National Grassland Biodiversity Programme

Background Information Report No. 4:
Strategic review of the coal mining industry with regard to grassland biodiversity and identification of opportunities for the development of interventions with the coal mining industry to address biodiversity

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STRATEGIC REVIEW OF THE COAL MINING INDUSTRY WITH REGARD TO GRASSLANDS BIODIVERSITY AND IDENTIFICATION OF OPPORTUNITIES FOR THE DEVELOPMENT OF INTERVENTIONS WITH THE COAL INDUSTRY TO ADDRESS BIODIVERSITY

National Grasslands Biodiversity Programme

Compiled by:

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EXECUTIVE SUMMARY

Key objectives
The objective of this report is to provide the NGBP with a strategic review of the coal mining industry operating within the grasslands biome within the Mpumalanga Province and to identify potential opportunities for interventions by the programme and industry to address the threats to biodiversity posed by the expansion of coal mining within the Mpumalanga Highveld grasslands.

Methodology
Literature reviews, personal interviews and data accessed from various organisations were synthesised to provide an overview of the coal mining process, the areas affected, the spatial and temporal impacts of mining, the industry approach to biodiversity and potential focal points for NDBP involvement.

Grassland biome
The grassland biome is one of the most threatened and under-protected biomes in South Africa. Within the grassland biome the grasslands of Mpumalanga are probably the least protected of the least protected biome and therefore the most threatened.

Coal mining industry in South Africa
The coal mining industry in South Africa is an important component of the economy of South Africa and is a significant global supplier of coal. South Africa has significant reserves of coal and mining is set to continue for the foreseeable future.

Impacts of mining
Underground coal mining has a negligible impact on biodiversity, apart from infrastructure related disturbances. Surface or opencast mining has a significant impact on biodiversity in relation to alternate land use categories such as agriculture and forestry, but this impact is limited to relatively small areas in comparison to the other land use categories. However, the impact is remains for many decades, and can be considered to be semi-permanent within common planning horizons.

Current mines are located mostly away from areas of biodiversity importance and in areas previously heavily impacted by agriculture. However, this should not be used as an excuse for sub-standard rehabilitation practices or relaxing biodiversity conservation standards. Rather, it should serve as a motivation to improve an already poor situation. Major mining companies have a strong awareness of biodiversity issues, have developed or are developing biodiversity plans and report on these plans. A significant increase of small mines developed by small mining companies is anticipated, probably away from the areas mined by the bigger companies, and possibly in areas of greater biodiversity value. Smaller companies are regarded as a potential threat to biodiversity conservation because of lower awareness, less resources and lack of capacity.
Rehabilitation
Current rehabilitation efforts are only marginally successful in returning land to its previous agricultural potential, and do not adequately address biodiversity issues. Restoration of full diversity to mined land is considered virtually impossible in the short term at this stage, and offsets are a distinct possibility as a means of mitigating the impacts. However, a strong, coordinated effort would be required to develop significant offsets.

Legislation
Past legislation governing environmental issues and rehabilitation was ineffective and this has created significant legacy problems in the form of unrehabilitated mines. These have a significant impact on biodiversity, but cover a small area relative to current mining activities. Current legislation is effective if implemented correctly, but does not adequately relate biodiversity to rehabilitation of mined areas. The Department of Mineral and Energy Affairs appears serious about biodiversity issues. There is a general lack of capacity in all government departments (including conservation bodies) at national and provincial levels to deal with biodiversity issues, particularly in the grassland biome).

Coal market as a key biodiversity driver
The coal market could be a potential driver of biodiversity and environmental standards. Most of the coal mined in South Africa is used by ESKOM or SASOL, or is exported (mainly to Europe). Development of ‘green’ market pressure may impact biodiversity and environmental standards. The consolidated market may facilitate the development of market pressures. This could be a key lever in enhancing biodiversity efforts.

Role of the National Grasslands Biodiversity Programme
The major role of the National Grasslands Biodiversity Programme in the coal mining sector should involve providing leadership on issues relating to biodiversity. This should include involvement at a review and assessment level, where standards and procedures can be influenced. An important aspect of this role should be to provide strong links to other land use sectors such as agriculture and forestry. Allocation of resources to biodiversity issues in the coal mining sector should be considered in terms the area currently and potentially affected by large-scale opencast mining, the area potentially affected by small-scale mining and the severity of the impacts of mining.
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OBJECTIVES
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TERMS OF REFERENCE
A strategic overview of the current biodiversity and mining context within which any interventions from the National Grasslands Biodiversity Programme (NGBP) would operate and how the NGBP should interface with this context – based on existing knowledge and interviews with a few key informants such as the Chamber of Mines of South Africa (COM).
An overview of the status and nature of threats facing grasslands biodiversity caused by coal mining in the Mpumalanga Highveld - to be based on interviews with key informants: DALA, MPB and DME (that deal with mining and environmental applications) and NGO’s operating in those areas (WESSA, EWT)
An overview of the coal mining industry in SA, and what the major strategic issues facing the sector are - based on existing knowledge and secondary resources
Coal mining companies approach to biodiversity, whether there are any key levers that will cause the coal industry to be interested in engaging around biodiversity, what the industry’s response is to biodiversity offsets and whether the company/coal sector is interested in working with the NGBP and why – based on interview with the key coal mining companies operating in Mpumalanga.
Identify opportunities for possible programme interventions and a process for taking this forward into a coal mining and grasslands biodiversity sector intervention within the limitations of the NGBP. The issue of biodiversity offsets must be specifically addressed.

DISCLAIMER
Facts and figures obtained from different sources within the coal mining industry vary, depending on the source. While every effort has been made to ensure the accuracy of the figures quoted, they should be regarded as approximate.
1. GLOBAL COAL MINING: ROLE, RELEVANCE AND FUTURE

1.1 Background
Coal is one of the most important sources of energy in the world and is currently the world’s fastest growing energy source, growing a faster rate than oil, gas, nuclear, hydro or renewable sources. About 40% of the world’s electricity is generated from coal. Many countries rely more heavily on coal for electricity generation, such as Poland (94%), South Africa (92%), China (77%) and Australia (76%). Increasing demand for electricity is one of the key demand drivers for coal. Apart from its role in electricity generation, coal is also used extensively as a fuel for steel and cement production, as well as for the production of liquid fuels.

Coal mines are usually located in rural areas where the mines and associated industries and supporting services often form the mainstay of the local economy. It is estimated that the coal mining sector employs over 7 million people worldwide. Ninety percent of these employees are in developing countries.

1.2 Coal reserves
Coal is found across the world, on each continent and in at least 70 countries. Coal reserves are defined as proved or measured reserves, and probable or indicated reserves. The probable reserves are usually estimated conservatively and are probably significantly greater. Proved reserves are usually defined as such based on economic recovery. This causes fluctuations in the levels of proved reserves based on the price of coal and the prevailing economy. Figures can thus vary significantly both internationally and locally, depending on the source of the information and the prevailing economic conditions. It can be accepted, however, that in future as alternate sources of energy such as oil are depleted, the value of coal will increase. This implies that the economic viability of reserves will improve, particularly as mining techniques improve, leading to increased mining.

It is estimated that there are over 479 billion tons of proven hard coal reserves in the world. South Africa has the world’s fifth largest reserves (48.8 billion tons or 10.2%). In terms of reserves relative to current utilisation levels, coal far outstrips oil and natural gas and is thus considered a more sustainable form of energy in terms of reserves. Although all fossil fuels will be depleted at some stage, it is estimated that coal will last at least 190 years globally, or longer, if efficiencies in mining and utilisation can be improved.

1.3 Coal consumption
Coal consumption has grown at about 38% over the last 20 years to a level of about 4030 Mt per annum. The top five coal producing countries are China,
USA, India, Australia and South Africa. Production growth has been strongest in Asian countries. The top five coal consuming countries are China, USA, India, South Africa and Japan. Generally most of the coal produced in a country is consumed locally. About 18% of coal production is exported to other countries, with Japan being the biggest importer. Demand for coal seems set to increase, particularly in Asia.

Coal exports and trade are largely governed by the cost of transportation. This essentially divides the world trade into two regions, namely the Atlantic (comprising Western Europe) and the Pacific (comprising Japan, Korea and other Asian countries). South Africa is a natural point of convergence between the two regions and is thus well placed for the export market. The top five coal exporting countries are Australia, China, Indonesia, South Africa and Russia.

2. SOUTH AFRICAN COAL MINING: ROLE, RELEVANCE AND FUTURE

South Africa is one of the top five countries in the world in terms of coal production, coal consumption and coal exports.

2.1 Distribution of coal reserves

The major coal deposits currently being utilised in South Africa are found in the Ecca Group, which is part of the Karoo Supergroup (Figure 1). These coalfields are present in the Free State, Gauteng, Mpumalanga and KwaZulu-Natal and are shown in Figure 2 in more detail. In general, the coal fields in South Africa are relatively easy to mine, comprising relatively thick seams at a reasonable depth below the surface.

The coalfields shown in Figure 2 are currently being exploited on a large scale and coal mined from these fields comprises the majority of coal mined in South Africa. Not all of the formations in the Ecca group have coal deposits, and there are coal deposits in other geological formations, for example the Waterberg area, which have not been exploited yet.

2.2 Coal utilisation in South Africa

Coal mining is South Africa’s second biggest mining sector after gold, and without coal South Africa’s rapid industrialisation would not have been possible. South Africa obtains about 80% of its primary energy from coal, with the balance being made up of crude oil (9.8%), renewable resources such as wood and bagasse (5.5%), gas (1.5%), nuclear (3.3%) and hydro (0.1%). Fossil fuels make up about 91% of the total primary energy consumption.

Coal in South Africa is utilised as follows (based on 2002 figures):

- Local use 18 Mt/yr (8%)
- Export 69 Mt/yr (30%)
- Electricity generation 93 Mt/yr (41%)
- Synthetic fuel 48 Mt/yr (21%)
In addition, approximately 60 Mt of coal is discarded every year as part of the beneficiation process. This discard coal is estimated to have accumulated to more than 1 billion tons to date.

Examination of coal consumption in South Africa over the last 10 years reveals some interesting trends. In general, it seems that the total increase in coal use, particularly in the last few years, is influenced largely by the demand for electricity, which has increased markedly since 2002. Other main consumption sectors increased at a slower rate (Figure 3).

About 90% of South Africa’s electricity requirements are obtained from coal-fired power stations. Most of these are located on the Mpumalanga Highveld. Much of the coal used for electricity generation is low in sulphur, but high in ash content. Ash is disposed of by stockpiling it close to power stations. During the 1980’s and early 1990’s, at a time when economic growth in the country was slowing, ESKOM mothballed several of its older power stations on the Mpumalanga Highveld because of oversupply of electricity. Most of those power stations are in the process of being re-commissioned, due to increased demand. The increased demand is related to the improving economic growth rates in the country, coupled to massive electrification.
programmes during the last decade. This will probably increase the demand for coal by ESKOM in the foreseeable future.

Figure 2: Coalfields of South Africa (a) and a close-up view of the Witbank, Highveld and Ermelo coalfields (b – using the same legend as a) (Source: DME).
South Africa currently operates the only commercial scale coal liquefaction process in the world and supplies about one third of its liquid fuel requirements in this manner from coal.

![Diagram of South African coal market from 1995 to 2004](Source: COM)

Figure 3. Trends in the South African coal market from 1995 to 2004 (Source: COM).

Figures above indicate that South Africa is the fourth largest exporter of coal in the world. Coal is currently the second largest earner of foreign exchange in South Africa, and contributes 4% of the Gross Domestic Product (GDP). The export of coal is currently limited by railway infrastructural constraints, as well as a steep rise in rail tariffs recently imposed by SPOORNET (which currently operates a monopoly). The constraints can be seen as technical and institutional in nature and will probably be overcome. Both Durban and Maputo also have coal export facilities, although on a significantly smaller scale than Richards Bay. With increasing demand for coal globally, solutions to the problems limiting exports will be sought, particularly when considering the increased value of export coal compared to the local market (Figure 4).

