth. Agriculture is the second largest sector that has provided approximately 120 000 of the 664 000 jobs in the province (Limpopo DFED, 2003).

During 2001, Limpopo Province had the highest economic growth rate of all the provinces of 6.8%, and also had the highest real economic growth rate between 1995 and 2001 (Limpopo DFED, 2003). However there are still numerous members of the population who are unemployed. “Approximately 1.3 million people between the ages of 15 and 65 are economically active...about 51% of the economically active population are employed and 49% are unemployed” (Limpopo DFED, 2003: 16).

Swartwater is an agricultural town with its economy mostly being supported by farming and agriculture (Lephalale Municipality, 2009). The main form of farming is stock farming, more specifically cattle farming. The Oaks Mine property was utilised for this purpose. Game farming and eco-tourism have increased in the area as more people have become more aware of the importance of conservation. The Oaks Mine property is presently being developed to be a conservation area and game farm. The town supports the farmers with basic infrastructure and services but is too small to service a large area. Mining in the area has increased marginally. The surrounding area has large and small scale mining, in addition to the now defunct Oaks Mine, which fall within a 50 km radius of the town (Lephalale Municipality, 2009).

The Oaks Mine falls within the Lephalale spatial development initiatives (Cymbian, 2007). The Lephalale Spatial Development Initiative (SDI) is a municipal management tool that integrates planning and delivery. The SDI is used to address issues such as land management, and social and economic development within Lephalale Municipality area. It is also used to align the current social and economic situation with future goals of satisfying community needs within a five year period (Lephalale Municipality, 2009). Therefore all the improvements proposed in the SDI will directly influence Swartwater and the surrounding community of the Oaks Mine.

### 3.6 Conclusion

This chapter has examined the bio-physical and socio-economic extent of Limpopo Province and the Oaks Mine. It is clear that the bio-physical environment at the Oaks Mine is diverse with a wide range of flora and fauna. The site is characterised by a semi-arid to arid climate, with low to moderate wind speeds. The Oaks Mine has limited surface and groundwater supply. The site has poor quality soil, unsuitable for agriculture.
The site and its surrounds have a low population demographic. The closest town, Swartwater, is an agricultural town which supplies goods and services to approximately 400 inhabitants, mainly involved in cattle farming, game conservation and hunting. As a result of the sparse population, the De Beers Oaks mine did not have as many social remediation issues on closure as other mines often experience.
CHAPTER 4  CASE STUDY APPROACH AND CRITICAL ANALYSIS
APPLIED TO THE CLOSURE OF THE OAKS MINE

4.1  Introduction

Research generally will use either a qualitative or quantitative methodology. In the case of this
research, the objectives set were qualitatively oriented and located directly within the qualitative
paradigm. A qualitative methodology is characterised by the tendency to produce qualitative data;
the use of smaller samples; the high validity of the research; and the development of subjective and
rich data (Collis & Hussey, 2003).

Within the qualitative methodology, there are specific types of methods that can be utilised to
acquire and examine data. An integrated qualitative approach was taken to analyse the Oaks Mine
closure process which included: information from documents developed for closure; interviews
conducted with both De Beers personnel and government officials to understand each of their
perspectives; and site visits to observe and fully understand the bio-physical aspects of the closure
process. Since 2002, when the Mineral and Petroleum Resources Development Act was
promulgated and the requirement for a mine closure certificate was legislated, no certificates have
been issued in South Africa. The research uses a case study approach of the Oaks Mine as a case
study. The reason for this was because, if successful in its application, the Oaks Mine would be the
first mine in South Africa to achieve a closure certificate.

The Oaks Mine closure plan was examined and analysed to identify the closure process used by De
Beers. An analytical study is one in which the researcher does not merely describe the issues and
problems, but rather analyses and explains why and how it happens (Collis & Hussey, 2003).
Therefore a critical analysis of all documentation pertaining to the Oaks Mine closure process was
conducted to ensure that the objectives set by De Beer were actually achieved. South African mine
closure legislation was assessed in the context of the De Beers Oaks closure procedures and
application process to determine the ways in which De Beers complied with legislative
requirements, and overcame the anticipated objections of government that have hindered other
applications from achieving the desired closure certificates.

The primary research information was collected by means of assembling documentation related to
closure planning, implementation and application for the certificate; interviews with key
stakeholders; and site visits. Open-ended and semi-structured interviews were the primary source
of support information collected to verify the Oaks Mine closure procedures and to determine the
institutional problems associated with issuing a mine closure certificate from the perspective of the
government.
4.2 Ethical Considerations

De Beers granted permission to the researcher to conduct a critical analysis of the Oaks Diamond Mine closure procedure. As a result, the research has minor ethical considerations that need to be noted. These include:

- Ensuring that the research is accurate and not subjective;
- Avoiding generalisations pertaining to mine closure procedures and practices;
- Respecting the confidentiality of specific information provided by the selected organisation for the research; and
- Ensuring that organizational information is presented correctly.

It should also be noted that the researcher is not working directly with communities and people are not the research subjects. Furthermore the De Beers Oaks Diamond Mine fulfilled the legislated social requirements pertaining to mine closure. The mine in question did not have serious social implications to consider.

4.3 Data Collection

Interviews and documentation collection were used as the primary methods to acquire data and source information necessary for evaluating and analysing the closure procedures of the Oaks Mine. The researcher obtained official permission from De Beers in 2010 to conduct this research and therefore had access to site as well as to all required documentation and relevant personnel. Two site visits were conducted to examine the results of the implemented closure and monitoring procedures. The first site visit was in September 2010 and the second was in May 2011. Details of the visits are presented in Appendix 1. The Environmental Officer from De Beers accompanied the researcher on site and provided extensive information regarding the site and its mine closure process.

4.3.1 Documentation Collection

Copies of all documentation developed for the Closure Plan of the Oaks Mine was given to the researched by the Mine Manager. The documentation collected included:

- Final Closure Plan of the Oaks Mine developed by Environmental Resource Management (ERM);
- Statutory Obligations with regards to the Closure of the Oaks Diamond Mine developed by De Beers;
- Oaks Mine Closure: Stakeholder Engagement and Consultation Report developed by ERM;
• Government / Authorities Engagement and Consultation Report developed by ERM;
• The Oaks Mine: Rehabilitation Plan developed by E_TEK Consulting;
• Second Level Environmental Risk Report developed by ERM;
• Limited Storm Water Investigation Report developed by ERM;
• Limited Phase I / Phase II Soil Investigation Report developed by ERM;
• Screening Level Biodiversity Risk Assessment Report developed by ERM; and
• Hydrological Investigation Report developed by ERM.

All relevant South African legislation pertaining to mine closure was also acquired and reviewed. The following acts were collected and utilised:

- Mineral and Petroleum Resources Development Act No. 28 of 2002;
- National Environmental Management Act No. 107 of 1998;
- National Water Act No. 36 of 1998; and

4.3.2 Open-ended Interviews

Once all documentation had been collected and examined, open-ended interviews were conducted with relevant personnel from De Beers to gain insight into the closure procedures. Open-ended interviews are defined as conversations between the interviewer and interviewee to explore the interviewee’s ideas, views and belief about certain phenomena (Maree, 2008).

Open-ended interviews have been used previously in mine closure research, however mostly for research of a social nature. For example Nygren & Karlsson (1992) did a study on the coping strategies of miners and their families after the Stekenjokk Mine in Northwest Sweden had closed. Nygren & Karlsson (1992) interviewed the miners and their families as well as the mine managers to identify the ways in which the miners deal with the closure of the mine.

In the case of the Oaks Mine, the Mine Manager, the Environmental Officer, the Social Specialist and the Legal Counsel from De Beers were interviewed. These members of De Beers carried the main responsibility to ensure that the closure process was carried out effectively. These interviews were conducted in June 2010 (Specific details of the interviews are recorded in Appendix 1). Follow up interviews were held with the Mine Manager and the Environmental Officer in April and July 2011 (see Appendix 2).

In June 2010, an open-ended interview was also conducted with the Sustainable Development Manager from Anglo American Technical Division as this manager developed the Anglo American plc (AAplc) Toolbox (for mine closure). This toolbox was used to aid the Oaks Mine closure
procedures and implementation thereof. The reason open-ended interviews were selected was because it was flexible and produced in-depth data (Amaratunga et al., 2002).

4.3.3 Semi-structured Interviews

In addition to conducting open-ended interviews, semi-structured interviews were conducted with members of the government specifically from the Department of Mineral Resources (DMR) and Department of Water and Environmental Affairs (DWEA) in July 2011 (See Appendix 3). A semi-structured interview is defined as “...a verbal exchange where one person, the interviewer, attempts to elicit information from another person by asking questions. Although the interviewer prepares a list of predetermined questions semi-structured interviews unfold in a conversational manner offering participants the chance to explore issues they feel are important” (Longhurst, 2010: 103).

Semi-structured interviews have been used in the mine closure field of research to acquire information from key personal working on a project or in a subfield of mine closure. For example Nel (2008) conducted an investigation on South African gold mines that struggle to obtain closure from the government departments. Nel utilised semi-structured interviews with mine managers to gain insight into the management of mine closure and thereafter used the interview to create key findings in this matter. Nel interviewed mine managers, whereas the researcher of the Oaks Mine used semi-structured interviews to obtain information from a range of government officials.