![Pie charts](Source: COM)

(a) (b)

Figure 4. Volumes (a) and values (b) of local and export coal as proportions of South African sales in 2004 (Source: COM).
Export coal comprises 27% of the volume but 51% of the total income. Close to 80% of South Africa’s exports are sold to various European countries, with the Netherlands being the largest importer.

COALTECH figures indicate that an additional 20 million tons of export contracts have been finalised to be exported via Richards Bay, which indicates that the infrastructural problems may have been resolved already. The additional 20 million tons is a substantial proportion of the approximately 70 million tons being exported currently. This coal will have to be sourced and indicates a potential increase in mining activity in the short term.

### 2.3 Employment in the coal mining sector

The South African mining sector in general employs more than 450 000 workers, with another 200 000 employed in associated industries. Close to 6 000 000 people in South Africa are directly dependant on mine employees for their daily subsistence. Employment numbers in the coal mining industry have declined over the last decade until 2003, but increased substantially in 2004 to 50 832. Earnings by coal mine employees has increased steadily over the last decade to R5.9 billion per annum (Figure 5).

![Figure 5. Employment figures and earnings on coal mines in South Africa between 1995 and 2004 (Source: DME).](image)

Research by COALTECH indicates that each coal mine employee (with 6 dependents) directly or indirectly creates 4 jobs (each with 6 dependents) in related upstream and downstream industries and in support systems such as education, commerce and community infrastructure. This translates to 1 coal mine employee supporting 34 other people, directly or indirectly (Source: COALTECH).

### 2.4 Economics

The profitability of mines and mining companies exporting coal is linked to the strength of the Rand, rising input costs and logistical constraints. In South
Africa, cost of labour is a major factor affecting cost of production. Increasing fuel costs are seen as a threat, both to the cost of mining as well as the cost of transporting coal. Opencast mining appears to be more vulnerable to the increasing cost of fuel because it is more reliant on diesel operated machinery and transport systems.

Mining can be described as a ‘price taker’, because the mining industry has no direct control over demand or commodity prices. The industry may theoretically have some control over supply which may influence price, but in reality would only be able to control supply in a highly regulated, controlled environment. In the current free market global environment the supply of coal is essentially limited by demand and the ability to supply. Individual companies are unlikely to limit supply in an attempt to increase demand, because other companies, both local and international, will increase supply to meet the extra demand. Collaboration among companies to fix prices is illegal.

The long-term economic outlook for the coal industry appears to be sound. Considering the huge reserves of coal relative to other energy sources, the value of coal is likely to increase in future. This should ensure that the industry in South Africa should remain financially viable for the foreseeable future.

2.5 Industry structure

In keeping with world trends in industry, the coal industry in South Africa has been characterised by several mergers, acquisitions and name changes over the last decade. These changes are likely to continue. The six main producers are BHP Billiton (Ingwe), Anglo Coal, Sasol Coal, Kumba Resources, Xstrata and Eyesizwe respectively, based on 2004 production figures (Figure 6).

![Figure 6. Proportional production by the six largest coal producers in South Africa in 2004. The category ‘other’ is made up of several small mines and independent mines (Source: COM).](image-url)
The major companies thus account for about 91% of the coal mined in South Africa. A large proportion of this coal is mined in the Witbank and Highveld coalfields (Figure 7). Much of the land currently being mined forms contiguous blocks. Kumba is concentrated mainly in KwaZulu-Natal and not on the Mpumalanga Highveld.

Figure 7. Map outlining the coal holding rights for the major companies in the Witbank and Highveld coalfields (source: COALTECH 2020 report). (Duiker Collieries is now owned by Xstrata).

2.6 Mining companies in South Africa and economies of scale

In general the large scale production necessary for supplying large customers like ESKOM and the export market necessitate large companies operating in an environment where coal can be easily and rapidly extracted using heavy machinery. These companies usually run several mines and benefit from economies of scale. The recent mergers and acquisitions probably emphasise that at that level, bigger is better from an economic perspective.

While small-scale mining has been prevalent in other southern African countries for many years, it is relatively new phenomenon in South Africa. Currently, smaller mines are usually limited to areas where coal is more difficult to extract with heavy (expensive) machinery but can be extracted in smaller quantities with smaller (cheaper) equipment. The political environment in South Africa currently favours establishment of small businesses, and small mines do qualify for some benefits, which will be highlighted below. Of the 182 applications for coal mining processed by the Mpumalanga parks Board from
2001, 73% are from companies other than the major coal mining companies listed above. A similar percentage of the 443 coal prospecting applications were also from small companies.

Examining the trend of applications over time, 81 applications (45% of the 182) were lodged during 2005. The balance was spread out between 2001 and 2004. Seventy six percent of these 81 applications were by small companies. Eighty two percent of prospecting applications over the same time period were lodged during 2005. Seventy six percent of the prospecting applications were by small companies.

These figures indicate an increasing trend in applications, particularly for prospecting applications. The ratio between applications by the major companies and small companies appears to be relatively constant over the period under consideration.

2.7 The role of ESKOM in the coal mining industry

More than 40% of the coal mined in South Africa is utilised by ESKOM for power generation. Most of the coal-fired power stations are located on the Mpumalanga Highveld. ESKOM is thus obviously the major purchaser of coal in South Africa. The relationship between ESKOM and some of the major mining companies is complex. In some cases, the mining companies own the mine property and the mineral rights. In other cases ESKOM owns the mine land, and the mining company will hold the mineral rights and may own a small portion of the land for offices, infrastructure etc.

ESKOM seems to be also entering the local end export market for coal. Apart from owning extensive stockpiles (some estimates put the stockpiles at 20 Mt) ESKOM is developing coal mines at Usutu, in the Ermelo vicinity. ESKOM has lodged several applications for prospecting and mining with the Mpumalanga Parks Board in the last few years.

As the major purchaser of coal in South Africa, ESKOM is in a unique position to influence the market and to influence the suppliers. Most of the major mining companies supply ESKOM with coal. This issue will be revisited below. SASOL is relatively unique in that most of its coal is used in-house for synthetic fuel and other beneficiation processes, although SASOL also purchases coal from other suppliers (relatively small amounts) and exports coal.

3. OVERVIEW OF COAL MINING PROCESS

Coal is extracted either by underground mining or opencast (surface) mining. The choice is generally made on geological and economic grounds. Globally about 60% of coal is extracted by underground mining, but this figure varies regionally. Opencast mining accounts for 80% of Australian production and 67% of American production. In South Africa, about 40% of coal is obtained
from surface mines, although this is not necessarily related to the area covered by opencast mines in relation to the areas undermined.

### 3.1 Underground mining

There are two main methods of underground mining:

1. **Room and pillar mining** where a network of rooms is cut into the coal seam leaving pillars of coal to support the roof. These pillars can comprise up to 40% of the available coal. Using a process known as high extraction or retreat mining, the pillars can later be removed, allowing the roof to collapse after extraction. A significantly greater percentage of coal can be extracted in this way. This causes surface subsidence of up to several metres and disturbance of rock structure and drainage patterns. The topography may be changed slightly.

2. **Longwall mining** is an expensive process of extracting coal from the seam in a manner that allows high extraction and also allows the roof to collapse after extraction.

### 3.2 Opencast mining

Opencast mining is economically favourable when the coal is close to the surface. The method allows for extracting a higher proportion of coal than underground mining, even when using high extraction mining techniques. The decision whether to surface mine or mine underground depends largely on what is called the strip ratio. The strip ratio relates the depth of the seam below ground level to the thickness of the seam. A ratio of greater than about 7:1 is currently considered uneconomical. For example, if a coal seam is 35m below ground level, then the seam would have to be at least 5m thick for economic opencast mining to be considered economically viable. As an example, SASOL’s Syferfontein mine is located more or less on the watershed between the Olifants and Vaal catchments. It occupies a high position in the landscape, while the coal seam remains roughly horizontal. As a consequence, the coal seam is quite deep and the strip ratio is marginal. The increases in price of diesel over the last few years have made the opencast sections of the mine uneconomical and they have been closed. Mining will continue underground.

The opencast mining process is simple:

- Topsoil is removed and stockpiled
- Overburden of rock is broken up by blasting
- It is removed using heavy equipment such as draglines
- When the coal seam is exposed, it is removed using heavy machinery.

Wetlands and streams are often dammed and diverted around the mining operations for the period that the mine is active.

Satellite imagery (Figure 8) gives a good aerial view of a typical opencast mine in relation to the surrounding agricultural environment.
Figure 8. Aerial view of an opencast mine in relation to its agricultural environment (top) and close-up (bottom). The white line indicates 1 km. (Source: Google Earth).
Dams on two watercourses that flow directly through the path of the mining area can clearly be seen in both images. Of interest in the image is the fragmented land use patterns in the agricultural land to the west of the mine and what appears to be old cultivated lands to the east of the mine.

4. ENVIRONMENTAL PROCESSES FOR PROSPECTING AND MINING

4.1 Legislation
The preamble of the Mineral and Petroleum Resources Act of 2002 affirms the State’s obligation to protect the environments for the benefit of present and future generations, to ensure ecologically sustainable development of mineral and petroleum resources and to promote economic and social development.

One of the objects of the Act is to ‘give effect to Section 24 of the Constitution by ensuring that the nation’s mineral and petroleum resources are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development’.

Another object of the Act is to ‘ensure that holders of mining and production rights contribute towards the social-economic development of the areas in which they are operating’. Significantly, no mention is made here of contributions towards ecological sustainability.

The Act outlines procedures that have to be followed when applying to prospect or to mine. Section 4 states that ‘no person may prospect for or remove, mine, conduct technical co-operation operations, reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto on any area without:

a) An approved environmental management programme or approved environmental management plan, as the case may be;

b) A reconnaissance permission, prospecting right, permission to remove, mining right, mining permit, retention permit, technical co-operation permit, reconnaissance permit, exploration right or production right, as the case may be; and

c) Notifying and consulting with the land owner or lawful occupier of the land in question.

All applications have to be lodged at the regional office of the DME in the area where the application is made. The regional office in Mpumalanga is located in Witbank. A series of steps have to be followed before mining takes place.

a) Application for a reconnaissance permit;

b) Application for prospecting rights; and

c) Application for mining rights.
The following extract from the Act outlines the process for granting mining rights (highlights added):

**“Granting and duration of mining right”**

23. (1) Subject to subsection (4), the Minister **must** grant a mining right if
   (a) the mineral can be mined optimally in accordance with the mining work programme;
   (b) the applicant has access to financial resources and has the technical ability to conduct the proposed mining operation optimally;
   (c) the financing plan is compatible with the intended mining operation and the duration thereof;
   (d) the mining will not result in unacceptable pollution, ecological degradation or damage to the environment;
   (e) the applicant has provided financially and otherwise for the prescribed social and labour plan;
   (f) the applicant has the ability to comply with the relevant provisions of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996);
   (g) the applicant is not in contravention of any provision of this Act; and
   (h) the granting of such right will further the objects referred to in section 2(d) and (f) and in accordance with the charter contemplated in section 100 and the prescribed social and labour plan.

(2) The Minister may, having regard to the nature of the mineral in question, take into consideration the provisions of section 26.

(3) The Minister must refuse to grant a mining right if the application does not meet all the requirements referred to in subsection (1).

(4) If the Minister refuses to grant a mining right, the Minister must, within 30 days of the decision, in writing notify the applicant of the decision and the reasons.

(5) A mining right granted in terms of subsection (1) comes into effect on the date on which the environmental management programme is approved in terms of section 39(4).