A limited number of interviewees were dealt with to encourage detailed responses and to ensure that the interviewer had the full attention of the interviewee (Rubin & Rubin, 1995). Semi-structured interviews are used to corroborate data collected from other sources and approaches (Maree, 2008). Therefore the interviews held with government officials were used to corroborate the documentary sources to determine the institutional problems associated with the issuing of mine closure certificates.

4.4 Data Collection Benefits and Limitations

In general interviews with stakeholders have numerous limitations and may result in the limitations far outweighing the benefits. The benefits and limitations of stakeholder interviews as developed by Cooper and Schindler (2003) are presented Table 4.1. Even though there are many limitations to this type of interviewing process, certain information and particular points of view cannot be obtained without the use of this methodology, therefore its benefits outweighed its limitations and that for this research it was selected as the best qualitative data collection method to use.

The interview process of this research had few limitations. For example no costs were incurred while doing the interviews as there was not a wide geographical dispersion of interviewees (most
were located in Gauteng). The researcher planned for time constraints and therefore started the data collection process very early (see Appendix 1). The responses to the questions asked were not altered in any way.

**Table 4.1: Benefits and limitations to stakeholder interviews (Cooper & Schindler, 2003)**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good co-operation</td>
<td>High costs</td>
</tr>
<tr>
<td>Interview can probe for answers, use follow-up questions and gather information by observation</td>
<td>Need for highly trained interviewer</td>
</tr>
<tr>
<td>Special visual aids can be used</td>
<td>Longer period needed in the field collecting data</td>
</tr>
<tr>
<td>Interviewer can pre-screen respondents to ensure that he/she fits the profile</td>
<td>May be a wide geographic dispersion</td>
</tr>
<tr>
<td>CAPI – computer assisted personal interviewing</td>
<td>Not all respondents are available or accessible</td>
</tr>
<tr>
<td></td>
<td>Questions may be altered or respondent coached by interviewer</td>
</tr>
</tbody>
</table>

In terms of this research there were areas of positive cooperation and of challenges experienced. Positive and full cooperation were received in the document collection process and interview sessions with De Beers and Anglo American Technical Division. The documentation collection process was done effectively as De Beers were willing to give the researcher all closure documentation for the Oaks Mine. The Sustainable Development Manager from Anglo Technical Division provided the researcher with documentation to explain the functions of the Toolbox and ways in which it can be applied. These two organisations aided the researcher in an effective manner and thus enabled the researcher to conduct an analysis on the Oaks Mine closure process.

Open-ended interviews conducted with members of De Beers and Anglo American were well received. The researcher asked numerous questions to fully understand the process and limitations of the closure methods employed by De Beers. All answers were explained in detail and personal opinions were shared with the researcher. This benefited the way in which the information was utilised and included in the analysis of the Oaks Mine closure process.

Limitations were experienced in the data collection process. The main limitation was the unwillingness of the Limpopo DMR to be interviewed. The DMR official stated that there may be legal ramifications if they were interviewed by the researcher. They further stated that they had not made their decision on whether to issue a closure certificate and as a result they did not feel it would be fair on De Beers if they conducted an interview with the researcher. Another limitation was the inability to contact the different government departments. The researcher tried numerous times to telephonically contact the different government departments and their associated members before finally making contact with the relevant authorities.
4.5 Methodology

Qualitative methodologies were applied due to the exploratory and explanatory nature of mine closure (Mehmetoglu & Altinary, 2005). In qualitative research there are many methods of analysis. The methods chosen for this research topic were dependent on the analytical nature of the research, the research objectives developed, and the time constraints. Therefore the methods used in the research were the case study approach and critical analysis.

4.5.1 Case Study Approach

The case study approach is most commonly used in qualitative studies. Numerous studies have utilised the case study approach. For example Mban (2008) used the case study approach to evaluate the planning methods for mine closure at the Oaks Mine. This study was similar to the research of this dissertation; however Mban’s focus was not on critiquing the closure process, but rather on emphasising planning for closure. The case study approach was utilised by Coetzee et al. (2008) and van Tonder et al. (2008). Both used a South African case study to evaluate the policies and regulations for mine closure in that specific country. Coetzee et al. (2008) evaluated the management of derelict and ownerless mines in South Africa to identify the associated issues of mine management, whereas van Tonder et al. (2008) evaluated the concept of regional mining and closure strategies utilised in South Africa to better understand the strategies employed by mining companies in a regional setting.

According to Yin (2003: 23), a case study is “... a research strategy that comprises an all-encompassing method with a design logic which incorporates specific approaches to data collection and data analysis”. There were two approaches that could have been used by researcher. The first was the single case study approach that focused on a specific group or organization, whereas the second was the multiple case study approach that focused on multiple organisations or individuals. The researcher utilised the single case study approach which was “...aimed at gaining greater insight and understanding the dynamics of a specific situation” (Maree, 2008: 75). The reason a single case study approach was selected was because this approach was used to understand the uniqueness of a particular case and to investigate the dynamics of a single bounded system such as a project (Welman & Kruger, 2002).

The specific case study selected for this research was the De Beers Oaks Diamond Mine situated in Limpopo Province, South Africa. The reason De Beers Oaks Diamond Mine was selected was because firstly, De Beers as an organisation has an excellent reputation for its adherence to international laws and best practice, as well as being conscious of their environmental responsibilities with regards to mining and mine closure, and secondly because the Oaks Mine is expected to be the first mine in South Africa to acquire a mine closure certificate.
There are a number of different types of case studies used in the phenomenological methodology. The case study approach used in this research was an illustrative study. This research attempted to illustrate new and innovative practices adopted by De Beers in order to close the Oaks Mine. This illustrative study was strengthened during the two site visits. During the first site visit it was noted that the closure procedures were still being carried out. For example, the concrete and steel structures of the processing plant were still on-site. During the second site visit, it was noted that the closure procedures had been completed and the monitoring processes had begun. All the concrete and steel had been sold and removed, and all mining areas had been rehabilitated. The procedures used in the rehabilitation and closure of the mine were then critically analysed.

4.5.2 Critical Analysis

Most academic disciplines use critical analysis as a research tool. Critical analysis involves a review and evaluation of certain documentation within a particular field of study (LeJeune, 2001). According to Browne and Keeley (2001: 2) critical analysis “…involves thinking critically, which is applying rational and logical thinking while deconstructing the text and claims made by theorists, official bodies, organisations etc.” Browne and Keeley (2001: 2) go further and defines critical thinking as: “…an awareness of a set of interrelated critical questions; the ability to ask and answer critical questions at appropriate times; and the desire to actively use the critical questions.” The researcher must be critical and base all their judgments on experience gained, knowledge acquired and observations, and evaluations of different texts and documentation (Gould, 2011).

Critical analysis methods have been utilised in numerous studies across many disciplines. In the case of mining, critical analysis has been extensively utilised. For example Van der Zwan and Nel (2010) utilised critical analysis in a study called The Impacts of the Mineral and Petroleum Resource Royalty Act on the South African Mining Industry. The purpose of the study was to “…critically analyse the MPRDA prior to its implementation to identify whether any of its aspects has the potential to have a significant adverse impact on the South African mining industry and would therefore necessitate further research once the regime has been implemented” (Van der Zwan & Nel, 2010: 90).

In the case of this research, critical analysis was the primary method used to evaluate and assess the Oaks Mine and its closure procedures against a set of ideal closure procedures. The documentation given to the researcher (see Section 4.3.1) by De Beers was critically analysed to determine whether the objectives developed by De Beers were relevant and appropriate, achieved in practice and how they were achieved. Areas that did not fulfill the objectives effectively were identified and critiqued. However the successful procedures implemented were also described in greater detail. The critical analysis of the documentation was supported by the open-ended interviews.
conducted with De Beers personnel. The interviews enable the researcher to gain greater insight into the implementation of the mine closure procedures as well as insight into the processes needed to implement these procedures.

Applicable South African mine closure legislation and other relevant legislation for the closure of the Oaks Mine was collected and discussed. This research firstly presented all the legislation needed to close the Oaks Mine and secondly critiqued whether the legislation was achievable and whether De Beers had complied with all applicable legislation. This critique identified all legislation that needed to be included in the Final Closure Plan of the Oaks Mine. The Final Closure Plan was evaluated against the legislation to ensure that the objectives set by De Beers were in line with the legislative requirements developed by the South African government.

4.6 Methodological Limitations

The research procedure as described above has two main methodological limitations:

- No extrapolation of the findings could be made to reflect other mining companies or mines because only a single case study was examined.
- The researcher was limited to work with the recognised information provided by the organisation therefore a degree of bias was possible. However a comparison of the information provided by the company with South African legislation governing mine closure procedures provided an independent framework for a critical analysis. In addition, where possible, interviews were conducted with the relevant government departments to ascertain their perspective on De Beer’s compliance.