(6) A mining right is subject to this Act, any relevant law, the terms and conditions stated in the right and the prescribed terms and conditions and is valid for the period specified in the right, which period may not exceed 30 years."

Mining rights may be renewed for further periods not exceeding 30 years at a time, provided certain conditions are met. These include complying with the approved environmental management programme.

Of interest in the Act is the provision for a mining permit, which differs from a mining right and is clearly intended to favour small-scale mining. The following extract from the Act outlines the process for granting a mining permit (highlights added):

**“Application for, issuing and duration of mining permit”**

27. (1) A mining permit may only be issued if:
   (a) the mineral in question can be mined optimally within a period of two years; and
   (b) the mining area in question does not exceed 1,5 hectares in extent.
(2) Any person who wishes to apply to the Minister for a mining permit must lodge the application
   (a) at the office of the Regional Manager in whose region the land is situated;
   (b) in the prescribed manner; and
   (c) together with the prescribed non-refundable application fee.

(3) The Regional Manager must accept an application for a mining permit if
   (a) the requirements contemplated in subsection (2) are met;
   (b) no other person holds a prospecting right, mining right, mining permit or retention permit for the same mineral and land.

(4) If the application does not comply with the requirements of this section, the Regional Manager must notify the applicant in writing of that fact within 14 days of the receipt of the application and return the application to the applicant.

(5) If the Regional Manager accepts the application, the Regional Manager must, within 14 days from the date of acceptance, notify the applicant in writing
   (a) to submit an environmental management plan; and
   (b) to notify in writing and consult with the land owner and lawful occupier and any other affected parties and submit the result of the said consultation within 30 days from the date of the notice.

(6) The Minister must issue a mining permit if:
   (a) the requirements contemplated in subsection (1) are satisfied; and
   (b) the applicant has submitted the environmental management plan.

(7) The holder of a mining permit:
   (a) may enter the land to which such permit relates together with his or her employees, and may bring onto that land any plant, machinery or equipment and build, construct or lay down any surface or underground infrastructure which may be required for purposes of mining;
   (b) subject to the National Water Act, 1998 (Act No. 36 of 1998), may use water from any natural spring, lake, river or stream situated on, or flowing through, such land or from any excavation previously made and used for prospecting or mining purposes, as the case may be, or sink a well or borehole required for use relating to prospecting or mining, as the case may be, on such land; and
   (c) must pay the State royalties;
   (d) may mine, for his or her own account on or under that mining area for the mineral for which such permit relates.

(8) A mining permit:
   (a) is valid for the period specified in the permit, which may not exceed a period of two years, and may be renewed for three periods each of which may not exceed one year;
   (b) may not be transferred, ceded, let, sublet, alienated or disposed of, in any way whatsoever, but may be encumbered or mortgaged only for the purpose of funding or financing of the mining project in question with the Minister's consent.”
This clearly allows for small-scale mining on an extensive scale. The limit of 1.5 ha limits large-scale opencast coal mines, but does allow for underground mining in hilly or mountainous areas. Typically, such a mine will open an area allowing access to the coal seam, and will then develop an underground mine. The 1.5 ha area allowed is likely to be heavily impacted.

Of concern is the provision in Section 27 (6(d)) that the Minister must issue a mining permit if the applicant has submitted an environmental management plan. No details are given as to the standard and content of the plan. In contrast, the granting of a mining right can only take place if the mining will not result in acceptable pollution, ecological degradation or damage to the environment (Section 23 (d)). The wording implies that the applications may be treated differently.

The Act also refers to environmental management principles that are set out in the National Environmental Management Act (NEMA) of 1998. The relevant sections are extracted below (highlights added):

“Environmental management principles

   (a) apply to all prospecting and mining operations, as the case may be, and any matter relating to such operation; and
   (b) serve as guidelines for the interpretation, administration and implementation of the environmental requirements of this Act.

(2) Any prospecting or mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations.

Integrated environmental management and responsibility to remedy

38. (1) The holder of a reconnaissance permission, prospecting right, mining right, mining permit or retention permit
   (a) must at all times give effect to the general objectives of integrated environmental management laid down in Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
   (b) must consider, investigate, assess and communicate the impact of his or her prospecting or mining on the environment as contemplated in section 24(7) of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
   (c) must manage all environmental impacts:
      (i) in accordance with his or her environmental management plan or approved environmental management programme, where appropriate; and
(ii) as an integral part of the reconnaissance, prospecting or mining operation, unless the Minister directs otherwise;

(d) must as far as it is reasonably practicable, rehabilitate the environment affected by the prospecting or mining operations to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and

(e) is responsible for any environmental damage, pollution or ecological degradation as a result of his or her reconnaissance prospecting or mining operations and which may occur inside and outside the boundaries of the area to which such right, permit or permission relates.

(2) Notwithstanding the Companies Act, 1973 (Act No. 61 of 1973), or the Close Corporations Act, 1984 (Act No. 69 of 1984), the directors of a company or members of a close corporation are jointly and severally liable for any unacceptable negative impact on the environment, including damage, degradation or pollution advertently or inadvertently caused by the company or close corporation which they represent or represented."

While the Act clarifies issues of responsibility, detail of the expectations of the environmental management is vague. The relevant passages referred to in NEMA outline processes to be followed and issues to be considered, investigation of impacts, investigation of mitigation and other factors, but is also vague on how decisions will be made regarding granting or refusing permission to mine. The procedure for developing an Environmental Management Plan (EMP) is outlined in Figure 9.

4.2 Financial provision for rehabilitation

Probably one of the most important aspects of the legislation relates to the concept of a rehabilitation trust fund, which has been introduced by the DME. Essentially the aim is to prevent companies closing down and declaring themselves insolvent after completion of mining, but before rehabilitation has been carried out satisfactorily. The DME now requires all prospective mining companies to place an amount of money stipulated by them into a trust fund, to be used at the time of mine closure to rehabilitate the area.

In terms of Act, an applicant for a prospecting permit must supply details of the way in which they intend to prospect and to rehabilitate any disturbances to the surface of the land mined. Details about the financial provision for rehabilitation must also be supplied. The Act makes similar provision for applications for mining authorisations. Section 5.16.1 provides that ‘the holder of a prospecting permit or mining authorisation shall demonstrate in his Environmental Management Programme Report (EMPR) that he has the financial means and has made sufficient and acceptable pecuniary provision to the satisfaction of the Director: Mineral Development to carry out such a programme’. The department will only issue permits and authorisations after the approval of an EMPR. The intention of the law is that those carrying out prospecting and mining will at all times have sufficient funds to restore the land affected by the operations.
Figure 9. Generic sequence of events prior to EMP approval (Source: DME).
4.3 Mine closure
The DME’s target with mine closure is that the area would appear as if there had never been a mine there i.e. no remaining impact. In the case of opencast mines, this means that the final cut would be closed completely, no spoil piles would be left and the overall surface topography would be very much as it was before mining started. Disturbed ground should be topsoiled and revegetated if necessary. All surface infrastructures should be demolished and removed. Roads, stockpiles, concrete bases etc should be ripped up and removed (usually by burying in the excavation prior to final levelling).
Provision must be made for water management. A drainage system to direct water around the mine must be constructed to ensure that no water leaves the mined out area.

After mine closure, the mined area has to be monitored for water pollution, surface subsidence or settlement and the revegetation has to be monitored for at least one growing season to observe the rate of regrowth and to determine if any reseeding is required. Any expenses after closure must be paid for by the mine, which is required to make provision for this.

No mention is made of biodiversity in the provisions for closure certificates.

4.4 Government (DME) approach to biodiversity issues
The regional DME office is responsible for administering the Mineral and Petroleum Resources Act of 2002. Interviews with staff at the regional office in Witbank created a favourable impression, that the DME is serious about environmental issues and ensures that the processes outlined above are followed strictly. In particular, there seems to be an awareness of sensitive areas and sensitive species. They follow a procedure of consulting with the Mpumalanga Parks Board or other government departments where necessary. Significant progress has been made with linking GIS systems between departments, so that any application for mining can immediately be located on the MPB biodiversity map and the MDA agricultural potential maps.

In general, it seems that prospecting applications are usually approved because they are low impact operations, ranging from flying over areas to drilling boreholes. Records indicate that, in Mpumalanga, between 60 and 80% of the coal prospecting applications result in potentially viable mine sites. Mining applications are more carefully scrutinised because of the inherently greater impact potential.

It is apparent that the new legislation is effective in ensuring responsibility for environmental issues. The less effective older legislation has created several legacy problems, where old mines have not been rehabilitated and have just been abandoned. These defunct mines are now the responsibility of the government (DME) and there is a programme in place to ensure that these mines are rehabilitated. DWAF assists with allocating money to rehabilitate areas that affect catchments and water quality.
DME and other government departments have apparently built up strong legal teams (termed ‘green scorpions’) and they have had success in winning significant court cases relating to environmental issues. The concept of a future ‘environmental court’ was mentioned.

Issues not ascertained clearly during the interviews related to capacity within the government departments to effectively deal with biodiversity issues and make informed decisions. It seems clear that capacity is a problem in the private sector and is probably also a problem in the government sector.

5. CURRENT REHABILITATION PROCESSES

5.1 Overview
Briefly, the opencast mining process commonly involves removing topsoil and stockpiling it, removing the overburden (rock strata above the coal seam) and placing it in heaps and then removing the coal. The rehabilitation process involves replacing the overburden and shaping it to something similar to the original landscape profile, and then replacing the topsoil. Vegetation is then established and nurtured until a permanent cover is achieved. The mining process is well illustrated in Figure 10.

Figure 10. Opencast mining process showing topsoil removed in the foreground in preparation for mining, a dragline removing overburden and pile of overburden in the background.
Of obvious interest is the revegetation process. When opencast mining started on the Highveld during the early 1970’s, conservation and the concept of biodiversity were not considered priorities. Instead, the main focus was agriculture. Land was typically classified in terms of agricultural potential and the main aim of rehabilitation was to stabilise the area and return it to its former agricultural potential. Terms such as ‘agricultural land capability’ were commonly used.

In practice, although much of the mined land was used for crops, such as maize, prior to mining, after mining the crop potential was found to be very low. As a consequence, pastures were usually established. This was initially viewed as acceptable, as some agricultural potential was being restored. The pastures used commonly comprise a mixture of seed, usually including Digitaria eriantha (Smuts fingergrass), Medicago sativa (Lucerne), Cynodon dactylon and Chloris gayana (Rhodes grass). An exotic annual grass, Eragrostis tef (Teff), is sometimes added to the mixture to provide a quick cover in the first season. In earlier examples of rehabilitation, Eragrostis curvula (Weeping lovegrass) was often used as a component in a seed mixture, but is seldom used now. Experience indicates that, if the pastures being maintained effectively as productive pastures, after several years Digitaria eriantha tends to dominate the pastures, with minor contributions by some of the other species in the mix (Figure 11).

These pastures usually require significant applications of fertilizer to form and maintain a reasonable cover, and to remain reasonably productive. Commonly, initial fertilizer applications include lime, phosphorus, potassium
and nitrogen. Regular seasonal applications of nitrogen, in particular, are required to maintain productivity and cover.

### 5.2 Impacts

There are several major problems with the approach outlined above, including:

- Extreme soil compaction, which results in low production potential for crops and pastures;
- Low soil fertility, necessitating substantial levels of ameliorant fertilizer in order to achieve reasonable levels of production;
- Productive, but expensive pastures which cannot be economically utilised in an agricultural production system;
- Low diversity and a very slow succession process to a more diverse vegetation cover.

During the late 1980’s it became apparent that the mining process (both opencast as well as underground) was seriously compromising the agricultural potential of the opencast mined land. It was reported that about half of the high potential agricultural land available to commercial agriculture at the time was situated in and around the Mpumalanga coalfields. The total area in Mpumalanga underlain by exploitable coalfields was 1.03 million ha. Of this, about 88% is expected to be mined by high extraction methods (underground high extraction procedures and opencast mines), resulting in subsidence or drastic land disturbance. The subsidence is caused by high extraction underground mining and is widespread in the coalfield area (Figure 12), while the ‘drastic land disturbance’ results from opencast mining.

![Figure 12. Warning of road subsidence on a main road near Witbank.](image-url)
5.3 Research

Many of the larger mining houses carried out their own in-house research aimed at improving and quantifying the impacts of mining during this time. Much of the research was focussed on soils. During 1989, the Minister of Agriculture commissioned an investigation into the effects of high recovery mining on agriculture. The resulting ‘Kraai van Niekerk’ report recommended that (Schoeman 2001):

- ‘Agriculture and mining should collectively strive towards establishing a sound basis for co-operation in order to ensure that the natural resources are optimally utilised in those areas in South Africa where mining activities exist alongside agriculture’, and
- that a liaison committee be established to provide a link between all components of agriculture and mining as well as other institutions concerned with the environmental effects of high recovery coal mining in the area.

This committee was duly established and included representatives from the South African Agricultural Union, the Department of Mineral and Energy Affairs, the Department of Environmental Affairs, the Department of Water Affairs and Forestry and the Chamber of Mines. They identified four research topics of importance, namely:

1. to develop a database on rehabilitated soil profiles;
2. to investigate the water holding capacity of rehabilitated soils;
3. to investigate the economics of crop and pasture production on rehabilitated land; and
4. to investigate the preparation of rehabilitated land to achieve acceptable agricultural soil.

Due to constraints on funding, only the first three topics were addressed. The research was conducted by the Agricultural Research Council and resulted in six final reports (Schoeman 2001).

5.3.1 Research topic: Database on rehabilitated soil profiles.

Project no. 1: Establishing a soil profile database for rehabilitated opencast coal mined land.

A total of 1634 pits were sampled and spatially referenced. Laboratory analyses were carried out on 617 samples and bulk density was determined on 3016 samples. The results indicated that increased bulk density was the most limiting and most widespread factor limiting production on rehabilitated land.

5.3.2 Research topic: The economics of crop and pasture production on rehabilitated land.

Project no. 2: The evaluation of existing pastures on rehabilitated mine land for economical animal production: agronomic evaluation.
Agronomically, pasture production was adequate, although quality was lower than expected. In particular, nitrogen, phosphorus, potassium and sodium levels were low, with high levels of cellulose and lignin contributing to the low quality. It was concluded that, based on the quality and quantity results, the pastures on rehabilitated land could be economically incorporated into farming systems. However, experience with beef farming indicates that while a certain area of pastures as a proportion of the total farming area may be economically incorporated into a production system, it is uneconomical to base the total system on pastures, or to have a high proportion of pastures in the production system (Engelbrecht, Kirkman & Swanepoel 2004). The high cost of fertiliser is the primary reason for the questionable economics.

Project no. 3: Evaluation of existing pastures on rehabilitated mine land for economical animal production: ecological evaluation.
The dominant naturally establishing species (or invading species) in the older pastures were *Eragrostis curvula*, *E. plana*, *Cynodon dactylon*, *Pennisetum clandestinum* (native to east Africa) and *Panicum coloratum*. The opinion was expressed that the vegetation of the mined areas would probably never return to its original state.

Project no. 4: The potential of rehabilitated mine soils for the production of maize and sunflower.
Crop yields were low to very low, mainly due to induced low soil water holding capacity or poor drainage. Compaction reduced the effective rooting depth significantly. It was found that ordinary agricultural implements were not effective for alleviating the severe compaction. It was concluded that the rehabilitated mine soils are not suitable for economical or sustainable crop production.

5.3.3 Research topic: Water-holding capacity of rehabilitated soils.

Project no. 5: Water-holding characteristics of rehabilitated opencast mine soils under maize.
Water uptake by maize was not as effective as expected due to difficulty experienced by the maize roots in penetrating zones of high bulk density. Any spoil material (overburden) occurring in the rooting zone was not penetrated by the maize roots. Crop simulation results indicated the potential for economic yields 50% of the time at one out of six sites only.

Project no. 5: Quantification of the water balance of selected rehabilitated mine soils under rainfed pastures in Mpumalanga.
Plant-available water holding capacity was poor in both the cover soil and the spoil material. Poor root distribution and shallow root development was caused by high bulk densities and hardsetting behaviour during dry periods. This leads to much of the available soil water not being extracted and used by the plants. Again, any spoil material in the rooting zone was not well penetrated by the roots. The general inability of the plants to utilise soil water between 0.3-0.7 m in
the zones of high bulk density negatively impacts pasture vigour, production and drought resistance.

5.3.4 Research recommendations
A series of recommendations from the report (Schoeman 2001) include:

- extend the studies on compaction and methods of alleviating it;
- investigate rehabilitation species with a view to finding species that can break up dense soil layers;
- investigate reducing fertilisation over time in an attempt to convert pastures to natural veld;
- propagate seed of endemic species;
- investigate the role of vesicular-arbuscular mycorrhiza as a means of increasing plant drought tolerance;
- investigate techniques for improving soil structure;
- recognise that land preparation is critical for subsequent land use;
- adherence to standards during the rehabilitation process (including monitoring, documenting and enforcing);
- pasture management after rehabilitation should take into account the fact that surface litter and earthworms may play an important role in increasing soil organic matter (only one earthworm was observed during the 4 year study); and
- the issue of adherence to standards during rehabilitation was highlighted.

5.4 State of rehabilitated land
Apparently no rehabilitated land has been sold or transferred back to farmers yet, although certain mining houses lease some rehabilitated land to farmers. The current practice is thus for the mining houses to establish pastures as part of the rehabilitation process. These pastures are fertilised as part of the process of stabilising the area and establishing an adequate vegetation cover, and generally used for production of hay. The market for hay is not consistent, and the hay can therefore not always be economically disposed of. In essence, in a good rainfall year the farmers in the area do not experience fodder shortages and therefore do not require hay. In dry years when there may be a demand, production on the rehabilitated sites is low. In some years hay is cut and left on the land decompose. Grazing of rehabilitated land appears to be a positive treatment, with indications that nutrient cycling increases and species diversity increases. It is however, difficult to bring cattle onto some of the rehabilitated areas, due to the close proximity of mining operations and the associated risks.

Profitable livestock production systems on the Highveld (Engelbrecht, Kirkman & Swanepoel 2004) are generally based on combinations of veld and crop residues with the minimum of more expensive fodder sources such as pastures or silage. There are examples of farmers who profitably incorporate large areas of pastures into their production systems, but this practice is not common on the Highveld.
It can probably be assumed that most of the rehabilitated areas are thus relatively unproductive in terms of agricultural production. If that is correct, then the rehabilitation efforts have been successful at stabilising the areas, but not successful at rehabilitating the mined land, bearing in mind that the original objectives of the rehabilitation process were to restore agricultural potential. The efforts do not come close to current definitions of ‘restoration’ if biodiversity is considered a criterion for success.

From a biodiversity perspective, re-establishment of veld grasses and other components of natural veld (forbs, shrubs and trees where applicable) is important in areas where vegetation has been disturbed or removed. These include areas degraded by inappropriate grazing management, old abandoned croplands and plantations and opencast coalmines. Experience shows that natural re-establishment of veld grasses on all of these situations is extremely slow, particularly in the more humid higher altitude areas of South Africa. The process of secondary succession is usually halted at some point. While there may be many factors affecting this, seed availability and dispersal are obviously important factors (Foster & Tilman 2003; Foster et al. 2004; Ozinga et al. 2005). In many instances seed from important veld grasses becomes locally extinct, thus precluding any treatment that does not involve some method of reseeding. Additional factors may include depleted soil organic carbon, depleted soil nitrogen and other essential elements. The role of soil micro-fauna is probably not fully understood yet, but may be critical.

There are several reasons for ineffective dispersal and reproduction by seed, including:

- Reproduction by seed is considered to be less important for veld grass (particularly late successional species e.g. Themeda triandra) in the humid areas of the country where tuft longevity and vegetative reproduction play an important role in survival. In contrast, in the arid areas of the country, reproduction by seed is probably the primary means of survival.
- Many of the climax veld grasses do not produce high numbers of seed and do not have very effective mechanisms of dispersal.
- Seed survival in humid areas is low.
- Dormancy mechanisms in many grass species inhibit germination for up to a year.
- High levels of seed predation during this dormant period consequently inhibit reproduction by seed.

These factors have complicated attempts to re-establish veld grasses on disturbed areas. In addition, there are no readily available commercial sources of veld grass seed, especially as ecotype variations imply that locally harvested seed should be used in rehabilitation. There has also been no real progress in developing techniques for planting veld grass seed economically on a large scale.
As a consequence of this, most rehabilitation projects (at least on mined land) are focused on establishing highly productive pasture grass species with concurrent fertiliser application. While there are many examples of success in terms of getting good cover and productive pastures as outlined above, this has generally come at a high cost and the economics of utilising these pastures is questionable. Ecologically, many of the preferred veld grass species are well adapted to relatively low soil fertility conditions and will not be competitive under high fertility conditions. The pasture systems established and maintained with high levels of fertiliser are not self-sustaining systems, and will run down if fertiliser is withheld. The rundown phase is likely to be characterised by decreased productivity and invasion by pioneer grasses and weeds. Economically and ecologically, it would be preferable to focus on establishing a wide range of veld grass species under soil fertility conditions similar to local undisturbed areas with a view to developing self-sustaining systems.

6. ENVIRONMENTAL IMPACTS

6.1 Overview

Much of the Mpumalanga coal mining area is located within the grassland biome at relatively high altitude and experiencing relatively high, consistent rainfall (in relation to much of the rest of South Africa), making the area one of the primary water catchment areas in South Africa. The area is also used extensively for agriculture, with crops (mainly maize, soybeans, sunflowers and sorghum), livestock (cattle and sheep) and more intensive horticultural crops including fruit and vegetables in certain areas. Crops are dominantly rainfed, but there are significant areas of crops grown under irrigation. There are major irrigation schemes downstream on all the main rivers (Vaal, Olifants and Nkomati) that depend on the rainfall and streamflow from the Highveld. In addition, all three river systems are used for human and industrial consumption as well. Livestock numbers are high in the area because of the high, consistent rainfall and consequent high, stable forage production from both natural veld and cultivated pastures.

The Highveld, comprising high altitude grassland, therefore supplies a range of essential services that are an integral part of the efficient functioning of the country, including water and food supply.

6.2 Water catchment areas

The main catchment areas are the Vaal, Olifants and Nkomati Rivers, and part of the Usutu to Mhlatuze water management area with several significant rivers, including the Usutu and Assegai Rivers (Figure 13).

The Olifants River catchment area comprises approximately 4% of the total mean annual runoff of South Africa (not all of which is on the Highveld or in the vicinity of coal mining activity) and activities in its water management area
contribute slightly more than 5% the country’s gross domestic product (GDP). The Olifants River catchment area faces deficits due to increasing demands, and also faces quality problems. For domestic use, fluoride levels are high. Water quality is occasionally outside the acceptable levels for recreational use due to toxic cyanobacteria (blue-green algae).

Figure 13. Water management areas of South Africa (Source: DWAF).

The Upper Vaal catchment area comprises about 5% of the total mean annual runoff of South Africa. Again, not all of the catchment area is in the vicinity of coal mining activity. The activities in the Upper Vaal water management area contribute about 18% to the country’s GDP). The Upper Vaal catchment appears to be adequately supplied until 2025, based on current projections of supply and demand. Plans are in place to augment the water quantity in future. Sulphate levels at some locations are high for domestic use. Water quality is occasionally outside the acceptable levels for recreational use due to toxic cyanobacteria.