4.7 Conclusion

The data collection procedures and interpretive methodologies used in this research were best suited for the study as they provide insight into the legislation needed to close the Oaks Mine, the institutional problems associated with issuing a closure certificate, and the procedures utilised in the closure of the Oaks Mine. This research was validated by combining perspectives from diverse qualitative methodologies. This combination is known as triangulation which limits weakness and fortifies the strengths of each method utilised (Amaratunga et al., 2002).
CHAPTER 5 ANALYSIS AND DISCUSSION OF SOUTH AFRICAN LEGISLATION, INSTITUTIONAL ISSUES AND THE OAKS MINE CLOSURE PROCEDURES

5.1 Introduction

The purpose of this chapter is to present the findings derived from the analysis of the documentation obtained through the data collection process. An integrated, critical analysis of the documentation has been conducted, which has been achieved by using a combination of documentation analysis and interviews as discussed in the previous chapter. This chapter: evaluates the legal requirements for mine closure certification in South Africa; identifies the problems associated with institutional authorisation of closure certificates; and critically analyses the mine closure procedures that were followed in the development of closure for the Oaks Mine.

5.2 Legal Requirements to Acquire Closure

In order to acquire closure of any mining operation, all South African legislation and regulations relating to the closure process need to be complied with. The relevant Acts relating to closure of mining operations are the following: the Mineral and Petroleum Resources Development Act, National Environmental Management Act, National Water Act, and the National Environmental Management: Air Qualities Act. Sections of these Acts dealing with mine closure applicable to the Oaks Mine are discussed in the following paragraphs. It should be noted that this legislation should be utilised in the closure of other mines, however in these 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 legislation will also need to be taken into account. Thereafter, the De Beers documents relating to the closure process of the Oaks Mine will be evaluated against these sections of the Acts (see Section 5.5).

Mineral and Petroleum Resources Development Act 28 of 2002

To facilitate the introduction of the MPRDA in 2002, a transitional programme was developed. The programme required all existing mines in South Africa to convert their old order mining right to a new order mining right. If the mining right was not converted by the 30 April 2009, the mine would have no right over the minerals and thus would cease to exist (Wentzel, 2010). The MPRDA stipulated the procedures that must be followed and the requirements that must be met by the holder of an old order mining right.

In terms of Section 43(1) of the MPRDA, responsibility for any environmental liability, pollution, ecological degradation and the management thereof remains with the (new) mining rights holder until a closure certificate has been issued. 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: 22).

The 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. 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: 23).

Section 41 of the MPRDA allows for the mining right holder to make financial provision for rehabilitation or management of negative environmental impacts. Mining right holders may provide various methods of financial provision. Regulation 54(1) determines that “the quantum of financial provision must provide a detailed itemisation of all actual costs for: (a) a premature closure; (b) decommissioning and final closure of the operations; and (c) post closure management and residual and latent environmental impacts” (DME, 2002: 46). Regulation 54(3) states that “inadequacies in regard to financial provision must be rectified by the mining right holder: (a) in an amendment of the EMP; or (b) within the time frame for; or (c) as determined by the Minister” (DME, 2002: 46).

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: 18).

National Water Act 36 of 1998

Regarding water management two Regulations are presented. The first is 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 is 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: 11).

National Environmental Management Act 107 of 1998

The MPRDA requires the use of NEMA to fully satisfy all closure requirements. Section 24 and 28 are the most important elements of NEMA. 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: 34). However in terms of Section 28 of NEMA, a duty of care is imposed on all persons to remediate environmental damage (DEAT, 1998: 42).

National Environmental Management Act: Air Quality Act, 2004

Section 33 of the AQA was examined. 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: 23).

5.3 Institutional Issues

In South Africa the government plays a vital role in mine closure. The government must ensure that the mining companies have firstly adequately prepared for impacts to occur over the life of mine, and secondly that the companies have carried out the closure plan to the satisfaction of all stakeholders and levels of government (Clark & Clark, 2005). There is strict mining and environmental legislation governing the mine closure process which is said to aid mining companies in acquiring a mine closure certification. However no mines in South Africa have been granted a mine closure certificate (Sivertsen, 2011).

The DMR asserts that this is because no mines are compliant with the legislative requirements (Maduka, 2011). Although this is true for many mining companies, many are compliant. It seems clear then that other issues exist which prevent the granting of a mine closure certificate. These issues are of an institutional nature.
5.3.1 Lack of Resources

The introduction of the MPRDA, NWA and NEMA were very effective in the establishment of legislation that would aid mining companies and government in the requirements needed to conduct mining activities in a given area. One problem with the stringent environmental legislation, identified by du Toit (2011a), was that this legislation holds great potential from an environmental perspective, but many government departments are not equipped with resources to handle the enforcement demands required by the legislation. For example the NWA required extensive resources such as experienced staff, finance, and technical knowledge. However, the DWA did not have these resources available and as a result back-logs were generated. The conversion of old order mining rights to new order resulted in a further delay of all water applications and enforcement requirements of approximately five to six years (du Toit, 2011a). Therefore the implementation of the Act created huge pressure on the DWA.

The government departments tried to rectify the lack of resources by creating an employment drive. Numerous advertisements were placed in South African newspapers stipulating the need for scientists. However the advertisements did not stipulate the required qualifications of the scientists, and thus many people applied for jobs for which they were not qualified. This issue exacerbated the back-log problems because managers had to sort through all the applications regardless of whether they were applicable or not and thus time was lost (du Toit, 2011a). As a result of this issue, government departments developed a training programme which sought to take students with an honours or masters degree and train them to be able to conduct the necessary mining and environmental monitoring and evaluation requirements (du Toit, 2011a). This process was slow and is still on-going as it takes time to train and supervise students. However, it is a potential long-term solution to the lack of staff available at the government departments.

5.3.2 Lack of Communication

The other main institutional issue was the lack of communication. There has always been a lack of communication between the various government departments. This lack of communication extended internally. In other words, there was a lack of communication not just between the different government departments but also between national and provincial governments of the same department (du Toit, 2011a). This lack of communication led to the lack of enforcement found presently in South Africa, which highlighted weaknesses of government to the mining companies. This resulted in certain mining companies taking advantage of these weaknesses by externalising some of their costs (Adler et al., 2007).

This lack of communication developed as a result of the responsibilities being divided up, through the various Acts, amongst a number of government departments. For example mine water
management was implemented and enforced by three primary (national) departments and six secondary (provincial) government departments (Adler et al., 2007). Due to the fragmentation of the legislation and lack of communication, environmental protection was affected and thus serious environmental concerns became prevalent.

For example in 2009 the DMR issued a general authorisation license to Coal of Africa (Pty) Ltd to mine coal near the Mapungubwe World Heritage Site located approximately 200 km west of the Kruger National Park without a Record of Decision (RoD) from the DEA and DWA (du Toit, 2011a). The lack of communication between the three departments resulted in the construction of a coal mine near a World Heritage Site. The RoD had stipulated that Coal of Africa was in violation of numerous environmental Acts and thus had to cease construction in the area (Kumwenda, 2010). No mine in South Africa is allowed to be established within a World Heritage Site without gaining the permission of the DEA. However the DMR was not aware of these stipulations due to the lack of communication and issued a general authorisation for the construction of Vele Mine. The DMR's decision had numerous environmental groups protesting, culminating in an appeal to not allow Coal of Africa to mine in the area at all. An investigation was conducted based on this appeal to determine whether the environmental groups were justified. This investigation took many months to conduct and thus stopped construction on the mine, which resulted in the shares dropping drastically (Kumwenda, 2010). This case is still on going and unresolved. Therefore it can be noted that due to a lack of communication, the environment and economy can be negatively affected.

5.4 Key Closure Procedures for the Oaks Mine

The De Beers philosophy ‘begin with the end in mind’ was adopted at the Oaks Mine; from the start of operations concurrent rehabilitation took place (Khati et al., 2008; Mban, 2008). As a result the Oaks Mine seeks to serve as an international benchmark for mine closure best practice. The main goals develop for the closure of the Oaks Mine were as follows:

- Little to no long-term liability;
- High quality and sustainable rehabilitation;
- Sustainable post closure land use;
- Excellent stakeholder engagement with their views included in the closure planning;
- Effective re-deployment of permanent employees;
- Legally compliant;
- Rehabilitation and closure criteria that satisfies authorities; and
- DMR satisfaction that results in the issuing of a closure certificate with no conditions (ERM, 2008).
This section identifies and critically analyses the procedures adopted and implemented by the Oaks Mine against the legislative requirements presented in Section 5.2. These procedures include: planning; physical and bio-physical closure; stakeholder engagement and socio-economic closure; post closure land use; and closure costs. By examining these procedures insight will be created on whether the goals and objectives were achieved to sufficient degree to merit the acquiring of a mine closure certificate.

5.4.1 Anglo American plc Toolbox for guiding mine closure implementation

Various mine closure toolkits have been developed to assist in the processes of closure. Toolkits / toolboxes are used to guide the technical and managerial challenges which may affect the success of implementing mine closure procedures (Fleury & Copley, 2008). One example of such a toolkit is the International Council of Mining and Metals toolkit (ICMM, 2008), 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 was regarded as primarily a planning tool to enable mining companies to develop the various plans (conceptual, operational, and decommissioning) required for closure and does not provide direct instructions on the methods, processes, and technologies needed for the closure processes of a specific mine. A toolbox, appropriate for use in the closure process, was developed in 2007 for the Anglo American group; this AApcl toolbox (Botha & Coombes, 2007) is more attuned to South African legislation and provides a step by step procedure for acquiring closure. As an Anglo American plc shareholder, De Beers had access to this copyright protected software toolbox (Botha & 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 the mine. It enabled De Beers to initiate an accelerated closure process. The toolbox quantified the different closure aspects in a logical and standardised way in order to ensure adequate financial provisions are available for closure (Mban, 2008).

The AApcl toolbox is a risk based approach that incorporates three tool sets (Figure 5.1) which ensure that the physical, bio-physical and socio-economic aspects of closure are integrated into the final closure procedure (Botha & 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: 4) 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; and
• Ensure there is provision for institutional support”.

Figure 5.1: Tools to aid closure (Credit: Botha & 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. The criteria for rapid assessment are summarised in Table 5.1. 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).

Application of the Toolbox indicated that the operation at the Oaks Mine did not effectively plan for closure (Mban, 2008). As a result De Beers altered their approach to closure and implemented all changes and modifications recommended made in the Toolbox results. The closure modifications pertained mainly planning for closure. These modifications are discussed in Section 5.4.2.
Table 5.1: Criteria for mine closure planning (After Botha & Coombes, 2007)

<table>
<thead>
<tr>
<th>Status of Closure Plan</th>
<th>Years to Closure</th>
<th>Level of Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>&gt;25 or 25 - 15</td>
<td>Physical and biophysical criteria are assumed and closure cost estimates are derived from experience and available information. In moving to reviewed criteria desktop, site specific investigations or detailed studies are required by experienced and qualified experts in relevant disciplines into closure methodology and mine closure criteria to either confirm the assumed criteria above or to establish appropriate criteria for physical and biophysical elements. Social criteria and consultation – either assumed, that is, requirements of I&amp;APs, government and employee, social closure criteria have been assumed and no consultation has taken place, or needs have been assessed, that is, social studies have been conducted and potential impacts and mitigation measures have been identified. The sustainable development/post closure vision has been described and I&amp;APs, government and employees informed of closure plan and may submit concern/issues.</td>
</tr>
<tr>
<td>Draft</td>
<td>15 – 10</td>
<td>Tested physical and biophysical closure criteria – the closure criteria recommended by experienced and qualified experts have been tested through trails (for example rehabilitation) on a small scale and the criteria approved and revised where necessary. Social criteria and consultation – confirmed socio-economic needs and post closure vision have been discussed with employees and I&amp;APs have been updated. I&amp;APs, employees and government have reviewed the closure plan, on-going consultation and feedback on alternatives incorporated into closure plan where necessary.</td>
</tr>
<tr>
<td>Detailed</td>
<td>10 – 5</td>
<td>Proven physical and biophysical criteria – through testing (field trials) criteria have been demonstrated and accepted to be acceptable. I&amp;APs, government have been consulted and are satisfied with closure criteria. Social criteria and consultation – confirmed social closure requirements and land use objectives have been identified in more detail and have been re-confirmed with government and I&amp;APs and they are involved to ensure issues are understood and considered and are afforded opportunity to make changes to closure plan and criteria.</td>
</tr>
<tr>
<td>Final</td>
<td>5 – 0</td>
<td>Physical, bio-physical and social criteria – agreement by the relevant authorities, sign off the closure criteria, I&amp;APs consulted and there is majority agreement with the closure criteria. Social criteria and consultation – majority agreement on final closure aspects and collaboration through partnership.</td>
</tr>
</tbody>
</table>

Class 0 – estimate of closure liability against the closure criteria.
Cash flow – initial contribution to mine closure that is not linked to the financial closure estimate or to a cash flow.

Class 1 – estimate of closure liability against the closure criteria.
Proposed mine closure programme/cash flow – the proposed closure programme is not linked to the financial closure estimate or to a cash flow.

Class 2 – estimate of closure liability against the closure criteria.
Linked programme/cash flow – the proposed closure programme is linked to the financial closure estimate or to a cash flow.

Class 3 – estimate of closure liability against the closure criteria.
Final detailed execution mine closure programme – the final agreed detailed closure execution programme linked to a cash flow, managed on an on-going basis.
5.4.2 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 & Sinding, 2009). From a physical and bio-physical closure perspective, the Oaks Mine was planned with closure in mind as De Beers planned for closure before construction began, the MRDC was progressively and concurrently rehabilitated (ERM, 2008).

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. These included stakeholder disillusionment and loss in terms of consultation outcomes.

5.4.3 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 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 such as the process plant, mine infrastructure, and general infrastructure which included 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 (ERM, 2008). Secondly, the rehabilitation objectives for non-restorable land such as the pit, waste rock dump and MRDC which
were similar to the restorable land objectives but did not include the objective referring to the removal of infrastructure as there was no infrastructure on these facilities that would be removed, and the objective referring to the land being suitable for wildlife as the pit would never be suitable for wildlife due to the high safety risk.

**Restorable land**

The processing plant used the crushing, washing and screening process to extract the diamonds from the Kimberlite ore. 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 (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 broken up to at least 1 m below surface and the remaining concrete be covered with approximately 1 m of waste rock and 300 mm of topsoil. 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 was also inert and does not pose a threat to the environment (see paragraph above). Once this was achieved the area was rehabilitated to match the surrounding topographical profile so that it is presently indistinguishable from the surrounding terrain. The alien plants (*Bidens pilosa* and *Datura*) present were then removed manually. According to the *Conversation of Agricultural Resource Act 43 of 1983*, these species are Category 1 invader plants and are prohibited and must be eradicated (ERM, 2008). The progressive reclamation of the plant infrastructure is depicted in Figure 5.2. This figure shows that the plant area was rehabilitated effectively as this area now blends into the surrounding vegetation.

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. Wash bay hydrocarbons were trapped in Drizit units and removed in similar fashion.
All hydrocarbon contaminated soil was bioremediated and left on-site. Bioremediation is a natural process where microbes are incorporated into the contaminated soil and activated through aeration and irrigation. The contaminated soil on-site was excavated and heaped into fenced off piles known as biopiles. The microbes were then added to the soil and activated. This activation resulted in the degradation of hydrocarbons present in the soil. The bioremediated soil was then analysed to ensure that the process of bioremediated was successful. Once determined successful the soil was left on-site to be utilised in the rehabilitation process. This remediation method ensured that the local soil did not become contaminated with oil and grease thus indicated that the protection of the environment was an important concern of De Beers (ERM, 2008). The DWA and LEDET stated, upon conducting an assessment of the site that they were satisfied with the closure procedures used to clear the oil contaminated areas (Sivertsen, 2011). This response indicates that De Beers has complied with NEMA regulations to the satisfaction of the government departments.

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, p.15). This shows that De Beers is committed to the “reduce, reuse and recycle” (three R’s) policy.

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. Three gravel roads were used to access the mining area. The roads were maintained using watering and bio-degradable coating mechanisms (Dust-Aside). 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. The borrow pit constructed during operations was reseeded early to allow for the establishment of sustainable vegetation cover. The Department of Roads borrow pit was left on-site and not rehabilitated (ERM, 2008).

The areas and infrastructure not being used post-closure (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).

**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 which is depicted in Figure 5.3. A moderate slope failure risk was created by the steep slope angle of 50°. One of the options considered (to reduce this risk) when planning pit closure was to step back the upper benches to a lower angle which would have minimised the risk of slope failure from moderate to low. 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.
but would simply occur at a deeper level. According to the objectives stated in the final closure plan, the non-restorable land will be chemically and physically stable however the pit is not stable (due to the moderate slope failure risk) and as a result this is the one objective that has not been effectively met.

Figure 5.3: Oaks Mine pit in 2008 (Sivertsen, 2011)

The Oaks Mine open pit will remain since backfilling was not a viable option. 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 the environmental preferred rehabilitation method and is viable for a shallow tabular type deposit mined in strips, where backfilling can take place during the life cycle of a mine (Queensland Government, 1995). 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, measures must be developed to minimise the environmental and social impacts associated with a pit (Queensland Government, 1995) therefore 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 presently 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. Storm water runoff into the pit would be minimal given the low precipitation rate. According to ERM (2008) the total annual runoff volume was predicted at 1 1140 m³ which would only add 16 mm of water into the pit. Nevertheless a berm of 700 m long and 0.5 m high was constructed (as depicted in Figure 5.4) 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 (ERM, 2008).

The Blouberg Municipality however believed that the safety measures adopted were not sufficient to prevent humans and animals from gaining access to an unstable pit (ERM, 2008). Similarly upon visiting the site in 2011, the DMR stated that there was no practical plan pertaining to the management of the pit area post closure and believed that the fence was not a sufficient safety measure and therefore recommended that some other safety measures should be implemented around the pit to prevent access. Furthermore the DMR stated that a pit risk assessment must be conducted post closure which would examine the associated risk thereof and be based on the type of activity taking place post closure (Sivertsen, 2011). Therefore the pit was and is a contentious issue that needs to be addressed prior to the issuing of a closure certificate. At present the mine managing officers are developing more suitable safety measurements which will satisfy the DMR and municipality. These developments will need to be implemented as soon as possible as the pit safety issue may result De Beers in not acquiring a mine closure certificate.

Conversely the waste rock dump and MRDC were designed with closure and full rehabilitation in mind because concurrent rehabilitation of these facilities started in 2002 (van Wyk, 2009). Innovative rehabilitation methods were utilised. For example the outer walls of the MRDC were
constructed first then co-disposal occurred during the operational phase. Some of the waste rock was used to construct the outer and 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 which is depicted in Figure 5.5. 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. To further prevent stormwater runoff and erosion, the contours were constructed every 30 m on the slopes. The contours were also constructed on the flat surfaces to minimise large water catchment areas (ERM, 2008). This indicates that the MRDC was progressively and concurrently rehabilitated, and that the slope stability and water flow was taken into consideration.