DWAF publications relating to national water resource strategies and water conservation and demand by the industrial, mining and power generation sectors reveal that priorities lie with improving water use efficiency, improving water storage capability, recycling and water quality. While impacts of acid mine drainage (both from underground and opencast mines) are mentioned as a concern, it seems to be a relatively minor problem in extent and can apparently be addressed with suitable technology. There are several success stories where mine water is being successfully and economically treated for domestic consumption. No mention is made of potential impacts of open cast mining on water quantity and quality.
While this may be an area of concern, the opencast mining footprint is a very small percentage of the major catchments, and as such is probably not considered to be a high priority. The actual mining footprint as a percentage of the respective catchment areas is not readily available, but can be inferred from the data relating mined land area as a proportion of municipal areas.

The vegetation of an area is an integral part of the hydrological cycle. It is commonly accepted that diverse grassland, free of aliens, comprises the ideal vegetation for water catchments. Most of the mined land has been planted to pasture, which probably has similar hydrological properties to natural veld (assuming no soil differences). There is a dearth of information on the hydrology of the previously mined areas relative to unmined natural veld and agricultural land, either in the form of cultivated pastures or crop lands.

6.3 Impacts of mining in relation to other land use categories

Apart from the impacts of mining on hydrology, the mining impacts can be separated into the impacts of below ground mining and surface or opencast mining. In addition, indirect or downstream effects can include pollution, acid rain and various other potential sources of impact on biodiversity.

6.3.1 Impacts of underground mining

The underground mining process can, and often does, result in surface subsidence in relatively flat areas where the coal seam is generally parallel to the surface. This subsidence can be up to a few metres. The topography generally stays similar to the original topography, but there may be some subtle differences where for example some pillars have been left underground while the surrounding rooms have collapsed. This can lead to unevenness on the surface where previously the surface may have been uniform. In general, the differences in topography are difficult to detect. This subsidence may have an impact on groundwater by altering drainage patterns. The impacts of this on biodiversity are difficult to quantify and have not been quantified. The impacts on grassland are expected to be less than, for example, the impacts on forest.

Where the topography is steep, the coal seam is usually not parallel to the surface because the seam is typically close to horizontal and the surface is sloped. Here, underground mining often takes the form a small opencast section where the exposed seam is mined from the surface until it becomes difficult to extract the coal using surface mining machinery and techniques. The approach then shifts to underground mining. Where high extraction mining techniques are used in areas steep topography, the collapsing of the mine underground may result in slumping down the slope, and not just surface subsidence. Clearly, this results in physical disturbance at the surface and has a potential impact on vegetation and biodiversity in general. Again, it is difficult to quantify the potential impacts and the extent of the area that could potentially be affected by this slumping.

Underground mining probably has a negligible impact on biodiversity in relation to other land use categories such as agriculture and forestry, bearing
in mind that agriculture and forestry also have infrastructural development that has a permanent to semi-permanent impact on the direct footprint area. Impacts of underground mining are likely to be significantly less than impacts of urban development.

6.3.2 Impacts of opencast mining
The impacts of opencast mining on biodiversity are severe on the direct footprint of the mine, and less so in the immediate vicinity where roads and infrastructure also have a significant impact. Other impacts such as dust are difficult to quantify, but probably do have some effect on biodiversity, particularly during the dry season and for the duration of mine activity. After mine closure, the impacts remain severe for significant periods of time. Some diversity and system function may start to return after a few decades, but information is scanty. The spatial impact is limited to the direct footprint and the temporal impact remains for a long period.

7. DESCRIPTION OF AREA AFFECTED (MPUMALANGA HIGHVELD)

7.1 Vegetation types
Most of the coal fields area on the Mpumalanga Highveld fall within the grassland biome. Apart from its biodiversity (or conservation) value, being second only to fynbos in terms of species richness, the grassland biome provides a range of services which often shape public perceptions of grasslands. Firstly, the grassland biome is generally perceived as comprising croplands and grazing areas. There is a perception that the ‘purpose’ of grasslands is to provide grazing. No other biome is perceived in the same way as having a ‘purpose’. Relating to ecological function, the grasslands provide a range of services, including water provision, flood attenuation, soil stabilisation and carbon sequestration. Social services include agriculture, livelihoods, recreation, tourism and aesthetics. However, aspects like tourism, recreation and aesthetics in the grassland biome are generally considered to be far less important than in other biomes such as savanna, fynbos and even desert. These factors have contributed to grasslands being considered as unimportant from a conservation perspective in the past. Fortunately this perspective is changing. Examples of these old perspectives include the classification of pristine veld on maps as ‘unimproved grassland’ while mono-specific pastures are often classified as ‘improved grassland’. Pristine veld is also often labelled as ‘wasteland’ on maps which have been drawn up for agricultural or other purposes. This irresponsible use of outdated terminology can be seen on many current maps obtainable from government departments, and are used for planning purposes, environmental impact assessments and developing management plans. The uninitiated will be influenced by the terminology.

The vegetation types primarily affected by opencast mining on the Highveld are Moist Clay Highveld Grassland, Moist Cool Highveld Grassland (affected to a smaller degree), Moist Sandy Highveld Grassland and North Eastern
Mountain Grassveld (Low & Robelo 1996). The formal conservation status of these vegetation types is extremely low. The Moist Clay and the Moist Cool Highveld Grassland vegetation types are have no formal conservation areas in Mpumalanga, although collectively they make up about 18% of the surface area of the province. The Moist Sandy Highveld Grassland has 0.67% of its area formally conserved, and it comprises almost 20% of the area of the province. The North Eastern Mountain Grassland comprises about 22% of the surface area of the province, and is the only grassland vegetation type with a reasonable proportion (about 10%) formally conserved. However, most of the conservation areas, including Blyde Canyon, Mount Sheba and Pilgrims Rest areas are far from the areas likely to be affected by coal mining (both present and future mining) which include areas close to Carolina, Piet Retief and the Ekangala Biosphere Reserve near Wakkerstroom (which is not a formal conservation area).

The Moist Clay Highveld Grassland (Bredenkamp & van Rooyen 1996) comprises relatively flat country with soils having very high clay content. The vegetation type is listed as being 79% transformed, but not often ploughed. Acocks (1988) on the other hand states that most of the area (Acocks Veld Type 52) has been ploughed where the soil is deep enough. From experience, all areas that can be ploughed and cultivated have been utilised fully. The balance of the area is used for livestock grazing.

The Moist Sandy Highveld Grassland (Bredenkamp & van Rooyen 1996) is listed as being 55% transformed. Most areas suited to cultivation have been cultivated and the balance of the area is used for livestock grazing.

The North Eastern Mountain Grassland (Bredenkamp, Granger & van Rooyen 1996) is less suitable for cultivation for agricultural crops due to the topography, shallow soils and infertile, acidic soils. Although about 45% has been transformed, much of the transformed area comprises timber plantations.

Clearly, soil type has a significant influence on vegetation, with soil texture (% clay) important (Figure 14).
The rainfall over the whole area under consideration generally ranges from 650 to about 1100 mm per annum and is considered to be one of the areas in the country with the most consistent rainfall (Figure 15). Inter-annual rainfall fluctuations are relatively low. This makes it one of higher potential agricultural areas of the country, both in terms of consistency of crop yields as well as livestock production potential.

Detailed vegetation maps of Mpumalanga have been compiled by the Mpumalanga Department of Agriculture (Figure 16). The classification differs slightly from that of Low & Robelo (1996) and Acocks (1988). The MDA also recognises moisture and soil texture as being the main factors defining vegetation type. Slope has also been incorporated as a defining factor. This is useful when considering land use, as slope is often closely related to erosion potential. Slope is a useful factor when considering mining as a land use category.

The MDA has based its GIS data on municipal boundaries. These reflect the greater areas under control of the respective municipalities and do not reflect only urban areas or the formerly common practice of using magisterial districts to delineate rural areas. The municipalities in the grassland biome of Mpumalanga where coal mining currently takes place or might in future take place are listed in Table 1 (MDA 2006).
Within these municipal areas, the major land use category is natural veld (63%), followed by cultivation (21.5%) and timber plantations (9%) (Figure 17). Urban and built up areas comprise 1.1%. Surface mining comprises 0.86%. The balance comprises rocky area, thicket, water bodies and wetlands. The area calculated for wetlands comprises about 0.2% of the total land area, which intuitively seems low. The total area affected by surface mining in these municipal areas is 36,820 ha (calculated from MDA GIS data). This excludes an additional 2,781 ha classified as mine tailings and waste dumps. The total of 39,601 ha (0.92% of the total area) is close to the approximate figure of 40,000 ha generally quoted as being the area affected by past and current opencast coal mining.

Table 1. Municipalities where opencast mining is carried out.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Main town/city</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albert Luthuli</td>
<td>Carolina</td>
</tr>
<tr>
<td>Delmas</td>
<td>Delmas</td>
</tr>
<tr>
<td>Dipalaseng</td>
<td>Balfour</td>
</tr>
<tr>
<td>Emakha Zeni</td>
<td>Belfast</td>
</tr>
<tr>
<td>Govan Mbeki</td>
<td>Bethal/Secunda</td>
</tr>
<tr>
<td>Lekwa</td>
<td>Standerton</td>
</tr>
<tr>
<td>Piet Retief</td>
<td>Mkhondo</td>
</tr>
<tr>
<td>Msukaligwa</td>
<td>Ermelo</td>
</tr>
<tr>
<td>Pixley Ka Sema</td>
<td>Wakkerstroom</td>
</tr>
<tr>
<td>Steve Tshwete</td>
<td>Middleburg</td>
</tr>
</tbody>
</table>
Figure 16. Vegetation map of Mpumalanga (Source: MDA).

Figure 17. Land use map of the grassland biome in Mpumalanga, showing natural veld (green) and other land use categories such as cultivation, forestry, urban development and mining (black) with municipal boundaries (red) (Source: MDA).
The apparent fragmentation in the land use patterns can clearly be seen in the following images of farmland in the Carolina district (Govan Mbeki municipality) (Figures 18a, b, c).

Figure 18(a). Image of the Carolina district, Govan Mbeki municipality, showing various categories of land use. The red colour indicates timber plantations. Carolina town is near the centre of the image. The areas outlined in yellow are shown in (b) and (c) (Source: MDA).

Figure 18(b). Close up image of the area immediately north east of Carolina (seen in the bottom left corner of the image) highlighting land use fragmentation (Source: MDA).
Interestingly, the area of cultivated pastures within these municipality boundaries is calculated as 0.04% of the total land area using the MDA GIS data. This figure is thought to be an underestimate, because of the similarity between certain pastures and natural veld in terms of cover and spectral reflectance. There are no other figures readily available to produce more accurate figures on cultivated pasture area. However, even allowing for an underestimate, what does emerge is that the proportion of cultivated pastures relative to natural veld is very low. This confirms personal experience and the experience of several MDA officials and advisors (both present and past) who were questioned. The implications of this are that cultivated pastures do not currently comprise a major component of most animal production systems on the Highveld. This reinforces the contention outlined above that cultivated pastures on rehabilitated mined land are not economically viable for livestock production systems under normal conditions.

The erosion potential is critical to conservation of biodiversity and influences the success of stabilising and rehabilitating opencast mines. Erosion potential is influenced by various factors, such as rainfall, rainfall erosivity (raindrop size and rainfall intensity), soil type, slope and vegetation type and cover, among others. Currently, most of the existing mining operations are located in areas of relatively flat landscape (Figure 19) and relatively low erosion potential (Figure 20).
It is well known that the grassland biome is under-protected in relation to the proportion of conserved areas in other biomes. The grasslands of Mpumalanga are probably the least protected of the least protected biome in South Africa.