![Image](https://example.com/figure5.5.png)

**Figure 5.5:** Coarse and fine residue deposits (Sivertsen, 2011)

The fine residue paddocks were capped with a 2 m layer of waste rock to prevent topsoil contamination. Thereafter a topsoil layer was 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 (Kraalmis and manure) 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 which is depicted in Figure 5.6 (ERM, 2008).

![Figure 5.6: Rehabilitated mine residue disposal complex, 2011 (Sivertsen, 2011)](image)

To obtain a 40% grass cover, the seeds of perennial grass species such as *Cenchrus ciliaris* (Blue Buffalo Grass), *Panicum maximum* (Guinea Grass), *Digitaria eriantha* (Finger Grass), and *Antheophora pubescens* (Wool Grass) 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 annually for three growing seasons by an external consultant and is discussed in greater detail in the Section 5.4.4 but thus far the results have indicated a good re-establishment of vegetation cover, both annuals and perennials. Due to animal droppings and seeds present in the manure, woody species are dispersed and establishing themselves on the MRDC.

5.4.4 Bio-Physical Post-Closure Monitoring

Monitoring forms an essential part of the entire closure and rehabilitation process. The main monitoring objective developed by De Beers was the assurance that an effectively functioning ecosystem had in fact been established and that positive trends had developed due to rehabilitation. Monitoring was used to prove that mitigation measure implemented in closure had been successful and that biological and environmental diversity had been restored. The following rehabilitated areas were monitored: soil quality; erosion; MRDC rehabilitated areas; and groundwater. The rehabilitated area was most vulnerable to damage during the first couple of years after rehabilitation. However over time the vulnerability would decrease and the area would stabilise thus monitoring at the Oaks Mine was important to determine that this stabilisation had occur and would continue to occur (ERM, 2008).
Soil and Erosion Monitoring

Monitoring of soil and erosion was important to ensure that erosion did not damage the rehabilitated mine site. Based on the Final Closure Plan monitoring tools were established to enable De Beers to effectively monitor the area. These tools included:

- Regular inspections of soils;
- Soil analyse after three to four growing seasons to determine areas that need mitigation and modification;
- Application of mitigation measures such as apply manure and organic matter where necessary to prevent adverse soil impacts;
- Re-vegetate where necessary;
- Removal and avoidance of vehicle traffic on rehabilitated site; and
- Avoidance of foot and hoof action on the slopes of the MRDC for the first two seasons of rehabilitation (ERM, 2008).

These tools allowed for the soil to establish and for limited erosion to occur. Some of these tools are still being utilised to ensure that the soil has been rehabilitated effectively and that there are no areas where erosion may occur.

Mine Residue Disposal Complex Rehabilitation Monitoring

Rehabilitation monitoring has been conducted by an external consultant. Prior to the first monitoring investigation held in 2009 there was one shortcoming, noted by Prof. van Wyk, the lack of rainfall data. The rainfall data would have been used to interpret the amount of species developed on-site. However some rainfall data was collected and thus conclusions were drawn but there may be some distortion. In 2010 prior to the second monitoring investigation it was noted that rainfall data had been collected for the years 2007, 2008, and 2009 by the Environmental Manager of the Oaks Mine, South African Weather Service, and neighbouring farm owners (van Wyk, 2009). Thus rectifying the lack of rainfall data and strengthening the conclusions made in the investigation conducted.

The conclusions drawn in 2009 indicate that the rehabilitation of the MRDC has been successful. There was an overall improvement compared to the 2008 results (van Wyk, 2009). The conclusions developed in 2010 were similar to those developed in 2009. There was an increase in vegetation growth. There was a increase of *Cenchrus ciliaris* and an increased mixture of annual and perennial species (van Wyk, 2010).

In the 2009 investigation, there were some aspects that needed improvement and modification. One such issue was the lack of animal life on the MRDC. Van Wyk (2009) stated that it was very important to have animals present on the MRDC because they harvest biomass which would lower
the fire risk. Animals present on the MRDC would have also produced dung containing organic matter and would have trampled the ground to incorporate seeds into the surface soil layer. Therefore van Wyk (2009) recommended that approximately 100 cattle should be present on the site for a short time period that would be determined by the rate of harvesting done by the cattle. As a result, the Oaks Mine managing officer developed an agreement with local cattle farmers to bring their cattle onto the MRDC for a maximum of three months to graze. It was thus noted in the 2010 investigation that the grazing practices developed must be continued but the number of cattle should be reduced or the time period should be modified due to the decrease in precipitation during the season (van Wyk, 2010).

The other aspect that needed improvement in 2009 was the development of erosion gullies on the north-eastern slope corner where the contour wall had failed (van Wyk, 2009). The contour wall was repaired and in 2010 it was noted that the wall was functioning well and the vegetation had recovered well. Thus there were no signs of erosion and all sheet, rill and gully erosion from 2008 and 2009 had completely disappeared. It was recommended, however, that monitoring should take place during the winter months to identify any erosional landforms that may develop (van Wyk, 2010).

Groundwater Monitoring

Groundwater abstraction during mining had drastically affected the groundwater levels on the mine property and created a cone of depression (a decrease of approximately 30 m). There had however been previous localised cones of depression created by agricultural practices. The post-mining groundwater cone of depression was however limited to the Oaks Farm on which the mining area was situated and thus groundwater had decreased only marginally on the surrounding farms. Pre-mining groundwater levels were between 35 and 90 m below surface. At the mine site the groundwater level was approximately 45 m below surface. According to ERM (2008) the groundwater will only recover to pre-mining levels in the next 20 years. This time period may decrease in the future due to high precipitation levels experienced in any given year. Coincidently however the pre-mining groundwater quality was not suitable for human consumption as it had high elevations of nitrates. Therefore the impact of decrease water levels was not anticipated to affect human consumption patterns but may have slightly affected stock water and domestic consumption levels (ERM, 2008).

During the risk assessment conducted in 2008, two possible groundwater risks were present. The first was the movement and transportation of groundwater and pollutants (increased salinity levels) from the MRDC to the surrounding receptors such as private boreholes and wells which would result in groundwater being unsuitable for irrigation purposes. The second was the fact that the pit may act in the future as a groundwater pollution source. As a result, a hydrological investigation
was undertaken in 2008 (ERM, 2008). It was determined in the results of this investigation that there was an insignificant risk that pollutants would leach from the MRDC into the groundwater as salinity levels and precipitation rates were low. The rehabilitation of the MRDC also contributed to the insignificant risk leachate posed as gypsum was added to the soil prior to its placement on the complex. The pit on the other hand was determined to always be a source of groundwater pollution as poor quality groundwater was and will be transported by a shear zone into the pit. Once in the pit the water will not be transported to downstream receptors as the impermeable walls of the pit will prevent this and thus the risk was not as great as predicted previously in 2005 (ERM, 2008).

Upon visiting the site, the DWA stated that they were satisfied with the hydrological conditions of the Oaks Mine. They stated that due to the impermeable walls of the pit, contaminants would be contained within the pit and thus would not pose a risk to groundwater users. They also stated that there was very little regional groundwater level disturbances noted, which confirmed the low permeability of the pit walls. The DWA did note however that there was a possible groundwater quality impact that may occur if pumping takes place downstream of the pit. Pumping would cause contaminated groundwater to flow from the pit into the shear zone and thus contaminate the surrounding groundwater (du Toit, 2011b). Therefore the DWA recommended that groundwater monitoring take place for the next three years from 2011 to 2014 (upstream and downstream of the pit) to confirm the assumptions made in the Final Closure Plan developed by ERM (du Toit, 2011b; Sivertsen, 2011).

5.4.5 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 (ERM, 2008). Therefore the previous land use was not a sustainable option for the post-closure land use and it did not fall within the closure vision developed by De Beers (Mban, 2008). During the post-closure land use consultation with stakeholders, some of the stakeholders commented on various alternative land uses while others stated that De Beers should examine a broader range of criteria prior to the sale of the land, such as local empowerment, water, social and environmental criteria. It was decided through this consultation that the most suitable post-closure land use would be conservation and game farming. The area will be preserved and the rehabilitated environment not severely disturbed by commercial and human activities (ERM, 2008). 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.
During the risk assessment conducted in 2008, it was noted that there may be a risk that if the end land use was started prior to the establishment of a sustainable vegetation cover, the end land use may not have supported the closure objectives established for the mine. To lower the significance of this risk the final closure plan stated 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 (ERM, 2008).

On this particular mine, the actual mining area was small in comparison to other mines. The small size of the mining area aided in the rehabilitation of the mining facilities. However the procedures employed to rehabilitate were applied to other mines, such as Venetia Mine, which applied rehabilitation procedures of the MRDC. Most of the property remained undisturbed by mining activities and as a result is in “pristine” condition, thus resulting in only a small area requiring monitoring. Monitoring of the site includes identifying and eradicating alien invasive species; annual 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 was largely due to the removal of cattle in the early days of the mine. The cattle were replaced with game on a controlled basis (ERM, 2008).

Upon visiting the site, the DRM stated that they needed to see an agreement between De Beers and the future land owners. The Mine Manager responded by stating that there were several offers to purchase the farm but as of yet these offers have not been finalised. However the Mine Manager did state that once the farm had been purchased, De Beers would send the DMR the agreement between De Beers and the land owner that would state the type of activity that would take place post-closure (Sivertsen, 2011). It should be noted that even though De Beers has selected the most sustainable option for the Oaks Mine property, the new land owner may be inclined to change the land use. However De Beers is intending to only sell the land to the new land owner once they have agreed to the conditions of the closure objectives established by De Beers.

5.4.6 Stakeholder Engagement and Socio-Economic Closure

The MPRDA stipulates that a Social and Labour Plan (SLP) needs to be developed for all mines with a new order mining right (DME, 2002). The Oaks Mine did not have to convert its mining right to the new mining right, and as a result a SLP did not have to be developed and implemented (Mban, 2008). Without an SLP, 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. Due to the fact that only a preliminary assessment was utilised, the effects of closure were not fully realised and thus caused greater negative effects than anticipated.
A stakeholder engagement programme was undertaken 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. 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.

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; and
- 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 retrenched with severance packages and would be given the opportunity to be trained in portable skills; 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 through the development of community development programmes (further discussed below). 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 SLP.

Insufficient time was given to stakeholders to fully understand the effects closure would have on them. These time constraints arose because planning for closure was accelerated. Thus, stakeholder and government engagement had to run parallel with the upgrading of the conceptual closure plan to the final closure plan. This resulted in some stakeholders feeling dissatisfied with the consultation outcomes. For example, labour sending communities (communities that send labourers which are employed by the mine) and tribal authorities were dissatisfied with the fact that they were not consulted during the operational phase of the mine. Furthermore all tribal authorities and communities stated that they did not receive benefits from mining during operational phase and as a result stated that they should have received benefits during closure. Stakeholders and government also expressed concern that there would be a decrease in economic activities at
Swartwater and the surrounding towns. Thus there was a sense of loss and disillusionment because firstly the stakeholders could not prevent the decision to close the mine and secondly they felt that they did not successfully secure community benefits through the process of closure. De Beers did however provide employment for 120 people within the local communities and trained them in other skills when the mine ceased operation. Thus providing indirect community upliftment as those 120 people could find other forms of employment. De Beers also provided direct community upliftment that improved the economy of the local communities (Tauatswala, Ga Seleka, GaMalebogo, and Swartwater) which decreased the expected economic impacts as expressed by the stakeholders (ERM, 2008). These communities are depicted in Figure 3.2 above.

Even though the consultation programme was not as effective as anticipated, De Beers did establish numerous community development projects, which formed part of their corporate social investment, 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 pebble processing plant, and renovated and provided equipment for two day care centres and three schools (Mban, 2008). A detailed summary of all community development projects are present in Table 5.2.

In 2007, the management officers of the Oaks Mine worked with education authorities and stakeholders to approve plans to build an ablution facility and renovate the hostels at Boithuto Combined School in Swartwater, and on the 11th September 2008, a ceremony to handover a bus to the Boithuto Combined School took place. The bus, depicted in Figure 5.7, was donated because the school children had to walk to school no matter the weather conditions. The bus would thus directly and indirectly positively affect the lives of the school children and their education. The Boithuto Combined School serves an extensive area which includes Swartwater, Wagensdrift, Kanariesfontein, Dassenberg, Louwfontein, Bessiesfontein, Batseba and Eendvolelsdrift, and has 184 students and 7 educators. Of the 184 students present at the school, the bus would benefit 31 students as the bus would serve a 15 km radius around the school and would cover an approximately 70 km route twice a day (Khati et al., 2008).
<table>
<thead>
<tr>
<th>Community</th>
<th>Project Description</th>
<th>Resources requested</th>
<th>No of Beneficiaries</th>
<th>Clear Objective(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tauatswala</td>
<td>Food production</td>
<td>Tractor, trailer</td>
<td>Babinwa community</td>
<td>Provide implements for land preparation</td>
</tr>
<tr>
<td>Community Mining Coop</td>
<td>Knowledge, Operator, Mining Plan, Safety Plan, and equipment</td>
<td>Babirwa community</td>
<td>23 women</td>
<td>Maximise production of pebbles; Assist other local small mines in neighbouring village market their products</td>
</tr>
<tr>
<td>Kopanong (Tauatswala) Drop In Centre</td>
<td>Furniture, 3 Cabinets, Carpets, Office chairs, Table, Photocopier, Fax machine, Computer, Telephone; Toys for children</td>
<td>28 destitute children (HIV/AIDS) orphans</td>
<td>Provide care to children infected and affected with HIV/AIDS; Provide meals to destitute children once per day. Toys will be used for recreational purposes whilst children are on site</td>
<td></td>
</tr>
<tr>
<td>Mphetari Day Care Centre</td>
<td>Renovation and appliances: Roofing, Electric stove, Computer, TV, Fridge, Carpet, 50 mattresses, Table &amp; chairs, Toys, Baby Blankets</td>
<td>128 children</td>
<td>Provide relief to working parents; prepare children for school, lifelong learning; protect children</td>
<td></td>
</tr>
<tr>
<td>Tauatsoala Trading Enterprise: Establishment of a lodge</td>
<td>Babirwa Tribe</td>
<td>Provide alternative accommodation and conference facilities; Create job opportunities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ga Seleka Matsiababa Secondary School</td>
<td>Tables, chairs, photocopier, Office cabinets</td>
<td>77 learners</td>
<td>Address congestion issue, provide suitable room &amp; security for equipment</td>
<td></td>
</tr>
<tr>
<td>GaMalebogo Mphela Secondary School: Facilities Upgrade (block of 4 classrooms)</td>
<td>Cyber Laboratory for computers, Laboratory, Admin Block, Commercial Centre</td>
<td>77 learners</td>
<td>Address congestion issue, provide suitable room &amp; security for equipment</td>
<td></td>
</tr>
<tr>
<td>Swartwater Boithuto Combined School</td>
<td>Bus Minor Renovations and repairs</td>
<td>Community of Swartwater</td>
<td>Provide accessible communication line to community in case Telkom lines are down</td>
<td></td>
</tr>
<tr>
<td>SAPS</td>
<td>Digital Telephone</td>
<td>Community of Swartwater</td>
<td>Provide accessible communication line to community in case Telkom lines are down</td>
<td></td>
</tr>
</tbody>
</table>
The Oaks Mine involved the Waterberg District Department of Education to develop a partnership between the mine and government. This partnership ensured that after the mine had closed, the bus would still be maintained and serviced. The Department committed itself to providing fuel and a driver for the bus and the school committed itself to take care of the bus, ensuring that the community and department work together to maintain the bus after the mine closed (Khati et al., 2008).

5.4.7 Engagement between the Oaks Mine and the Regulator Agent

De Beers have experienced numerous time delays during the closure application process on the part of the DMR. In early 2011, the Manager of the Oaks Mine stated that “…the Oaks Mine submitted its closure application to the DMR for comment in 2008 and formally in 2009, and has since then not received any response from the Department” (Sivertsen, 2011: 1). In response the DMR stated that they have circulated the closure application to the Department of Water Affairs (DWA) and the Limpopo Department of Economic Development, Environment and Tourism (LEDET) and have not received comments from these departments to date. These departments then responded by stating that they have made comments and sent these comments to the principles of their department, and will follow up on the status (Sivertsen, 2011). This indicates the difficulty in obtaining closure due to the fact that different aspects of closure have to be approved by a number of different departments. This has created the time delays experienced by De Beers.
5.4.8 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. However there were insufficient resources available to convert the conceptual closure plan to a final closure plan. This was attributed to the outstanding rehabilitation (R5 000 000) and social (R2 000 000) costs realised once closure commenced for example the inclusion of specialists to modify and strengthen the rehabilitation plan. It was also attributed to the additional information required for the socio-economic closure of the mine. Additional socio-economic information included: employee and community engagement plan, and re-skilling plan. These additional closure costs were therefore borne by the parent company (Mban, 2008). The lack of planning for closure costs resulted in the outstanding amounts totaling approximately R7 000 000.

Determining accurate closure costs is a difficult procedure to undertake. However, outstanding costs could have been prevented if estimate closure costs developed in the conceptual phase were accurate. Using the AAplc Toolbox, the final closure costs were 10 times more than originally predicted. This led to the realisation that if these costs had been estimated correctly at the start of the projects planning, De Beers would have known the exact cost of closure and would not have had to internalise the additional costs. However 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 (Mban, 2008). 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.
5.5 Critical evaluation of Oaks Mine closure procedure against applicable legislation

In this section the actions of the De Beers Oaks Mine in terms of the legislative requirements set out in Section 5.2 are evaluated, to confirm whether all the required closure issues have been dealt with. This section identifies the procedures, as analysed in Section 5.4, that were partially and fully compliant to the legislative requirements as determined by the Mineral and Petroleum Resources Development Act, the National Environment Management Act, the National Water Act, and the Air Quality Act.

5.5.1 Mineral and Petroleum Resources Development Act 28 of 2002

As 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 (Lala, 2008). As the holder of the mining right, De Beers is responsible for the management of impacts associated with the mining operation and closure until a closure certificate is awarded.

Risk and second level reports were compiled for the Oaks Mine and included in the final closure plan which was submitted formally to the DMR in 2009, addressing the relevant sections of the four applicable Acts as set out in Section 5.2. The second level environmental risk report (ERM, 2008) identified five issues: groundwater; surface water; vegetation and animal life; soil contamination; and geology (open pit safety zone). Most of these risks were low and did not require intensive mitigation measures. The pit, however, presented a moderate (slope failure) risk which was not effectively mitigated and managed (as identified in Section 5.4.3).