7.2 Land use impacts on biodiversity

Current land use on unmined land, as well as land use prior to mining on existing mined land is largely crop and livestock farming. In practice, east of the 30° longitude line (which runs through Ermelo), higher rainfall, lower soil fertility and soil acidity result in a decline in proportion of cultivated land for crops and an increase in timber plantations. Timber is generally a long-term land use, and most of the land area planted to timber has been under timber for many years, often several rotations, and is likely to stay under timber at least in the medium term. Current economic conditions dictate that timber is more profitable than most crop farming enterprises and certainly more profitable than livestock farming. Returns from intensive, irrigated crops and intensive, irrigated dairy systems may rival returns from timber, but timber is likely to outperform dryland crops, particularly in marginal cropping areas where soil fertility is low and soil acidity limits crop growth. It is well known that establishment of timber plantations in extensive agricultural areas generally results in a significant increase in land prices.
West of the 30° longitude line there is an increase in proportion of land cultivated for crops, which include maize, soybeans, sunflowers, sorghum (on the high clay content soils around Standerton), with a few other minor crops utilising small areas. The major crop is maize. In many areas, maize is planted on the same land year after year, and has been for decades in some cases, with no rotation or fallow periods. In general, this leads to a decline in soil organic matter and probably leads to a decline in soil fauna. Such practices certainly exhaust the soil seedbank of any seeds apart from weeds.

Both agricultural crops and timber plantations have a profound impact on biodiversity, both while they are being grown as well as after production stops. In areas where crop or timber production has ceased, for economic or other reasons, natural grassland does not regenerate, as outlined above. The impacts of crop and timber production on biodiversity last for a long time. Natural grassland used for grazing livestock, on the other hand, usually retains a reasonable level of diversity. Even where areas are relatively degraded through inappropriate grazing management, experience indicates that when remedial action is taken, natural re-establishment of indigenous species can occur relatively quickly. Obviously, where degradation of natural grassland has progressed to the point of significant loss of diversity, then natural restoration of diversity can be extremely slow. Significant loss of biodiversity does often occur when a particular grass species, such as *Aristida junciformis*, becomes dominant and is able to maintain its dominance irrespective of management changes.
The impacts of land use on biodiversity can be considered in terms of landscape composition, landscape structure and ecosystem functioning (O’Connor & Kuyler 2005). Of the above land use options, they listed timber plantations as having the greatest negative impact on biodiversity, followed by crop farming. These impacts are mainly a result of transformation and fragmentation, both of which are elements of landscape structure. Livestock production was found to have a slight negative impact on biodiversity relative to the conservation benchmark.

The report by O’Connor & Kuyler (2005) gave a general overview of land use impacts on biodiversity. On the Mpumalanga Highveld, livestock and crop farming are possibly more closely coupled than in other areas of the country. Historically, livestock farming on much of the Highveld (particularly the more eastern and southern areas) was based on a system of moving cattle and sheep between the Highveld for summer grazing and surrounding lower lying areas, including Swaziland, for winter grazing. This practice was common until the middle of the last century, when political changes in Swaziland, coupled to the growth of the timber industry, precluded the practice. At the same time, crop farming was increasing in extent on the Highveld, particularly in the western areas. This increased the amount of crop residues available for wintering livestock in what is a sourveld area. The livestock production systems on the Highveld are typically adapted to the amount of crop residues available for winter feed. East of the 30° longitude, shortages of winter feed constrain livestock production and stocking rates. Many farmers in the eastern areas are primarily livestock farmers, and sustainable veld management is considered important. West of the 30° longitude line, the abundance of crop residues for winter feed in most cases results in a shortage of summer forage (veld) constraining livestock production. This commonly results in relatively high grazing intensity on the veld during summer. Considering that in these areas, the only veld that has not been ploughed comprises wetlands, shallow soils, rocky areas or steep slopes, there is a real potential for degradation induced by excessive grazing pressure. Many of the farmers in the western areas are primarily crop farmers who derive their main income from crops. Livestock are a secondary enterprise, and the importance of sustainable utilisation of veld is probably a secondary priority because it provides a secondary source of income. Obviously, the 30° longitude line is used for convenience, and should be considered a ‘soft’ boundary between the two scenarios. Realistically, there will be a gradient between the extremes of livestock production on farms with no croplands (or a very small proportion of the total farm area comprises croplands) in the east, and livestock production on farms where veld comprises a small proportion of the total farm area in the west (Figure 21).

Two comprehensive surveys of veld condition have been carried out on the Highveld. Rethman & Kotze (1986) surveyed 738 sites representing 1.4 million ha in the eastern and southern regions of the Highveld. They concluded that the veld was ‘in a parlous state’ in terms of species composition (grass species), cover and vigour. This was reflected in low estimates of grazing capacity. While they did not directly assess species diversity, it is interesting to note that many areas assessed as degraded were
dominated by single or a few grass species, including *Aristida* species, *Rendlia altera* and *Eragrostis* species. Veld regarded as being in good condition generally comprised a wider range of grass species.

Barnes (1990a; 1990b) surveyed 112 paired (grazed and adjacent ungrazed) sites. The ungrazed sites were typically located in undisturbed road or railway reserves, not grazed regularly but burnt regularly. The grazed sites were located on adjacent farms. The ungrazed sites clearly had a higher grazing capacity than the grazed sites, suggesting that the grazed sites were showing some signs of compositional change, confirming Rethman & Kotze’s (1986) study. In undegraded sites, soils with high clay content were found to be dominated by relatively few species, while sandy soils had a more diverse composition. Of particular interest is the observation that grazing capacity declined with decreasing soil pH. Barnes (1990b) pointed out the potential impact of declining soil pH as result of acid rain on the grazing capacity of the Highveld. Degradation was described in terms of dominance of certain species, such as *Rendlia altera*, *Loudetia simplex* and *Eragrostis plana*. Again, although diversity was not directly measured, perusal of the data reveals that as veld condition and grazing capacity decline, the species composition becomes characterised by the dominance of a few species. From experience, when the above species dominate an area as a result of inappropriate grazing management, they tend to persist even if grazing
animals are withdrawn. Also from experience, the diversity of non-grass species declines when the grass species listed above dominate.

From the evidence outlined above, it appears that on parts of the Highveld, particularly the western areas, livestock grazing on veld may have had a greater impact on biodiversity than suggested by O'Connor & Kuyler (2005), although its position relative to the impact of other land uses such as timber plantations and crop farming remains the same. It is probable that the veld on the western parts of the Highveld is in a relatively poor condition compared to the humid grasslands of KwaZulu-Natal, for example. On the positive side, sheep numbers on the Highveld have declined dramatically in recent years due to stock theft and low wool prices. It is well known that cattle have a lesser impact on veld than sheep and it would be useful to ascertain whether there has been any improvement in veld condition as a result.

It seems reasonable to assume that biodiversity has been seriously compromised over most of the western parts of the Mpumalanga Highveld, largely due to crop and livestock farming, with the impact of livestock due to the close coupling between crop and livestock farming in this area. In the eastern parts of the Highveld, including the escarpment, timber is the main land use impacting biodiversity. In the eastern, central and mountainous southern parts of the Highveld (in the Wakkerstroom vicinity), it is probable that the impact of livestock on biodiversity is relatively lower than in the western parts.

Based on the above, the impacts of opencast mining can be assessed in terms of landscape composition, landscape structure and ecosystem functioning (using indicators outlined by O’Connor & Kuyler 2005) relative to the three major land use categories on the Highveld, namely livestock production, crop farming and timber plantations.

### 7.3 Landscape structure

The impacts of mining on landscape structure are complex relative to the other land use categories. Firstly, the landscape is totally transformed under the direct footprint of the mining operation. The extent of transformation in terms of land area is relatively small compared to crop farming, timber production and urban development. The direct opencast mining footprint within the municipalities listed above is less than 1%, although obviously the proportional area directly within the coalfields area is greater. The concentration of mining operations in a relatively small area creates a significant visual impact. It is difficult to quantify the indirect effects of opencast mining on the transformation of the landscape structure in adjacent areas. Opencast mining contributes to fragmentation of the landscape, although in the western parts of the Highveld the landscape is already fragmented to a great degree as a result of crop production. The fragmentation caused by opencast mining is different to that created by forestry and crop farming, in that opencast mining is continuous and generally unaffected by wetlands, soil depth and other irregularities in the landscape. Crop farming and timber plantations usually have corridors along
watercourses and wetlands, and also usually surround patches of land unsuitable for production purposes. Crop land and timber plantations are likely to exhibit a greater degree of connectivity. Rehabilitated mined land is generally similar in terms of physiognomy to natural grassland (both in space and time), while crop lands are different and vary seasonally. Timber plantations are significantly different to all other land use categories.

7.4 Ecosystem functioning

The natural grassland on the Highveld has been shaped by fire and grazing, both of which play a major role in nutrient cycling. Rehabilitated mined land is generally not burnt or grazed to any significant degree at present. The pasture systems commonly established on mined land are usually fertilised and cut for hay, which is removed. It seems probable therefore, that nutrient cycling on the rehabilitated land will be significantly different from that of natural grassland. Grazing patterns on natural grassland are usually discontinuous, leading to spatial and temporal patchiness. Pastures on rehabilitated land are commonly all of similar length and treated in a similar manner, leading to spatial and temporal uniformity. Hydrological functioning on the Highveld is important both for maintaining ecosystem integrity as well as for providing water for human consumption in the various catchments. Opencast mining clearly impacts hydrological functioning, both during the mining operations that can last for decades in a particular area, as well as after mining, where the rehabilitated areas will function differently to natural systems. Wetlands are often the first area mined when a new opencast mine is opened. Economically, wetlands are relatively cheap to mine. Coal seams are typically horizontal, and wetlands are the lowest point in the landscape, and thus closest to the coal seam and the strip ratio is low. The quickest way for a mine to start generating a financial return to offset the high start-up costs is to first mine the cheapest coal.

The mining is likely to impact water quality and quantity because of altered patterns of infiltration, drainage and groundwater movement. Indirect effects on adjacent areas are not easily quantified. In addition, underground mining also affects hydrological functioning, particularly in terms of water quality. The other main land use categories, crop farming and timber plantations, also significantly affect hydrological functioning, and have a much larger footprint in relation to opencast mining. Rehabilitated mined land is potentially an erosion hazard, depending on factors such as slope and vegetation cover. Again the direct footprint is relatively small, compared to crop farming and timber plantations, both of which contribute significantly to soil loss. Most of the current opencast mines are on relatively flat areas with low erosion potential. Productivity of rehabilitated land is difficult to assess relative to natural grassland. There is no doubt that in the absence of fertiliser, productivity of the rehabilitated land would be below that of natural grassland. With suitable fertiliser applications, productivity is generally above natural grasslands.
7.5 Landscape composition

Crop farming and timber plantations directly impact certain habitats and indirectly impact others such as wetlands. Livestock farming generally impacts all habitats to a greater or lesser degree. In the western parts of the Highveld, livestock impact on wetlands is probably greater than the impact on wetlands in other areas, largely due to the strong coupling between crop farming and livestock outlined above. Opencast mining directly impacts all habitats under the mining footprint and probably indirectly affects habitats like wetlands in the immediate vicinity.

The impact of opencast mining on plant and animal species is drastic. The composition of the rehabilitated areas is reduced to a few plant species. Animal diversity is consequently reduced dramatically under the direct footprint area, and to a far greater extent than any other land use. The potential for alien plant invasion on rehabilitated areas is high, as it is on crop lands and timber plantations. In general the Mpumalanga Highveld has significant alien plant problems. The existing aliens tend to spread onto the rehabilitated mined land. It is important to notice that the alien plants affecting mined land are already locally present.