Pit closure is not legislated. De Beers developed safety measures to ensure that the pit was a safe area once the Oaks Mine closed (see Section 5.4.3). Conversely, the pit was an issue for the DMR as they were concerned that illegal miners could gain access to the pit, which would present a high safety risk. Even though the pit is in a remote area, the DMR are still not satisfied and have suggested that De Beers “establish activities” around the pit that would further prevent access. As a result a response from the DMR regarding the issuing of a closure certificate is still pending. The interactions with the DMR are discussed further in Section 5.5.5.

Financial provision as required by Section 41 and Regulation 54 of the MPRDA was not effectively established for the closure of the Oaks Mine. The closure costs were not accurately determined in the conceptual planning phase and the full extent of social and rehabilitation costs were only realised after the final closure plan had been developed. The additional rehabilitation and social costs had to
be borne by De Beers. The sale of scrap metal and the sale of the property will neutralise these costs borne by De Beers.

5.5.2 National Water Act 36 of 1998

“...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: 5). As stated in Regulation 9 of NWA, De Beers needed to ensure that the surface and ground water was not contaminated by pollutants, and was obligated to 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 the pit to capture all polluted groundwater and monitoring of surface and groundwater quality (see Section 5.4.4). The surface and ground water quality was determined by the hydrogeological investigation conducted in 2008. This investigation determined that leachate water from the Mine Residue Disposal Complex would be naturally transported to and stored in the pit as the walls are impermeable.

Groundwater abstraction was a low risk as a cone of depression was localised and groundwater levels would recover in 20 years. The Department of Waters Affairs (DWA) recommended that groundwater monitoring occur for the next three years in order to ensure that the groundwater levels are recovering. Overall the DWA was satisfied with the present groundwater quality as it was never suitable for domestic use. However, confirmation of acceptance of the remediation with respect to the Water Act by the Department of Water Affairs is still pending.

5.5.3 National Environmental Management Act 107 of 1998

De Beers has developed and implemented an EMP throughout the life of the mine to comply with the environmental requirements as stated in Section 24 of NEMA. In terms of Section 28 De Beers was obligated not just to comply with requirements of the EMP as stipulated in NEMA and the MPRDA, but were also responsible for the care and maintenance of environmental damages that occurred prior to and post mining operations. This was achieved through regular monitoring of vegetation and animal life (discussed in Section 5.4.4). The mine site has been rehabilitated, the soil has been ameliorated and a sustainable vegetation cover has been established (as required in Section 28 of NEMA). The vegetation was monitored annually by an external consultant. The results have indicated that the vegetation cover is establishing effectively.

The wild life populations on the property have been developing well with an increase in species numbers and diversity. The wild life has been prevented from entering the rehabilitated mining area as the vegetation cover needed time to become properly established. However once the area has been completely rehabilitated, the fence (preventing access) will be taken down. This preventative
action complies with Section 24 of NEMA. The Limpopo Department of Economic Development, Environment and Tourism (LEDET) is presently satisfied with the rehabilitation measures that have been utilised and the monitoring that has taken place.

5.5.4 National Environmental Management Act: Air Quality Act, 2004

Dust generation and fallout at the Oaks Mine is insignificant as dust generated by the mining operations is not a nuisance to the surrounding ecosystem and the land users. Dust is insignificant as operations have ceased. If any dust does fall on to the surrounding vegetation, it will be washed away with the next rainfall (Cymbian, 2007). However, legislative requirements still needed to be complied with in terms of Section 33 of the AQA. De Beers submitted notification to the Minister of Environmental Affairs and Tourism of the cessation of operations in 2008. 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. De Beers rehabilitated the mining area (see Section 5.4.3) to ensure that dust generation did not occur or was minimal. The establishment of vegetation ensured that dust generation was prevented as the roots of the grass species would hold the soil together. The LEDET is satisfied with the rehabilitation measures utilised and monitoring methods used to ensure that dust generation is minimal.

5.5.5 Post Submission Matters

In 2009, De Beers formally submitted a request for final closure to the Limpopo regional office of the DMR, supported by the final closure plan. Other relevant government departments were notified that De Beers intended to close the Oaks Mine. By early 2011 De Beers had not received any feedback on the application from the DMR, DWA or LEDET. By this time, the stipulated timeframe of 180 days to respond, as stated in Section 43(4) of the MPRDA, had lapsed. In order to receive feedback from the government, De Beers invited the DMR, DWA and LEDET to the Oaks Mine on 15 April 2011. The LEDET and DWA stated that they were satisfied with the rehabilitation of the Oaks Mine and recommended that groundwater monitoring take place for a further three years. The DMR however raised concerns regarding the pit even though pit closure is not a legislative requirement. Conversely, these concerns should have been expressed to De Beers prior to the initiation of a site visit. If changes to the pit (such as blasting of the pit walls) need to be done, the monitoring timeframe established will have to be extended as the area surrounding the pit will need to be rehabilitated once again by re-establishing the vegetation cover present on the berm therefore delaying the entire closure process of the Oaks Mine.

Even though De Beers has complied with legislation, and had addressed all concerns raised by the DMR during earlier site inspections, the new expressed concerns raised by the DMR regarding the pit at the Oaks Mine appear to have affected the issuing of a closure certificate. These concerns,
however, may be nullified by the fact that the pit is situated in a remote area on private land with high game fences that limit access to the site. It seems that the DMR does not wish to issue a closure certificate and thereby it may avoid taking over liability of the mine site and incidentally any other contingent liability.

If it is the case that the DMR is withholding a closure permit on the basis that the pit has not been backfilled, then this will prevent other open cast mines in obtaining a mine closure certificate, as most pits in South Africa have employed safety measures as opposed to backfilling. The DMR states that these safety measures are not sufficient in preventing access and more stringent methods need to be developed. They do not however indicate or identify further methods that need to be developed, thus leaving mining companies to determine these methods. If incorrect methods are employed, delays and escalating costs could result, with no definitive guidelines on how closure could be achieved in practice. One is left wondering whether any open pit mine in South Africa will be able to acquire closure. The DMR urgently needs to develop clarification on what would constitute acceptable pit closure practices so that operating mines can properly address the issues and make adequate financial provisions.

5.6 CONCLUSION

All applicable legislation pertaining to the closure of the Oaks Mine was examined. Compliance by De Beers to all the legislation required for closure was determined and analysed. De Beers developed and implemented an EMP which was used throughout the life of mine. They also developed and implemented a final closure plan with a risk assessment and rehabilitation plan which was submitted to the authorities in 2009 with an application for a closure certificate. The final closure plan was used in conjunction with the AAplic Toolbox which enabled an accelerated closure process to take place.

The physical and bio-physical closure objectives were mostly achieved. The MRDC and waste rock dump were rehabilitated effectively and achieved all rehabilitation objectives. Physical and bio-physical closure was dealt with commendably, especially the rehabilitation of the mine infrastructure, waste rock dump and MRDC. There were some problems with the stakeholder consultation process arising from the fact that it was an accelerated process and not all of their issues were accommodated effectively. This was attributed to the accelerated consultation process and the fact that members of the surrounding tribes and communities were not consulted at the start of operations. De Beers did however ensure that all employees were redeployed within De Beers. De Beers also uplifted the local community by providing the necessary tools to manage and operate farms.
As part of the closure plan, the open pit was not backfilled, but the perimeter was secured to limit access, the bottom benches were blasted and filled with rock to discourage informal mining post-closure. This is in line with practice conducted in most open pit mines globally. This practice was part of the draft closure plan, and conveyed to DMR officials in documents and during on site inspections prior to submission of the final application. It was only during a further site inspection, after the statutory 180 response period had lapsed, that a different group of DMR officials raised the pit issue as a matter that needed to be addressed in order for the DMR to consider a closure certificate.

In conclusion, even though there were some problems associated with closure, most of the processes and many of the lessons learnt at the Oaks Mine can be used as a benchmark for other mines wishing to achieve closure. The main lessons learnt include: planning for closure at the outset of the design and construction phases of a mine; concurrent rehabilitation should be initiated in the operational phase of mining; stakeholder consultation, in terms of closure, should commence when the conceptual closure plan is drawn up; accurate closure costs should be developed in the conceptual closure plan; and a suitable post-closure land use must be developed as early as possible.
CHAPTER 6  CONCLUSIONS

The research created an understanding of best practice needed to acquire a mine closure certificate in South Africa with a specific focus in the diamond mining industry. The research identified the best mine closure practices. All applicable legislation utilised in the closure process of the Oaks Mine was examined and the closure procedures employed by De Beers were critically analysed. This research therefore serves as a model for acquiring a mine closure certificate.

During this research it was noted in the literature review that there were numerous international mine closure procedures (planning, stakeholder involvement, risk management, cost estimates, and rehabilitation) that have been implemented by different countries to achieve effective closure. These procedures were retrofitted to the individual nature of the mines utilising the procedures. In South Africa, a few literature reports have reported on these mine closure procedures adopted in a context specific way. The literature review examined the mine closure procedures utilised internationally and within South Africa. The South African mine closure legislation was examined and the challenges faced when closing were identified and explained. An understanding of the South African mine closure situation was created and insight was provided into the best practice requirements to acquire a mine closure certificate.

The bio-physical and socio-economic extent of Limpopo Province and the Oaks Mine was then examined. The bio-physical environment at the Oaks Mine was diverse with a wide range of flora and fauna. A semi-arid to arid climate with limited wind generation was present on the site. There was also limited surface and groundwater supply on the site. The Oaks Mine was charaterised by poor quality soils not suitable for agriculture. The property will be utilised as a game farm and conservation area.

From a socio-economic perspective, the site and its surroundings had a low population density. Swartwater, the nearest town, was an agricultural town which supplied goods and services to 400 people. Due to the low population demographic, the Oaks Mine did not have as many social remediation issues to contend with at closure as other mines often would have.

This research was validated by the combination of different qualitative methodologies. This combination (triangulation) limited weaknesses and fortified the strengths of each methodology employed (Amaratunga et al., 2002). Documentation collection, interviews, and site visits were the integrated qualitative methodologies used in this research to acquire the necessary information utilised to critically analyse the Oaks Mine closure procedure. These methods were best suited for this research as insight was provided into the legislation needed to close the Oaks Mine. Insight into
the institutional issues associated with mine closure was also gained. The procedure utilised in the closure of the Oaks Mine was examined and critically analysed.

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. The planning process was retrofitted to fast-track closure. However there were some associated risks. While it was possible to fast-track certain physical procedures such as the reclamation of restorable land, some bio-physical procedures, successful rehabilitation were not easy to achieve within the time frame left for closure (Mban, 2008).

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 such as the MRDC and waste rock dump was rehabilitated effectively. Some risks however were still present: the possible pit wall failure; and alternatives to backfilling of the pit having to be sought. These issues needed to be rectified in order for the DMR to issue a closure certificate. 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 the opportunity for continued employment within the group after closure, or were offered alternative compensation and the opportunity for reskilling. De Beers also carried out community social and economic upliftment projects, by providing the necessary tools to manage and operate farms and by renovating and rebuilding schools and day care centres in the area. Even though some stakeholders were dissatisfied with the outcomes, De Beers did comply with legislation and achieved all the social goals De Beers developed.

Government was consulted regularly during the closure period, in order to establish a good relationship and to fulfill all legal closure requirements, thus strengthening the ability of the Oaks Mine to acquire a closure certificate. Nevertheless, at the time of writing, the pit is still a contentious issue, having been raised as a post-application site inspection. The DMR have to date not issued technical guidelines or rulings on what would constitute acceptable pit closure procedures. The mining industry is left in a quandary as to whether the Government intends ever to allow closure to take place.
With the exception of one or two steps that needed to be adapted during the closure process, most of the procedures and many of the lessons learnt could be used as a benchmark for 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 an event at the end of the life of mine that will be addressed in the final five years of operating life. There are issues in interpreting and implementing the provisions of the mine closure legislation that need to be solved by inter-departmental cooperation where there are overlapping jurisdictions affecting mine closure; and in the issuing of technical guidelines of pit closure practices that would be acceptable to the Department of Mineral Resources.

To conclude, the critical analysis of the closure procedures against legislative requirements has indicated that the Oaks Mine has effectively complied with the closure legislation. De Beers has in most case done more than what was legislated. De Beers ensured that the environment (both natural and social) is rehabilitated in such a manner that it was restored to a state acceptable by regulators and post-closure land users. However, it appears that the DMR are hesitant to award a closure certificate as they are not satisfied with the pit closure. Despite all of rehabilitation effects and all the costs De Beers have incurred, a closure certificate may never be issued. A large contributor to the issue is that the DMR has not developed standards for pit closure. Raising the question of whether mine closure is in fact achievable in South Africa.
REFERENCES


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# APPENDIX 1: INTERVIEW AND SITE VISIT DATES

<table>
<thead>
<tr>
<th>Date</th>
<th>Person</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 June 2010</td>
<td>Sustainable Development Manager</td>
<td>Interview regarding the AAplc Toolbox</td>
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<tr>
<td>24 June 2010</td>
<td>Legal Counsel</td>
<td>Interview regarding Legal compliance</td>
</tr>
<tr>
<td>28 June 2010</td>
<td>Mine Manager</td>
<td>Interview regarding closure process</td>
</tr>
<tr>
<td>28 June 2010</td>
<td>Environmental Officer</td>
<td>Interview regarding closure process</td>
</tr>
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<td>5 – 7 September 2010</td>
<td>Environmental Officer</td>
<td>Site Visit</td>
</tr>
<tr>
<td>12 April 2011</td>
<td>Mine Manager and Environmental Officer</td>
<td>Follow up interview regarding the closure process</td>
</tr>
<tr>
<td>22 – 24 May 2011</td>
<td>Environmental Officer</td>
<td>Site Visit</td>
</tr>
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<td>14 July 2011</td>
<td>Mine Manager and Environmental Officer</td>
<td>Follow up interview regarding the closure process</td>
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<td>22 July 2011</td>
<td>Groundwater Scientific Manager – Limpopo DWA</td>
<td>Government interview regarding water quality and monitoring at the Oaks Mine</td>
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<td>27 July 2011</td>
<td>Deputy Director of the Environment - DMR</td>
<td>Government interview regarding the DMR’s role in issuing a mine closure certificate</td>
</tr>
<tr>
<td>29 July 2011</td>
<td>Chief Air Pollution Control Officer</td>
<td>Government interview regarding the DEA’s role in issuing a mine closure certificate</td>
</tr>
</tbody>
</table>
APPENDIX 2: DE BEERS INTERVIEW QUESTIONS

1. Was all the waste rock used to rehabilitate the MRDC and plant areas?
2. Did the monitoring process indicate that the vegetation had adequately re-established itself?
   a. If not what needed to be done to rectify this?
3. Was monitoring done in-house or by an external consultant?
4. Why was the pit not backfilled?
5. Were there safety and environmental risks preventing backfilling? If so what were these risks?
6. When did the rehabilitation on the MRDC begin?
7. Were any of the rehabilitation methods used innovative?
   a. If so what are these methods?
8. How long are the cattle (used for grazing) kept on the MRDC for?
9. Did mine closure only succeed because the Oaks is a small mine? (provide reasons)
10. Is the closure process, used at the Oaks, capable of being replicated in other mines?
11. What was done differently by De Beers from other mines that have failed to achieve closure?
12. What areas of the process could have been improved upon and why?
13. In your opinion, have there been any institutional problems associated with issuing of a closure certificate?
14. If so what are the major problems?
15. How have these problems impacted on the issuing of a closure certificate?
APPENDIX 3:  DMR AND DWEA INTERVIEW QUESTIONS

DMR

1. What is a mine closure certificate?
2. How does a mine acquire a closure certificate?
   a. Is it solely legislation that must be utilised or are there other ways in which a closure certificate can be issued?
   b. How long does it take for a closure certificate to be issued?
   c. What process is followed to issue a closure certificate?
3. Which other national departments are involved in the issuing of a closure certificate?
4. Does a representative from the DMR have to go to the site to assess the situation?
   a. If so, what environmental and social elements are assessed?
5. In the case of an open pit diamond mine, what environmental aspects need to be rehabilitated and reclaimed in order to acquire a mine closure certificate?
6. Does an open pit need to be backfilled?
   a. If so, is it required in the legislation?
   b. If not required by legislation, why is it recommended in Chamber of Mines and DMR Closure Guidelines?
   c. If it does not need to be backfilled, why has no open cast mine as yet received a full closure certificate?
7. Why, in your opinion, have no mines in South Africa received a closure certificate?
   a. Is the reason solely due to the non-compliance of the mine or are there institutional problems?
   b. What are the major institutional problems?
   c. How have these problems impacted on the issuing of a closure certificate?
   d. How are these problems being dealt with?
8. In your opinion, does the legislation affect the issuing of a closure certificate?
   a. Is the legislation too stringent and therefore making it impossible for the DMR to issue a closure certificate?
   b. If so, what parts of the MPRDA (in your opinion) need to change?
   c. How could these changes affect the issuing of a certificate?
DWEA

1. What part does DWEA play in issuing a mine closure certificate?
2. Why has no mine in South Africa acquired a closure certificate?
   a. In your opinion is this likely to change in the near future?
3. Are there any mines that you are aware of that are likely to receive a closure certificate soon?
4. Do environmental monitoring personnel go on site to assess the closure process?
   a. What method of assessment is used?
   b. What environmental aspects are assessed?
   c. Are these site specific or general aspects?
   d. In the case of a diamond mine, what environmental aspects are most commonly assessed?
5. Are open pits a concern for DWEA when aiding the issuing a closure certificate?
   a. If so what is the major concerns?
   b. How can these concerns be rectified?
   c. Are these concerns accounted for in legislation?
6. Are there any institutional problems which may hinder the issuing of a mine closure certificate?
   a. What are the major problems?
   b. How can these problems be solved?
7. Are the two departments (DWEA and DMR) in communication with one another when issuing a closure certificate?
   a. Is there a lack of communication?
   b. If so where do the problems occur?
8. In your opinion, is it possible for a mine to obtain a full closure certificate?
   a. Are the requirements of NEMA attainable for a mining project or will they Act as a disincentive for mining activities due to their stringent requirements?
   b. If so what needs to change in order to issue a closure certificate?