7.6 Mining impact

Opencast mining clearly has a drastic and long lasting effect on biodiversity. This must be viewed in the context of its relatively small footprint, and the impacts of the other main land use categories and their respective footprints. Probably because of the small mining footprint, the Mpumalanga State of the Environment Report (2001) makes no mention of opencast mining being a threat to biodiversity. Approximately 40 000 ha have already been impacted by opencast mining, with estimates of another 40 000 ha potentially available for opencast mining in future. The figure of 40 000 ha of potentially available opencast mining area is a tentative figure and should be treated with caution. As mentioned above, several factors contribute to the decision on whether to mine underground or opencast. Economic factors play a role, and if the coal price in relation to input costs (including cost of diesel) changes then previously unviable seams may become viable. Once the projected 80 000 ha has been mined, the total area will comprise close to 2% of the municipal districts affected by mining.

Underground mining has a lesser, probably immeasurable, impact on grassland biodiversity. Surface subsidence and possible changes in drainage patterns and groundwater movement are expected to have little impact on indigenous grassland vegetation. The area on the Highveld undermined is greater than that affected by opencast mining. Obvious measurable impacts of underground mining include infrastructure and roads. These cover relatively small areas.
7.7 State of the environment
The Mpumalanga parks Board has compiled a biodiversity assessment of the province which lists protected areas, areas that are irreplaceable, highly significant areas, important areas, areas of least concern and areas where no natural habitat remains (Figure 22).

Figure 22. Biodiversity priority map for Mpumalanga.

Aquatic biodiversity has also been assessed (Figure 23). From these two maps, there seems to be a reasonable degree of coincidence between
terrestrial and aquatic biodiversity priorities. Areas around Wakkerstroom and Carolina stand out as being priority areas in the coalfields area.

Figure 23. Aquatic biodiversity priority map for Mpumalanga (source: MPB).

The area in the vicinity of the 30° longitude line and immediately east of this line over the extent of the grassland biome in Mpumalanga stands out as being an important belt with a high proportion of irreplaceable, highly significant and important terrestrial biodiversity habitats. It also has a high proportion of irreplaceable, highly significant and important catchments.

Development applications process by the Mpumalanga Parks Board between January 2005 and February 2006 reveal a spatially wider spread of prospecting and mining applications in relation to the position of the main coalfields and mines operated by the major companies (Figure 24). These prospecting and mining applications do include mining other than coal. Coal mining activities do, however, comprise the majority of applications (Figure 25). The number of applications and spatial area affected by the applications reflects the large number of applications by small companies reported earlier. This reinforces the perception that development of small mines over a wide area, away from existing mining areas, poses a threat to biodiversity conservation.
Figure 24. Development applications received by Mpumalanga Parks Board between January 2005 and February 2006 (source: MPB).

Figure 25. Outline of the types of development in the development applications received by Mpumalanga Parks Board between January 2005 and February 2006. Coal related activities are indicated in red (source: MPB).
7.8 Non-governmental organisations

The Highveld areas affected by mining has not been a conservation priority area in the past for many reasons, relating mainly to the significant agricultural impacts on biodiversity, and the distinct lack of romanticism associated with flat grasslands (no big five) which lowers tourism potential.

Tourism is often a strong driver of conservation. Of the major non-governmental conservation bodies in South Africa, both the Endangered Wildlife Trust (EWT) and the Wildlife and Environmental Society of South Africa (WESSA) are involved in the area to a limited extent. EWT is concerned with conservation of endangered species, which in the grassland biome include oribi, cranes and blue swallows. WESSA has a branch in Mpumalanga based in Nelspruit, and most activities have been focused in the Lowveld to date. However, WESSA now has a small branch office in Witbank, and has started to become directly involved with opencast coal mining issues. Both organisations recognise the potential impacts of coal mining on biodiversity, and see it as an important issue that needs attention.

8. CORPORATE MINING APPROACH TO BIODIVERSITY

Interviews were held with staff members at various levels from most of the bigger mining houses as well as with representatives from COALTECH 2020, CSIR MININGTEK and the Chamber of Mines (COM) in order to gain insight into the corporate approach to biodiversity. Detail from each interview will not be presented. Rather, a global overview, highlighting strengths and weaknesses, is more appropriate for this report.

Worldwide, coal mining and the industries utilising coal (and other fossil fuel) products have a bad reputation. There is a large public awareness that the coal industry is a ‘dirty’ industry. All of the major mining houses active in South Africa are acutely aware of this negative public image. All of the major mining houses have significant global links, either by being owned entirely by international, overseas based companies, by being listed on overseas stock markets, or by significant levels of investment by international companies. International investors are particularly sensitive to environmental concerns. As a result of the poor image and the growing international pressure, these major mining houses operating in South Africa are serious about environmental aspects and are aligned with international practices to a greater or lesser degree, depending on the company. Some of the companies are ahead of others, but all seem to be moving in the same direction at the moment.

Most of the multinational companies seem to adopt the principle of the ‘triple bottom line’, where financial profitability is aligned with social and environmental considerations (Figure 26). Reporting is focused on all three aspects, and this is very obvious when perusing corporate reports from these companies. For this triple bottom line approach to function effectively, the operating environment controlled and influenced by government at national,
provincial and local level has to function effectively. This is particularly important for an effective focus on social and environmental aspects. This ‘triple bottom line’ approach is closely allied to the four pillars of sustainable development commonly referred to; being social equity, environmental protection, economic development and the formulation of effective governance structures.

It also becomes obvious that if the triple bottom line approach is going to be effective, then all three legs have to be strong, and have to be allocated enough resources within the company to be able to function effectively. Resources for social and environmental programmes obviously come from the financial leg. In general, it seems as if there are strong links between the social and environmental responsibility of companies, irrespective of their size. Those companies with poor safety records, poor employer/employee relations and poor or non-existent social programmes will also have poor environmental records, and vice versa. In the coal mining sector in South
Africa, the bigger companies have a stated triple bottom line approach which can be seen from annual reports, mission statements and other social or environmental support programmes. Smaller companies, however, generally have a financial focus with much less of a focus, if any, on social and environmental aspects.

It is clear that many of the bigger companies have developed their own environmental practices and standards that are in line with their international holding companies, owners or investors. These standards are often higher than those currently prescribed by law in South Africa. This obviously comes at a cost, and gives smaller companies a financial advantage.

The environmental approach that most of the bigger companies follow has changed significantly in recent years, and is continuing to adapt to new ways of thinking about biodiversity and environmental responsibility. As outlined above, early approaches to rehabilitation were focused mainly on restoring some agricultural land use function without much regard for the concept of biodiversity. However, in recent years biodiversity conservation has become recognized as being a critical component of development.

This has led to changes in the approach of most big businesses, including mining. In particular, the major mining companies in South Africa seem to have no desire to avoid environmental problems and accept responsibility for environmental issues. However, smaller companies are not subjected to the same international pressures and pressure from shareholders. Smaller companies also tend to have less expertise and resources available for addressing environmental issues. In general, smaller companies also tend to have worse safety records and do not address social responsibilities to the same extent as the major companies.

The current business approach adopted by major companies is to manage risk. Risks can be classified as events or issues that would affect shareholder perceptions and public image. Important risks include all social aspects including safety, health, human resource management etc., and environmental issues, including pollution and biodiversity, among others.

A typical approach to managing biodiversity as a risk by a multinational company would be to develop and formulate a commitment, develop policies and then implement strategies. Targets and performance criteria will then be used to measure performance.

At an operational level the mining process is divided into four distinct phases. Phase 1 comprises the exploration process, where biodiversity issues are highlighted up front. At this stage engagement with government departments facilitates decisions on the process. Phase 2 comprises the design phase. Phase 3 comprises the operational or mining phase and phase 4 comprises the mine closure process.

Biodiversity action plans are typically drawn up after phase 1, following a risk based approach to determine potential impacts on biodiversity. Biodiversity
sensitivity analyses are conducted in conjunction with specialists. Action plans are developed for sites that are sensitive. At all stages risk to the company is considered.

The companies vary in terms of their stage of implementation, their commitment and capacity to implement biodiversity strategies in several ways. Several companies have implemented comprehensive biodiversity plans and are already reporting on progress in their annual reports. Others are in the process of implementing plans by starting baseline biodiversity surveys on mine owned properties and implementing a reporting process. Where EMPR’s previously did not address issues specific to biodiversity, most EMPR’s now have specific procedures outlined for assessing and addressing issues related to biodiversity. In many cases, these procedures are developed in collaboration with international partners or owners and go beyond current legislation in South Africa. Some companies have developed biodiversity awareness campaigns for their employees and have integrated biodiversity awareness into their induction programmes for all new employees and contractors. These campaigns highlight the concept that biodiversity goes beyond rehabilitation of the opencast mines. In general, assessments and monitoring programmes were restricted to rehabilitation sites, but now generally include all the property owned by the mine, including areas that will never be mined. These monitoring programmes often include using annual orthophotos at a high resolution to monitor change. Several companies used to only report on the state of their mined land rehabilitation, and ignore the additional land that they own and manage. Most now report on all land that they own. This can be viewed as both positive and negative. On the positive side, biodiversity assessments are being carried out on a greater area, and monitoring takes place on a greater area. A possible negative side is that the impact of the mining operation on the mining footprint area may be masked when considering the state of biodiversity on the whole property, depending on how the report is structured.

Some of the companies have sound strategies in place, but lack capacity and sometimes the will to implement strategies. Each company has a different structure in place responsible for biodiversity, environmental issues and rehabilitation. In many cases, environmental issues include pollution, waste management and similar issues that are important, high risk and require significant resources and attention. Waste management and pollution related issues usually require urgent and ongoing attention. This dilutes the focus on biodiversity and rehabilitation related issues. In some cases, the persons responsible for implementing strategy do not get full support from top management, unless there is high level of risk, for example bad publicity. While all the major companies have good policies and have an apparent focus on biodiversity, some appear hold back on actual implementation (don’t put their money where there mouth is). As an example, it is highly likely that cattle grazing has a significant positive impact on rehabilitated mined land. The cost of rehabilitating opencast mined land to pasture ranges from R200 000 to R250 000 per ha, depending on the depth and topography, among other factors. Few companies will invest an extra few thousand Rand per ha (a small percentage of the total cost) for fencing so that the land can be grazed.
One of the requirements for the ‘triple bottom line’ approach to function effectively is good governance at national, provincial and local level. Opinions regarding the capacity of the government to provide a suitable environment vary. Most of the major mining companies feel that government is sometimes a hindrance to progress rather than assisting progress, and that the various government departments at all levels lack capacity to deal effectively with issues related to biodiversity. In particular, several people interviewed implied that the government was more concerned with applying the letter of the law rather than exploring different options, which could potentially be more beneficial.

The major companies tend to view small mines and small mining companies as a risk in the sense that smaller mines often have poor safety records, poor social responsibility and also have poor environmental records. Smaller companies, in other words, do not follow the ‘triple bottom line’ approach (this is a generalisation, and there may obviously be exceptions). This potentially damages the reputation of the coal mining industry as a whole. In addition, many of the bigger companies spend substantial amounts of money on safety, social responsibility and environmental issues, while the smaller companies tend to avoid that expenditure. It seems to be a general trend that many of the smaller mining companies don’t send representation to meetings involving environmental issues and it can be consequently assumed that they often don’t adhere to standards.

Many of the major companies are ISO14001 certified or have other methods of auditing their environmental impact. While this is positive, the ISO14001 Environmental Management System is not perfect. It is seen as strong on ‘brown’ issues related to pollution and consumptive use, rather than ‘green’ issues related to conservation (Lotter & Phelan 2005). Strict compliance and good auditing reports may not mean much when considering biodiversity impacts.

All the major companies interviewed expressed a desire to collaborate with other role players on the issue of biodiversity, provided there is adequate coordination and structure to the collaboration.

9. OPPORTUNITIES FOR ENHANCING BIODIVERSITY IN COLLABORATION WITH MAJOR COMPANIES

9.1 Overview
The Chamber of Mines (COM) is an umbrella organisation representing most of the large mines. It probably represents about 80% of mining in South Africa. Its main function involves lobbying and advocacy between its members and government, Non-Governmental Organisations (NGO) etc. The bigger mines have direct representation, while small-scale mines collectively have group representation. This limits the effectiveness of the COM as a conduit for
liaising with small mining companies. The COM is structured with commodity committees, including a collieries committee. The Chief Executive Officers of the member companies are members of the committees.

The COM has been quite proactive in becoming involved with biodiversity issues, with the biodiversity forum (run by a steering committee), links with IUCN and involvement with the ICMM best practice guidelines. The COM brought out a re-vegetation guideline in 1970, which is currently being rewritten. Incidentally, the fact that the 1970 guidelines are only now being rewritten is a reflection of the changing attitudes and approach to environmental concerns, with biodiversity increasingly becoming a priority.

The COM is in a position to influence mining companies in terms of policy and strategy, and can also play a role in liaising with government. In essence, the role of the COM can be described as managing risk on behalf of its members.

There are many opportunities for potentially enhancing biodiversity of land owned by mining companies, which comprises surface mined land, undermined land and land that has not been mined and will never be mined. In most cases, the surface mined land comprises only a small proportion of the total area owned by the company. As an example, Sasol’s Syferfontein Mine is a property of approximately 4000 ha. The opencast mine comprises about 700 ha. An additional area of approximately 300 ha is utilised for buildings, infrastructure and roads. This means that approximately 1000 ha of a total of 4000 ha (25%) is directly affected by mining. The unmined 3000 ha comprises natural veld and old lands. There are obvious opportunities for both management of natural veld in a manner that would benefit biodiversity, as well as opportunities for rehabilitation of old lands in an attempt to increase biodiversity. Restoration of old lands to a level of increased diversity should be easier than attempting to restore diversity on mined land. While the example and areas quoted are for Syferfontein, many mining companies have large land holdings that are not mined.

Policies regarding land ownership differ between companies, with some companies purchasing surrounding farms, while others only purchase the land to be mined and a servitude to ensure access. The latter scenario has farmers owning land close to mining operations and on land being undermined. It seems that the there is an increasing tendency for companies to purchase farms being undermined and farms likely to be affected by mining. This means that the major mining companies are likely to increase land holdings.

In general, the major companies are positively disposed to the concept of biodiversity offsets (as defined in ICMM 2005), but are at the same time cautious. When considering the concept of offsets from a risk perspective, then any planned offset carries a high level of risk unless it forms part of a permanent conservation strategy at national or provincial level. The risk involves an offset area not being managed after the particular mining company has moved on, because the companies name and reputation may be compromised if an offset area is not maintained. If, however, a national or provincial government department takes responsibility for an offset area as
part of its conservation strategy, then the risk is lowered substantially. Probably the biggest hurdle to significant company investments in offsets is ensuring the long term sustainability of an offset area. Certain companies have already become involved with offsets, such as Anglo Coal’s wetland rehabilitation project at Isibonelo Mine near Trichardt. Certain companies mentioned the possibility of abuse where rehabilitation responsibilities may be neglected in favour of inputs to a high profile offset area.

There are a few areas where offsite offsets could be important. Firstly, the area in the vicinity of the 30° longitude line and slightly to the east of that line lies between the major cropping areas and the major forest areas and has large areas of natural veld that are currently used for livestock grazing. From experience, the veld condition and vegetation diversity in these areas is reasonable. Secondly, the areas around Wakkerstroom (Ekangala Biosphere Reserve) also comprise large areas of natural veld that are also in reasonable condition. Neither of these areas is pristine, with alien species being an obvious concern. Both of the areas are important water catchment areas. Thirdly, the Moist Clay Highveld Grasslands are unique, highly transformed, have no formally conserved areas, and yet are not classified as high priority on the Mpumalanga Parks Board priority map. Some form of offset conservation area, possibly on mine owned land, may contribute to conservation of this vegetation type. The Mpumalanga Parks Board is not likely to get the resources to be able to purchase land in under-conserved vegetation types. Their current approach is to rely on conservancies and cooperation with private land owners to develop conservation of under-conserved vegetation types. The view of ecologists in the Mpumalanga Parks Board is that offsets may be positive in terrestrial systems, but that wetlands are irreplaceable.

One of the important issues about offsets is the acceptance by mining companies that they have to make a significant contribution to biodiversity conservation and that this contribution goes beyond some form of rehabilitation of the direct area affected by mining. However, again only the major companies are likely to contribute towards offsets, while the small companies are not likely to become involved.

Other potentially important offsets include localised wetlands and specialised habitats for endangered fauna and flora.

Three other, possibly unique, ideas related to the concept of offsets may be worth considering. Firstly, the proliferation of small mining companies and small mines is potentially a threat to biodiversity because of a lack of capacity, both financial and expertise, to deal with biodiversity issues. Some form of partnership between big and small companies may contribute towards overcoming the potential threat to biodiversity. This implies that big companies would have to invest some resources (financial and human) offsite in assisting small companies. It is one way of managing risk where that risk is the public image of the coal mining industry as a whole, and not just the profile of a particular company. It also contributes towards social and environmental responsibility.
The second idea relates to attempting to restore some measure of diversity to degraded land on mine owned property (such as old crop lands) that was degraded prior to the mining. It is highly likely that it is easier to restore some diversity to old lands, as an example, than mined land. Provided there is some long-term future for the restored areas, the contribution of a more diverse cover on old lands could contribute significantly to offsetting the impact of mining. In particular, the Moist Clay Grasslands may benefit from this approach. From experience, many of the late successional grass species do colonise disturbed areas over time on heavy, clay soils to a much greater degree than on sandy soils.

The third idea relates to collaboration between the major mining companies. Several mines are already run as joint ventures between companies. It seems feasible for companies to collaborate formally in establishing offset areas, either offsite or across properties owned by different mines but geographically contiguous. This is an issue that could and should be explored, particularly in areas of importance such as corridor areas.

An important consideration of offsets is to first avoid and minimise any damage to biodiversity before considering offsets. In the case of opencast mining, it may be prudent to add that rehabilitation should go beyond stabilisation as well.

A further important point for consideration relates the existing biodiversity status of the areas already mined and in potential mining areas. The fact that the biodiversity status has been significantly compromised by previous land use practices should not be used as an excuse for sub-standard rehabilitation practices or downgrading the importance of biodiversity conservation in the area. Rather, it should serve as a motivation to attempt to enhance the biodiversity status of the area.

**9.2 Market pressure**

In many of the more mature overseas mining markets, environmental issues play a significant role. There are several examples where companies with a good environmental track record become preferred suppliers, because the purchaser wishes to be seen to be environmentally responsible. In South Africa, more than 90% of coal is purchased by ESKOM and SASOL (including coal produced in-house), or exported. The export market (mainly Europe) should be a mature market and may gain significant benefit from exerting environmental pressure on its suppliers. Within the local market, SASOL could probably exert some influence on environmental issues, but most of the coal used is cycled in-house. ESKOM probably has the potential to have a major influence on the market by exerting environmental pressure. Currently, there is no environmental pressure in the market that is evident.
10. ROLE OF THE NATIONAL GRASSLANDS BIODIVERSITY PROGRAMME (NGBP) IN ENHANCING BIODIVERSITY CONSERVATION IN THE COAL MINING AREAS OF MPUMALANGA

Grasslands provide a range of ecosystem services which are of great benefit to the country’s economy and the well being of its citizens. However, the resultant economic development is a threat to the existence of the grasslands. Mining is essentially unrelated to the biome, but potentially has high impacts locally, with resultant development spreading the impact. Agriculture, forestry, mining and other land use categories that impact grasslands each have their own (usually economic) goals. Environmental issues and biodiversity are often considered important, but are not always dealt with effectively for a range of reasons, including:

- Lack of capacity (in government and private sectors)
- Lack of information
- Lack of direction
- Fragmentation of expertise among government departments
- Lack of co-ordination
- Lack of easily implemented standards
- Lack of real motivation to invest in conservation of biodiversity.

Any industry that impacts on biodiversity has a legal and moral obligation to minimise and mitigate the impacts of their activities. The reasons for inactivity listed above should form the focus of the NGBP efforts.

These issues are all aspects that could be effectively addressed by NGBP playing a leadership and facilitation role in the following ways:

- Lack of capacity:
  - Publicising the sort of expertise needed.
  - Developing some qualification standards for government departmental officials and mine environmental staff.
  - Developing short courses for departmental officials and mine environmental staff.
  - Provide specialist input to determine significance of biodiversity issues.
  - Fulfil the role of an independent third party in assessing sensitivity of areas and mitigating actions to be taken.

- Lack of information:
  - Collating and distributing relevant information in mining circles, as well as among provincial conservation and agricultural staff.
  - Promoting research in relevant areas, such as restoration ecology.

- Lack of direction:
  - The concept of biodiversity has been well publicised, but remains a nebulous concept for many people outside of conservation circles. Providing direction and clarifying issues is essential.
• Raise awareness within the industry, and particularly among purchasers who are in a position to influence the market.
• Raise awareness within government departments.
• Fragmentation of expertise among government departments:
  o Most government departments, both national and provincial, lack capacity. Assistance and advice to government departments is essential.

• Lack of co-ordination:
  o The attempts by COM to coordinate biodiversity conservation issues is a step in the right direction, but the COM does not have the expertise in biodiversity conservation, and they directly represent the mines, who are their members, and they are thus not an impartial third party.
  o Progress by the COM has been slow to date.
  o Coordination and liaison with NGO’s such as Endangered Wildlife Trust and the Wildlife and Environmental Society of Southern Africa.

• Lack of easily implemented standards:
  o The legislation is vague in regard to detail and gives guidelines rather than standards to be adhered to.
  o Reviewing and monitoring the approaches and practices followed by mining companies can create ‘best practice’ standards by selecting strong points from the various companies.
  o This can serve to raise the bar and effectively influence companies to raise their environmental standards.
  o This can also influence the environmental standards that smaller companies will need to follow.

• Lack of real motivation to invest in conservation of biodiversity.
  o The only way that any commercial enterprise will willingly invest money in anything is if there will be a return on their investment.
  o Probably the most important role for NGBP will be to promote business reasons for investing in biodiversity conservation.

Several opinions were expressed regarding the potential role of NGBP and SANBI. Firstly, all the major companies feel that they have developed suitable policy, strategies and performance indicators to enable them deal with biodiversity issues effectively. These have been developed in line with international standards and apparently go beyond what is required in South Africa in some cases. Consequently, the role of NGBP is seen in this context as functioning at a review level and fulfilling a monitoring role as its primary function, with the points listed above being important. In addition, NGBP will be well placed to provide links to the other land use categories such as agriculture and forestry in a coordinated manner. In particular, NGBP could provide impetus to furthering the investigation of significant biodiversity offsets within the industry, and possibly linking to other land use categories as well.

Probably the most important function for the NGBP is to provide leadership, in the form of a “biodiversity champion” in a balanced and objective manner to
ensure respect for biodiversity issues within the coal mining industry while establishing and maintaining strong links with other land use categories.
11. ACKNOWLEDGMENTS AND LIST OF PEOPLE INTERVIEWED

Many people from a range of organisations listed below kindly gave up their time to contribute to this report. Their contributions are gratefully acknowledged. Mathieu Rouget kindly assisted with overlaying maps of coal mining areas onto biodiversity priority base maps.

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12. REFERENCE LIST


Department of Water Affairs and Forestry www.dwaf.gov.za


Mpumalanga Department of Agriculture, Nooitgedacht Agricultural Development Centre, Ermelo, Mpumalanga.


